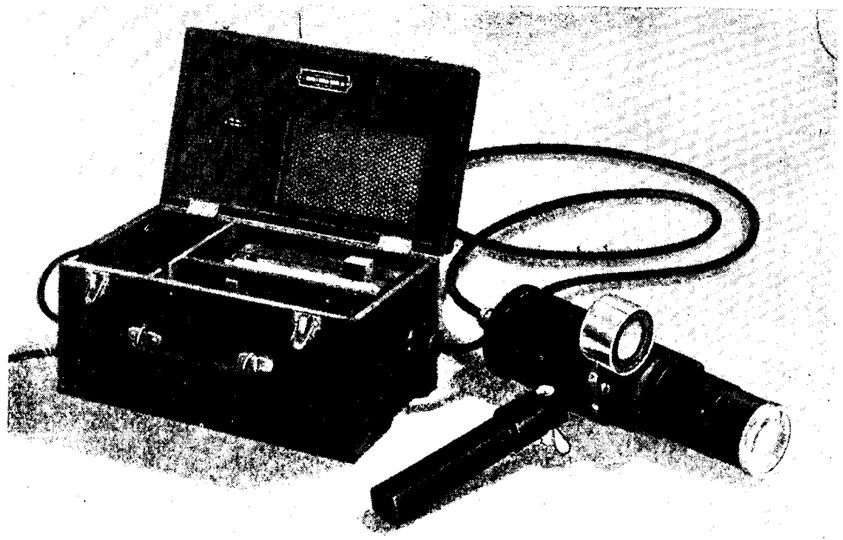
The Indian Journal of Surgery

Vol. XX] FEBRUARY 1958 [No. 1

HAND OPERATING LAMP



For use on 220 volts A.C. or D.C. mains

Two important features of the Lamp are portability and lightness.

The Lamp is also notable for the intense brilliancy of the projected beam which gives an even patch of light.

The Lamp is furnished with a resistance for working on D.C. mains. For A.C. mains a transformer instead of a resistance is supplied. The whole apparatus including resistance or transformer is contained in a black wooden case fitted with leather carrying handle.

Manufactured by:

H. MUKERJI & BANERJEE SURGICAL PRIVATE LTD.

39/1, COLLEGE ST., (Regd. Office) CALCUTTA - 12.

and at

ASUTOSH BLDG., (Cal. University) CALCUTTA - 12.

THE INDIAN JOURNAL OF SURGERY

FEBRUARY, 1958

BIMONTHLY

Annual Subscription Rs. 24

The Indian Journal of Surgery

Vol. XX No. 1

CONTENTS FEBRUARY 1958

NOTICE TO CONTRIBUTORS

The Indian Journal of Surgery publishes original articles in all branches of surgery and allied subjects. Papers for publication and all editorial communications should be addressed to the Editorial Secretary, Indian Journal of Surgery, 164, Poonamallee High Road, Madras 10. Papers sent to the journal are sent to a panel of referees and are accepted for publication on their recommendation. The accepted papers are published on the understanding that they have not been, and will not be published in whole or in part in any other journal.

Orthopaedic Section: Articles intended for publication in the Orthopaedic Section of the Journal may kindly be sent to the Sectional Editor, Dr. N. S. Narasimhan, F.R.C.S., 221, Thambu Chetty St., Madras-1.

Style: Manuscripts must be typewritten on one side on quarto or foolscap sheets, double space and with a margin of not less than two inches. They should bear the name and full address of the author to whom the proofs are to be sent. The paper should conclude with a brief summary stating the conclusions described in the paper.

Tables and Illustrations: Tables should be numbered in Roman numerals and set out on sheets separate from the text. The illustrations should be kept separate from the text and should be numbered consecutively in Arabic numerals. Each figure should be referred to in the text and the descriptive legends should be typewritten on a separate sheet of paper. Nothing should be written or typed on the back of the illustrations. Photographs and photo-micrographs should be printed on glossy paper and generally should not be larger than 6.5 x 6.5 cms. If transmitted through the post they should not be folded and should be protected by corrugated cardboard paper.

Illustrations will not be accepted unless they reach a certain standard of excellence technically, present an attractive appearance and add significantly to the value of the presentation.

References: These should be arranged alphabetically by authors. For citation of a book, give in order author's name, initials, complete title, place of publication, name of publishers, year and page. For an article author's name, initials, full title of paper exactly as it appears, name of journal (abbreviated as in the Quarterly Cumulative Index Medicus), volume number (in heavy type Arabic numerals), inclusive page numbers and year. The following example illustrates the desired punctuation and arrangement.

Christopher, F.: Minor Surgery, 5th Edition, Philadelphia and London: W. B. Saunders Company, 1945, p. 348.

Citations in the text should give the author's name followed by the number listed in the reference.

Proofs: Contributors will receive one proof in galley by air mail, if necessary, which should be immediately corrected and returned by air mail to the Editorial Secretary. Only minor alterations will be accepted in the original manuscript at the time of the correction of proofs.

Reprints: 25 reprints of an article will be sent to the author or divided among the authors. Additional reprints can be supplied at cost price if application is made when the proofs are returned.

All communications regarding membership of the Association, subscription to the Journal, and advertisements may be addressed to the Hony. Secretary, Association of Surgeons of India, 164, Poonamallee High Road, Madras 10.

THE INDIAN JOURNAL OF SURGERY

Vol. XX FEBRUARY 1958 No. 1

CHRONIC CONSTRICTIVE PERICARDITIS

*by SANTOKH SINGH ANAND and WARYAM SINGH, Amritsar.**

The operative treatment of this disease has been a most fascinating chapter in the recent advances in the realm of cardiac surgery. In fact this disease has had a uniformly fatal ending in the past till the surgical decortication of heart was accepted as the procedure of choice for the relief of these unfortunate patients. The gravity of the final outcome can be easily seen from the work of Harvey and Whitehill who write "Of 20 proven cases with effusion 16 died and of the 17 cases without effusion 15 died — a mortality of 83%". Blalock in a study of 22 proven cases in 1937 repeated that "Every patient, with one exception, with proved diagnosis of tuberculous pericarditis was dead".

Historical :

The disease has been known since ancient times but there has been a considerable amount of confusion in the literature both about its aetiology and diagnosis. In fact the disease has been mistaken very often for cirrhosis of the liver and polyserositis. Pick in 1896, whose name is very often associated with this disease, was the first to differentiate constrictive pericarditis from cirrhosis of the liver. However, according to White, Lower gave a clear account of this disease in 1669. The disease was also recognised by Lancisi in 1728, by Morgagni in 1761 and by Laennec in 1819. Hope in 1839 thought that constrictive pericarditis was generally associated with endocarditis and was the earliest observer to realize the possibility of tuberculosis being the cause of this disease. Chevers in 1842 from postmortem findings was able to emphasize the small size of the heart in two cases with pericardial thickening as much as 3 cm. at the base of the heart. Fig. 1 shows an autopsy specimen with a markedly thickened pericardium. In 1873, Kusomaul called attention to the decrease in the amplitude of pulse during inspiration — the pulses paradoxicus. The surgical intervention was first suggested by Weill and Delorme. The operation of pericardectomy was first attempted by Henle in 1907. However the first successful operation was performed by Rehn in 1920. It is worth mentioning that the great Noble Laureate Niels Finsen suffered from this disease at the age of 23 and died at the young age of 44 years — having led a very restricted life for 21 years.

Volhard in his classical paper in 1923 emphasized the cardinal point that the adhesions in the pericardium prevent the proper diastole of the heart and hence the filling of the right heart. He commented on the rise in venous pressure and emphasized the increase in the venous pressure in the neck veins as the most important point in differentiating it from cirrhosis of the liver. Churchill in 1929 reported the successful resection of pericardium. Blalock and Burwell in 1941, presented a most comprehensive review on this subject. Holmes Sellors (1946) in his Hunterian lecture gave an excellent account of the disease. Holman in 1949 emphasized the need for an adequate exposure and for a much wider excision of the pericardium. Betts and Wells (1953) presented a review of the

*From the Department of Surgery, Medical College, Amritsar.

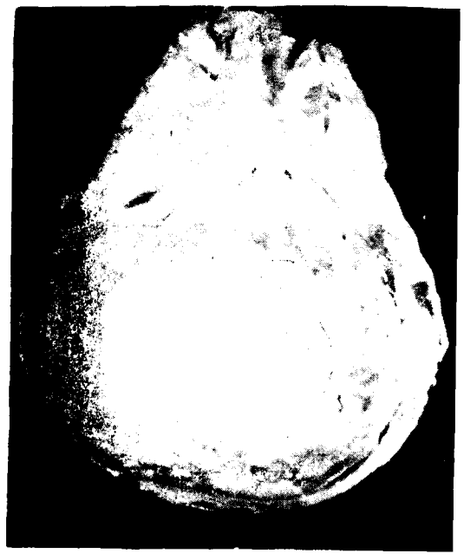


Fig. 1.

Fig. 1-a.

Figs. 1 & 1-a. Patient H.L., who died of pulmonary oedema. Autopsy specimen. Shows the wide extent of pericardial excision necessary. Pericardium 1.2 cm. thick at places.

literature with their own experience of 4 cases. Sen (1954) reported on 30 operated cases of this disease. Our limited experience, however, is confined to only 8 cases. An attempt would be made to emphasize the clinical features, the pre-operative management, the surgical approach which we have used, and the end results. Emphasis would also be laid on the 'adequate' excision of the pericardium to achieve the early rehabilitation of these unfortunate patients.

Etiology :

There has been a considerable difference of opinion in the past about the commonest cause of this disease. Even early workers agreed that the disease was not due to rheumatic fever, as there has been no involvement of the valves of the heart. As early as 1842 Chevers suspected tuberculosis as an important etiological factor. Pyogenic infection has often been blamed but the recent trend of opinion seems to be that tuberculosis is the main cause of this disease. In the active stage of the disease tubercle bacilli have been grown from the pericardial effusion. In the terminal stage of the disease when dense fibrotic adhesions have formed it is hard to show tubercular infection. The evidence of tuberculosis is based on general clinical grounds rather than on histological evidence. However, our own cases have shown giant cell system in three out of eight cases, two of which also show caseation necrosis (Figs. 2 & 3). One other case showed an X-ray evidence of lesion in the lung.

Clinical features :

Because of the constricting action of the dense fibrous tissue round the heart there is a progressive impairment of the cardiac function. The main effect of this fibrosis

Fig. 2.
Patient H.L. Low power section of excised pericardium. Shows tubercle follicle formation.

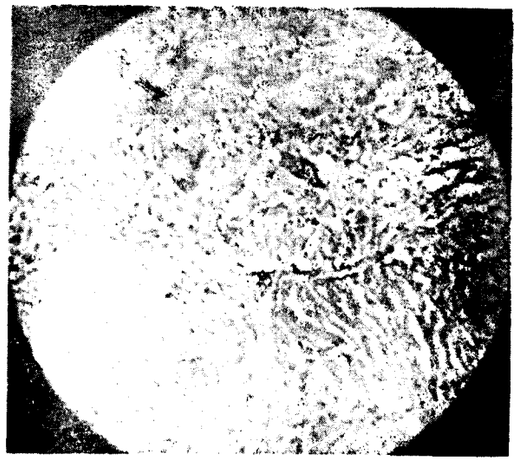


Fig. 3.
Patient G.R. High power section of pericardial peel. Typical giant cells are seen.

is to limit the diastole and so there is incomplete filling of the heart. This is due to the fibrosis round the right ventricle, right atrium and at the base of the superior and inferior vena cavae. Holman has repeatedly emphasised the importance of this constriction round the great veins, although several authors believe that the constriction round the ventricles is the main lesion in this disease.

The limitation of venous return to the right heart necessarily decreases the output of the left ventricle. Therefore the systolic blood pressure is low and so also is the pulse pressure. Due to low output, tachycardia is an early sign.

The most significant sign is the rise in venous pressure due to poor venous return. The neck veins are markedly congested and venous pressure rises above 200-400 mm. water. Due to increased venous pressure there is oedema of the lower extremities, ascites, and pleural effusion (Figs. 4 & 5). The liver is enlarged. Patient is generally cyanotic and breathless. Pulses paradoxicus is felt in most of the cases.

The myocardium is not diseased : only its activity is markedly restricted. The apex beat is not felt easily and on fleuroscopy the movements of the heart are limited.

A remarkable feature, in spite of the profound circulatory disturbances, is that the lungs show no congestion. A probable explanation is that the restricted diastole of the right ventricle leads to a limited output in the pulmonary circulation.

Such symptoms as lassitude, wasting and weakness are commonly seen. The E.C.G. shows typical low voltage type of curve with lowering or inversion of T-waves, seen in Lead I, II & III. After pericardectomy there is marked improvement in this picture. Voltage improves and T-waves become less flat.

During the active stage with pericardial effusion the X-ray will show an enlarged cardiac shadow. When the constriction has

Fig. 4. Fig. 5.

Figs. 4 & 5. Patient P.K. Advanced ascites was the predominant feature in this case.

become a prominent feature the heart shadow becomes smaller (Figs. 6 & 7).

TABLE I

Showing clinical features in 8 cases of constrictive pericarditis

	Per cent.
Tachycardia	100
Faint heart sounds	100
Distended veins	100
Diminished pulsation (on screening)	100
Enlarged liver	75
Ascites	75
Low pulse pressure	75
Cyanosis	62·5
Paradoxical pulse	50
Pleural effusion or thickening	50
History of low grade pyrexia	37·5
Oedema (peripheral)	37·5
Previous pericardial effusion (tapped)	25
Previous pericardial rub	25
Tubercular lesion in lung	12·5
Widened superior mediastinum	12·5

Preoperative Management :

Reduction of oedema was achieved by the use of mercural diuretic Mersalyl, salt free diet, limitation of daily fluid intake to 1500 c.c. and high protein diet. Large accumulation of fluid in the peritoneal and pleural cavities had to be tapped. Every patient received streptomycin and anti-tubercular chemotherapy.

Digitalis has not been used in any of our cases. It might have to be used in cases associated with auricular fibrillation.

Anaesthesia :

Premedication :—Morphia 1/8 gr. to 1/6 gr. with atropine 1/100 gr. is given 1½ hours before the operation. Pentothal 6—10 c.c. of 2·5% solution is used for induction with 50% of N_2O and oxygen with minimal amount of ether. An initial dose of 20—40 mg. of Scoline is used as a relaxant to pass the endotracheal tube with cuff. The respiration is controlled throughout and muscle relaxants are avoided after the initial dose. The patient is kept under light annaesthesia and as soon as the operation is over, the endotracheal tube is removed and the patient is put on 100% oxygen for 5—10 minutes and then O_2 is given by a nasal catheter at 3 to 4 litres flow per minute for about 6 to 8 hours. If the blood pressure is good pethidine is used for analgesia in the post-operative period; otherwise morphia is used 1/8 gr. doses. Before the operation a cannula is inserted into the saphenous vein at the ankle and 5% glucose solution is given very slowly. Blood is kept for an emergency but generally avoided unless there has been considerable bleeding needing replacement.

Position of the Patient :

All our patients have been placed during the operation on their back.

Fig. 6.
Cardiac shadow before medical treatment.

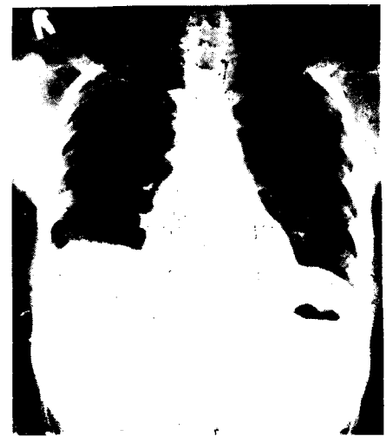


Fig. 7.
Cardiac shadow after medical treatment and before pericardectomy.

Figs. 6 & 7. Patient G. S. Preoperative radiograms of the chest.

Fig. 8. Fig. 8-a.

Figs. 8 & 8-a. Patient G.R. Photograph showing the line of incision across the chest extending from one anterior axillary line to the other.

Exposure of the Pericardium :

A complete exposure of the pericardium is extremely essential to achieve good results and to prevent untoward complications. The older approach of excising the 3rd, 4th, 5th and 6th costal cartilages on the left side with nibbling away of the left lateral margin of the sternum, or the left thoracotomy incision did not permit the proper decortication of the right ventricle and the right auricle.

Holman in 1949 described his incision of midsternotomy with transverse division of sternum at the first or second intercostal space. This incision gives a very good exposure of the front of the heart. We have used this incision in four cases. However a much better exposure is obtained by an incision described by Julian Johnson and Kirby in 1951. This is a transverse incision made across the chest anteriorly from one anterior axillary line to the other (Fig. 8). The right and left pleural cavities are entered through the 4th or 5th intercostal space. The sternum is approached from either side with ligation and division of the internal mammary arteries and division of the sternum with the help of Lebsche sternal knife. The rib-spreader is inserted and a very fine view of the whole heart and great blood vessels is obtained (Fig. 9). We have used this incision in four cases and find it eminently satisfactory.

The operation is started on the left ventricle where the peel is not as thick as on the right ventricle. Besides it is a well recognised fact that the left ventricle should be liberated first to permit a better output of the heart, before decorticating the right heart, otherwise there is a danger that the sudden release of the right heart may lead to increase of pulmonary vascular bed causing oedema of the lungs or dilatation of the right heart. Moreover the muscle on the left side is much thicker and is much less likely to be injured and so the plane of cleavage is easier to find. The right and left borders are freed upto the phrenic nerve. The lower border including the apex of the heart is completely freed from the diaphragm. The use of bilateral sub-mammary incision described by Johnson and Kirby permits this extensive decortication under direct vision. There is an ever present danger of injuring the right ventricle or right auricle because of their thin wall. In fact our first patient died on the table because of a tear of the right atrium with uncontrollable haemorrhage due to inadequate exposure. The plane of cleavage is difficult to find in some cases and both sharp and blunt dissection has to be carried out to separate both layers of pericardium from the surface of heart muscle. Bigger (1932) has pointed out the importance of not excising the scar as it is freed and leaving the flaps

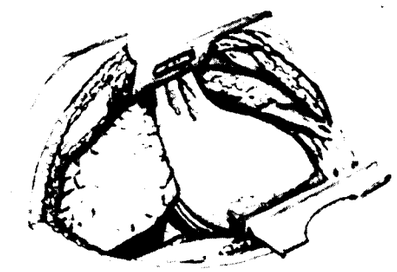


Fig. 9.
Shows the excellent exposure obtained by the incision shown in Fig. 8.

Fig. 10.
Patient H.L. Excised pieces of pericardium. The flaps are left attached to the heart till the completion of the decortication.

temporarily attached so that it could be used as a covering in case an unfortunate rent is made in the heart wall. Churchill (1936) recommends extreme caution while approaching the sulcus formed by the descending coronary artery. This may be approached from both sides till a line of cleavage is obtained. Fig. 10 shows the excised pericardial flaps, in one of our cases.

During decortication when the heart muscle has been exposed 1% procaine solution is used as a spray over its surface to prevent any irregularities of the heart. After completion of decortication the split sternum is approximated by strong silk sutures passed through two drill holes made in the sternum at either end. The chest wall is closed on either side in layers after leaving a drainage tube in either pleural cavity, through a lower intercostal space, down to the water seal. This prevents any accumulation of fluid in either pleural cavity and facilitates the re-expansion of lungs. Fear of opening both pleural cavities simultaneously which has been associated particularly with cardiac surgery, does not appear to be warranted especially when endotracheal anaesthesia with controlled respiration is available. In all the four cases, in this series, in which we used this incision no complication was met with.

Extent of Decortication :

There is a difference of opinion on this point. Churchill (1936) has emphasized that the free movement of the atrioventricular groove is an important physiological mechanism in the action of the heart and every effort should be made to free it. On the other hand Holmes Sellors (1946) has emphasized that excision should be confined to both the ventricles only and he says " It is highly doubtful that the constriction around the caval and auricular regions could produce such a degree of stenosis that a direct attack on this region should be necessary ". Blalock and Burwell (1941) have said that " the decortication of the base of superior and inferior vena cava is rarely necessary and more rarely accomplished successfully ". Holman (1949, 1951) has commented on these conflicting opinions about the extent of decortication and has emphasized two important principles : the necessity of adequately exposing the heart and the great blood vessels so that the surgeon has all the critical areas under his direct vision, and secondly the imperative need of removing the pericardium not only from the anterior surface of the heart but also from the right and the left borders as well as the lower border of the heart including the apex along with the freeing of both the caval openings into the right atrium. An evidence that this liberal decortication is necessary is shown by the report of many cases in the literature in which there is a delay of several months in the improvement of the patients and the persistance of high venous pressure if the decortication is confined to the right and left ventricles only. Holman has further shown in experimental laboratory that the constriction of the inferior vena cava to one half of its calibre leads to the development of ascites in 7 days and constriction of superior vena cava below the entrance of azygos vein produces pleural effusion in 9 days. Experimentally, therefore the symptoms of constrictive pericarditis have been produced by compression of the right heart or by constriction of inferior vena cava alone or constriction of both the superior and inferior vena cavae. On the basis of our limited experience, we are in full agreement with Holman and have in every case tried to decorticate both the left and the right heart including the right atrium, and the caval openings.

Effects of Pericardectomy :

The freeing of both the ventricles restores the pulse pressure to an almost normal level. It is gratifying to see the heart beat much more strongly after decortication. It seems as if it were released from a cage ! There is a sharp fall in the venous pressure. This lowering of venous pressure will be noticed within a few days or weeks if the decortication is extensive and will no doubt be accompanied by the

reduction of ascites and the size of the liver. The E.C.G. shows an increase in the voltage and return to a nearly normal T-wave (Figs. 11 & 12). There is an amelioration of symptoms and a totally incapacitated person returns to almost normal activity in the course of a few months. Imperfect results are due to inadequate decortication.

Post-operative Care :

Patients are continued on streptomycin and anti-tubercular chemotherapy. The drainage tube in either chest is removed after 48 hours and the patients are allowed out of bed any time after fourth or fifth post-operative day.

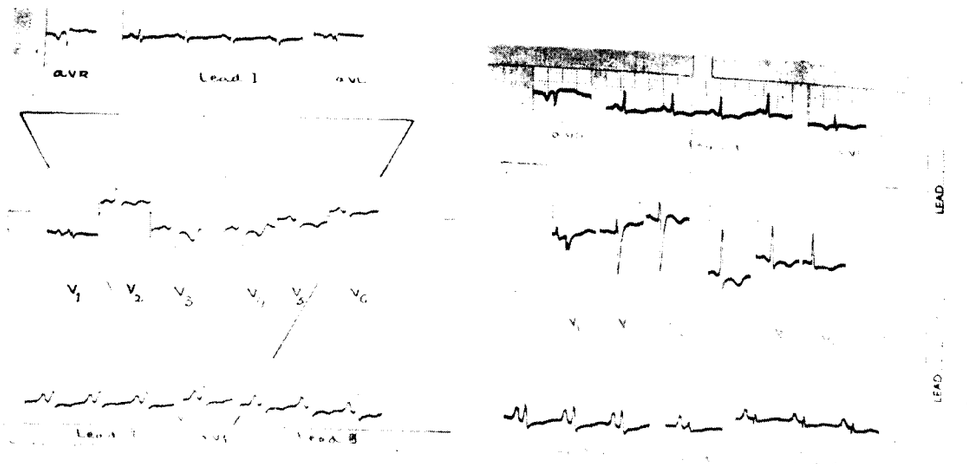


Fig. 11. Fig. 12.

Figs. 11 & 12. Patient G. R. Preoperative and postoperative E.C.G., showing increase in amplitude of the graph 5½ months after pericardectomy. The T waves still remain inverted.

TABLE II

Chronic Constrictive Pericarditis

Patient	Age	Sex	Occupation	Date of operation	Type of incision	Result
1. P.K.	35	F	Housewife	5—1—1952	Holman's	Died—Rapture of right atrium at time of operation.
2. H.L.	20	M	Farmer	21—1—1954	Holman's	Died—Pulmonary oedema 4 days after decortication.
3. R.P.	25	F	Housewife	24—3—1955	Transverse	Cured
4. K.D.	25	F	Housewife	2—4—1955	Holman's	Died—Hepatic failure 25 days after operation.
5. G.S.	35	M	Painter	1—11—1955	Holman's	Cured.
6. S.S.	40	M	Farmer	10—12—1955	Transverse	Cured.
7. K.K.	17	F	Student	29—11—1956	Transverse	Cured.
8. G.R.	42	M	Labourer	23—5—1957	Transverse	Cured.

Some of the typical cases are described below :—

CASE 1.

G.R., 42 years, male, labourer, was transferred on 26-4-1957 from Medical Wards where he had been admitted 3 weeks earlier with the complaints of dyspnoea on exertion of 10 months' duration. He also had palpitation and abdominal distension of 4 months' duration. At the time of admission to Surgical side his dyspnoea had been relieved by the administration of mersalyl.

Examination showed distended neck veins, no cyanosis, pulsus paradoxicus present, pulse rate 100/min., B.P. 89/70 mm. Hg. Ascites present and liver enlarged by 2 fingers. On auscultation of the heart a triple rhythm was present in all the areas, best marked in the 3rd space on the left side of the sternum.

Fluoroscopy of chest showed a slightly enlarged cardiac shadow and visible though weak cardiac pulsations. Radiogram of chest showed lungs and plurae to be clear (Fig. 13). E.C.G. showed poor voltage and generalized inversion of T-waves (Fig. 11). Urine — nothing abnormal. Blood urea — 32 mgm.%. Haemoglobin — 11.2 gms.%. Total serum proteins — 7.2 gms.%. Albumin — 4%. Globulin — 3.2%. Vital capacity — 2.5 litres.

On 23-5-1957 excision of pericardium was done through a bilateral transverse incision, with the patient under endotracheal, controlled respiration, anaesthesia. The peel was 8 mm. thick and was removed first over the left side of the heart and then over the right side including openings of superior and inferior vena cavae. Beats of the heart improved visibly on elevation of the peel. Chest closed after draining both sides down to a water seal. There was extensive oozing during the operation. Therefore he received an unusually large blood transfusion (1750 ccs.). Blood pressure — 95/65 mm. Hg. at the conclusion of the operation.

Oxygen inhalations 3 litres per minute given intranasally and fluids restricted to 1500 cc. during the post-operative period. Streptomycin and Isonex continued. Drainage tubes removed after 48 hours. He had a smooth post-operative period. Lungs expanded completely. Histological report was of tuberculous pericarditis (Fig. 3 showing giant cells). Wound healed by primary intention (Fig. 14). Tachycardia and ascites decreased. Discharged on 1-6-1957.

Follow up on 12-11-1957. Patient has resumed moderate labour. No tachycardia or ascites. Radiogram of the chest (Fig. 15) shows a prominent pulmonary conus. E.C.G. (Fig. 12) reveals improved voltage, the T-waves being still inverted.

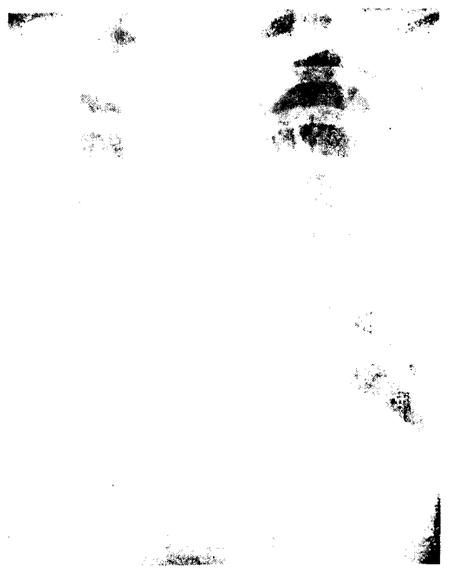


Fig. 13.

Patient G.R. Preoperative radiogram of the chest.

Fig. 14.

Patient G.R. Showing the primarily united type of incision.

Fig. 15.
Patient G.R. Radiograms of chest 5½ months after operation.

Fig. 16.
Patient K.K. Preoperative radiogram of the chest.

Fig. 17.
Patient K.K. Postoperative radiogram of the chest.

Fig. 18.
Patient K.K. Nine months after pericardectomy.

Comments: This patient proved to be tubercular constrictive pericarditis as the pericardium showed caseation necrosis and giant cell formation. He showed a marked improvement after decortication; the ascites disappeared and neck veins could not be observed.

CASE 2.

K.K., 17 years, female, student, transferred on 23-11-1956 from Medical Wards where she had been admitted 1½ months earlier for treatment of low grade fever, distended abdomen, dyspnoea on exertion, all of 1 year's duration and oedema of feet of 3 months' duration. On admission to the Surgical side her main complaints were distended abdomen and tachycardia.

On examination the cervical veins were prominent, cyanosis, ascites and eversion of the umbilicus were present. Heart sounds distant in all the areas, no accompaniments. Pulse 90 per minute. B.P. 108/94 mm. Hg. Liver palpable three fingers below the costal margin.

Fluoroscopic examination of heart revealed restricted movements and no shifting of heart on lateral bending. Radiogram of the chest showed the lungs and plurae to be clear (Fig. 16). E.C.G. showed low voltage and flattening of T-wave. Urine — No abnormality. Blood urea — 31 mgm%. Haemoglobin 11 gms%. Total serum protein 5.4%; albumin 3%; globulin 2.4%. Vital capacity 2 litres.

Pericardectomy through bilateral transverse incision under controlled respiration endotracheal anaesthesia was performed on 29-11-1956. Heart was encased by a thick white peel of pericardium 6 mm. thick which was excised over the left ventricle first and then over the right side including the openings of superior and inferior venae cavae. Movements of the heart improved markedly on completion of the operation. B.P. 100/70 mm. Hg. After approximation of the cut sternal edges by silk sutures wound was closed in layers over drainage tube in either side of the chest. She received 350 ccs. of blood. Drainage tubes attached to water seals on both sides.

Fluid intake restricted to 1500 c.c. post-operatively, and oxygen inhalation 3 litres per minute intranasally. Streptomycin and Isonex continued. She had an uneventful recovery. Tubes removed after 48 hours. Wound healed by primary intension. Lungs expanded on both sides (Fig. 17). Histological report was of chronic inflammation. No caseation or giant cell were detected. Tachycardia disappeared and ascites decreased. Discharged on 23-12-1956.

Follow up on 26-8-1957. Patient is a picture of good health (Fig. 18). She is carrying out all normal household activities. There is no ascites or tachycardia.

Comments: The decorticated material showed only chronic inflammation on histopathology. The patient made a remarkable recovery and has returned to her normal work.

CASE 3.

H.L., 20 years, male, farmer, transferred on 9-1-1954 from Medical side where he had been admitted a month earlier with the history of swelling of abdomen, loss of appetite, fever 100—120 F., palpation and dry cough of 3 months duration. He had dyspnoea on exertion, cardiac pain and oedema of feet of one month's duration. At the time of admission to Surgical side he had distended abdomen, dyspnoea on exertion and tachycardia.

Examination showed distended cervical veins, slight cyanosis, small amount of free fluid in the abdomen and an enlarged liver. Pulse — 96/min. Pulsus paradoxicus present. Blood pressure — 108/90 mm. Hg. Breath sound distant over the right lower chest and heart sound feeble over all the areas.

Fluoroscopy revealed effusion in the right side of the chest with thickened pleura and a widening of the superior mediastinum. Pulsations of the heart were very slight. Radiogram P.A. and lateral views revealed an encysted interlobar fluid in upper part of oblique fissure on right side. E.C.G. showed low voltage and inverted T-waves. Urine — no abnormality. Blood urea — 22 mgm%. Haemoglobin — 12 gm%. Serum proteins — 7.8%. Vital capacity — 1.5 litres.

Operated on 21-1-1954. Midsternotomy with transverse division of sternum at the level of the 2nd intercostal space revealed adhesions between sternum and the anterior surface of pericardium. The pericardium which was 1.2 cm. thick at places (Fig. 1) was excised first over the left heart and then over the right heart and the openings of superior and inferior venae cavae. Chest was not drained. He received 650 c.c. of blood.

Oxygen inhalations 3 litres per minute intranasally and streptomycin continued. On the 4th post-operative day the patient developed pulmonary oedema, which proved fatal despite every effort to control it.

With the permission of the relatives a partial post-mortem was carried out. The pleura on right side was markedly thickened all over and adherent to the pericardium. Frothy fluid exuded from the lungs on pressure. The heart seemed to be encased in a very thick pericardium which engulfed the roots of large vessels also (Fig. 1). Microscopic examination revealed typical tubercle follicle formation (Fig. 2).

Comments: This patient had a markedly thickened pleura on the right side. The decorticated material showed tubercle follicle formation. He died of pulmonary oedema on the fourth post-operative day.

Results

Out of 8 cases we lost three cases. The first case died on the table due to uncontrollable haemorrhage from a tear in the right atrium. This could not be controlled due to inadequate exposure. The second case died on 4th post-operative day due to pulmonary oedema. The third death in this series was due to cholaemia and liver failure on the 25th post-operative day. The rest of the five patients have been cured and have returned to their normal vocation. All the five cases have been followed up from 6 months to 1½ years. The improvement noticed in the immediate post-operative period has been maintained in all the cases. The results have been assessed as excellent in two cases, very good in another two cases, and good in one case. We believe with Holman that this is the result of extensive decortication of the heart including right atrium and the vena caval openings into it.

Discussion

1. An extensive review of the literature shows that very often there is a delay in the diagnosis of constrictive pericarditis. Fortunately the disease is not very common but may be easily mistaken for cirrhosis of the liver, tuberculous peritonitis or rheumatic heart disease. A young person with an apparently normal heart but with signs of circulatory failure, with ascites, pleural fluid, absence of signs of pulmonary congestion, a small quiet heart without any murmurs and a fluoroscopic evidence of little movements of the cardiac borders, should be suspected to be suffering from this disease. In addition if the neck veins are prominent, venous pressure is raised, the systolic and pulse pressures are low, and the E.C.G. shows low voltage with inversion of T-waves the diagnosis of constrictive pericarditis should not be difficult.

2. The progressive nature of the disease with marked constriction of the heart is a common feature. During the early stage when there is pericardial effusion tubercle bacilli may be grown from the pericardial fluid. Later on when the disease is advanced the pericardial peel may show giant cell system or only Collagen fibres. When the compression has been produced the end result is usually fatal unless relief is provided by pericardectomy.

3. The extent of pericardectomy varies from case to case. To ensure adequate decortication all the borders of the heart including the apex, must be completely freed. This would prevent any need for a secondary operation or a delay in the general well-being and rehabilitation of the patient.

4. The use of transverse incision with bilateral thoracotomy and division of the sternum gives excellent exposure. There is no risk of opening both the pleural cavities with endotracheal anaesthesia and assisted respiration. In our opinion this is the incision of choice.

Acknowledgements

We are very grateful to many of our colleagues who have helped us with investigation and care of these cases. We particularly wish to thank Professor R. P. Malhotra, our Cardiologist, for referring the cases to us for surgical treatment. The anaesthesia has been administered by Professor S. K. Bakhshi and Professor Pritam Singh. Our thanks are also due to Professor M. L. Agarwal and Professor N. L. Chitkara, for help in radiological and pathological investigations respectively.

Bibliography

1. Betts, R. H. and Thompson Wells, J.: Ind. Jour. Surg. **15**: 91, 1953.
2. Blalock, A. and Burwell, C. S.: Chronic Pericardial Disease. Surg., Gynec. & Obst. **73**: 433, 1941.
3. Churchill, E. D.: Annals of Surgery. **104**: 516, 1936.
4. Holman, E. and Willett, F.: Surgical Correction of Constrictive Pericarditis. Surg., Gynec. & Obst. **89**: 129, 1949.
5. Holman, E.: The Surgical Treatment of Constrictive Pericarditis. Annals of R. C. S. England. **9**: 309, 1951.
6. Holmes Sellors, T.: Constrictive Pericarditis. Brit. Jour. Surg. **33**: 215, 1946.
7. Johnson, J. and Kirby, C. K.: Annals of Surgery. **133**: 540, 1951.
8. Sen, S. K.: Ind. Jour. Tuberculosis. **1**: 142. 1954.

Received for publication on 28-12-'57.

PRIMARY RETROPERITONEAL TUMOURS

(A Clinicopathologic Study of Five Cases)

*by H. ROY. A. C. GUHA and S. M. GHOSH, Calcutta.**

Tumours of the retroperitoneal space were first described by Morgagni [45] in 1761 with a case report of retroperitoneal lipoma. Although Lobstein [36] (1829) is credited with priority of application of the term retroperitoneal tumour, it was Douglas [12] (1897) who for the first time presented a group of retroperitoneal tumours at a meeting of the Southern Surgical Association. Subsequent writers added to the records of retroperitoneal tumours and applied this name to increasing varieties of tumours in that situation.

Growths arising in the retroperitoneal space and independent of any adult organs are considered as primary retroperitoneal tumours. Metastatic tumours in retroperitoneal space and tumours of lymphoid tissue origin are not to be considered as primary retroperitoneal tumours. Many of the authors are in favour of putting the lymphomas in this category due to the common problem in diagnosis and treatment that is met with other types of retroperitoneal tumours and biopsy being the final method of diagnosis in all of these cases. While discussing about histogenesis of retroperitoneal tumours Pattison [54] (1954) has rightly raised the question whether or not lymphomas, the largest group of retroperitoneal neoplasms should actually be considered in the primary retroperitoneal tumour category. Tumours of lymphoid tissue origin should be considered as a part of the systemic disease. The developmental concept of the origin of retroperitoneal tumours also does not attempt to include the lymphomas. A wide variety of tumours both malignant and potentially malignant occur in the retroperitoneal space, connective tissue tumours, however, constituting an overwhelming majority.

Retroperitoneal tumours are a common problem to the surgeons, and the radiologists in treatment as well as in diagnosis, and it is of no less importance to the histopathologists due to the cloudy concept of their histogenesis. Our interest in this subject was further stimulated when we encountered five such interesting cases within a period of two years.

Histogenesis : Intensive study of primary retroperitoneal tumours led Hansmann and Budd [26] (1931) to believe in their embryological derivation. The histological similarity of these growths with neoplasms having their origin in the adult urogenital apparatus made them advocate that remnants of embryonic urogenital element is the source of their origin. The mesothelium of the urogenital fold is capable of producing various types of tissues and this explains the diverse nature of the retroperitoneal tumours. The histologic picture of case No. 4 of this series was similar to the undifferentiated carcinoma occurring in the testis with similar tendency to spread by venous invasion. The genital cells are found initially near the root of the mesentery in human embryo from where they migrate to their final site, the genital glands. (Handfield-Jones [25] 1924). Some of these genital cells may fail to reach their final destination and are the possible source of such neoplasms.

Tumours of mesonephric origin in different parts of the body have been described in the literature (Hansmann and Budd [26] 1931, Teilum [69] 1954) — the distinctive feature being intracytoplasmic vacuoles and intercellular clear spaces. The histologic picture of the case No. 3 in the present series is typical of mesonephric origin.

Smooth muscle tumour in the retroperitoneal region is not uncommon. Hansmann and Budd [26] (1931) have rightly suggested them to be of M[illegible] Mullerian derivative[illegible] commonest site of plain muscle[illegible]

* Department of Pathology and Surgery, National Medical College, Calcutta.

The huge size of liposarcoma and the resultant distortion of the relative structures in the present case as well as in most of the reported cases shrouded all obvious clues as to their origin. The basic problem of the origin and nature of adipose tissue is still not entirely agreed upon and many obscurities are still present in our knowledge. Kolliker[33] as early as 1886 described two types of cells in adipose tissues, one of which was able to accumulate fat but appearing as an ordinary connective tissue cell, the other which is called primitive fat organ was a polyhedral cell with plentyful cytoplasm and arranged as lobules when they take up fat. Murray and Stout[47] (1943), Arey[4] (1946) and others have described two different modes of origin of fat cells in human foetus. One is preadipose tissue or embryonal adipose tissue, consists of stellate or fusiform cells with processes closely resembling fibroblasts, the other the hibernal fat or brown fat composed of rounded or polyhedral cells with a central nucleus and abundant granular cytoplasm. Review of the literature as well as of the histologic study of case No. 2 of this series led us to agree with Stout[66] (1944) that malignant lipomatous tumours are a single group capable of manifesting different degrees of differentiation. They arise from the adipose tissue consisting of both types of cells, only the preponderance of cell type makes them either hibernoma or embryonal liposarcoma but more commonly they are of a mixed variety. Willis[74] (1953) also emphasized the unnecessity of histological subdivision of liposarcomas.

The pathogenesis of angiosarcoma is a matter of great controversy and this is reflected in its diverse and unsatisfactory classification found in the literature. That the mesenchyme, 'angioblastic cells', pluripotent cells or the differentiated vascular tissue is the source of origin of angiosarcoma is not yet settled. "Angioblasts develop in embryo in solid or syncitial masses in which cell outline cannot be discerned. Later the vascularisation and liquifaction of some of the cells in the syncitium, vesicles are formed, the wall of which becomes endothelium. There is a real differentiation of the cells thus left along the edges of the newly formed vessels and the endothelial cells differ considerably from the angioblast having a slightly longer nucleus and less granular cytoplasm (Sabin[57])". When endothelial cells undergo malignant change, they may show various degrees of anaplasia. Murray and Stout[48] (1944) showed by tissue culture that growing endothelial cells cannot be distinguished from fibrocytes. Stout[66] (1947) classified the malignant blood vessel tumour into three types— (a) malignant haemangioendothelioma — where capillary endothelial cells proliferate inside the reticulin sheath of the capillary, (b) malignant haemangiopericytoma — where Zimmermann's pericytes proliferate outside the reticulin sheath of the capillary, and (c) Kaposi's disease— showing proliferation of normal appearing capillaries in association with fibrosarcoma-like tissue. From the study of histologic pictures of case no. 1 of this series as well as those of the vascular tumours reported in the literature it appears that in addition to the three varieties of malignant blood vessel tumours described above there do exist another group which does not represent the true picture of any of the above three varieties. This might be due to anaplasia of the differentiated vascular tissue or they might be the 'vasoformative varient of the genus mesenchymoma'. This is the group which merits to be distinguished as angiosarcoma. The conclusion is that the malignant blood vessel tumours may have their origin both from the differentiated vascular tissue as well as from the vasoformative mesenchyme.

CASE NOTES

CASE 1.

R.B.A., aged 51, Hindu, male, was admitted to the National Medical College Hospitals, on May 12, 1956 with complaints of swelling in the right upper abdomen for eight months and gradual deterioration of health for five months. About eight months previously the patient noticed a small swelling in the right hypochondriac region. Initially soft in consistency, the tumour gradually became hard and was rapidly increasing in size. There was no pain. His bowels moved regularly. There was no history of jaundice. He had no urinary complaints.

On examination — a man of average build and moderate nutrition. No lymphoglandular enlargement found in any part of the body. Abdomen was full with a visible swelling in the right hypochondriac region extending into the right lumbar region. No distended veins were present on the abdominal wall. The swelling was firm in consistency with smooth surface and margins could not be well defined. It was not tender and was fixed to the posterior abdominal wall. Heart and lungs showed no abnormality. Urinalysis revealed normal picture. Haematological investigation showed slight anaemia. A provisional diagnosis of retroperitoneal tumour was made and exploratory leparotomy was done on the fourth day of admission. On opening the abdomen a big retroperitoneal cystic swelling was found in the right upper quadrant. The mass was adherent to the ascending colon and duodenum in front and great vessels medially. Haemorrhagic fluid came out on aspiration from the cyst. The cyst was opened and its wall was found to be very thick. Being inoperable a piece of tissue was removed from the cyst wall for microscopic examination and the abdomen was closed.

Fig. 1.

Angiosarcoma showing irregular anastomosing spaces containing R.B.C. and lined by spindle shaped cells. (H & E x 100)

The patient was treated with deep X-ray and at the last follow up (one year after operation)— his symptoms had cleared up and clinically no growth could be detected and his health appeared good.

Histology — (Fig. 1) Paraffin section stained with haematoxylin and eosin showed numerous irregular spaces consisting of anastomosing channels. These spaces appear to be capillaries containing R.B.C. and lined by loosely arranged layers of spindle shaped cells of varying size. Separating the spaces are trabeculae of undifferentiated tissue consisting of closely packed cells, variable in size and shape. The predominent cells show elongated cytoplasm with tapering poles and well stained drawn out nucleus of varying size. Most of the cells appear to run in bundles irregularly in different directions with definite tendency to form capillaries which gradually merge into larger spaces where capillary structure is less evident. In places giant cells with larger hyperchromatic nuclei are present and throughout the tissue mitotic figures are common.

CASE 2.

M.H., aged 35, Muslim, male, was admitted to the National Medical College Hospitals on March 4, 1956. About four months before his admission he had a sudden attack of pain in the epigastric region. The pain was of moderate intensity associated with fever of continuous type. After three days both pain and temperature subsided but the patient noticed a swelling in the epigastric region. Since then the swelling has been rapidly increasing in size. The patient felt heaviness and dragging sensation in the abdomen with the increase of the swelling. He had occasional attacks of diarrhoea during last four months. On examination the patient was found to be markedly emaciated with a hugely enlarged abdomen, more marked on the right side. Palpation revealed a tense abdomen diffusely occupied by a swelling which was tense and cystic except in the epigastric region where it was firm. The mass was slightly tender. There was no enlargement of lymphnodes in any part of the body.

Abdomen was opened with a provisional diagnosis of retroperitoneal sarcoma. Whole of the abdominal cavity was found occupied by a tumour mass obscuring the other viscera. Diaphragm and the liver were pushed up. Liver was studded with metastatic deposits. The intestines were compressed in front but not involved by the tumour. Other abdominal viscera could not be individually identified. The tumour was firm in consistency, grayishwhite in colour and friable. The surface of the tumour was irregular with nodular protruding parts of various sizes. There were scattered areas of degeneration and in the central part there was a big cyst formation. Being

Fig. 2.

Liposarcoma showing fat cells at various stages of development and arranged in a lobular pattern. (H & E x 100)

Fig. 3.

Liposarcoma showing foamy cells and multiglobular fat cells. (H & E x 100)

inoperable a portion of the tumour was removed for microscopic examination and the abdomen was closed. The patient expired on the tenth day of operation. Permission for necropsy was refused.

The lobule removed for biopsy measured 4 cm. x 2 cm., grayish-white in colour, soft and friable. Outer surface was smooth. Cut surface showed homogeneous appearance covered with a mucoid material.

Histology: Two pieces of sections were taken, one for parafin sections and the other for frozen section and stain with Scharlach R. Paraffin sections stained with haematoxylin and eosin showed the tumour consisting of different types of fat cells in all stages of development (Fig. 2). The whole mass was bound together by a loose meshwork of connective tissue. The most immature cells were small fibroblast-like, with bright cytoplasm, containing one or several distinct vacuoles and hyperchromatic, slightly eccentrically placed nuclei. More mature fat cells were irregular or polyhedral in shape with an eccentric nucleus and a single small vacuole. Typical signet-ring form with a big vacuole, peripheral flattened nucleus and cytoplasmic rim resembling closely to the normal adipose tissue were also present. Certain parts of the tumour showed foamy cells and multiglobular fat cells (Fig. 3). They were usually oval with regular or undulating outline, and had finely particulate, foamy, eosinophilic cytoplasm containing variable number of small round vacuoles and nuclei usually remain in the center. Undifferentiated sarcoma cells with nuclei of various sizes and shapes and distinct cell boundary were met with in certain portions of the tumour. Mitotic figures were rare. Major parts of the sections showed lobular architecture. Frozen sections stained with Scharlach R. showed that the vacuoles seen in paraffin sections contained fat globules.

The relative distribution of different types of cells was variable. Certain type of cell was found predominent in certain areas while an admixture of them was the usual finding. The tumour was vascular but haemorrhage and necrosis was scanty in the sections. Argyrophil reticulum showing pericellular network were clearly seen in certain parts whereas in compiete undifferentiated areas reticulum was scanty and showed no definite pericellular arrangement (Fig. 4).

Fig. 4.

Showing distribution of reticulin fibres in the liposarcoma. At places they form pericellular network while at others they show irregular distribution. (Reticulin x 100)

Fig. 5.

Papillary cystic adenocarcinoma showing numerous papillary processes with plenty of R.B.C. in the interpapillary spaces. (H & E x 100)

CASE 3.

A.M.P., aged 36, Hindu, male was admitted to the National Medical College Hospitals on August 11, 1956 with complaints of gradually increasing lump in the abdomen for three months. He also complained of pain in the abdomen and low rise of temperature for the same duration.

On examination the patient was found to be emaciated, markedly anaemic and no enlarged lymphnode was found in any part of the body. A mass was found occupying the right hypochondriac, epigastric, umbilical and right iliac region. It was hard, tender and fixed to the posterior abdominal wall. Liver and spleen were not palpable. Abdomen was opened with a provisional diagnosis of retroperitoneal tumour. No free fluid was found in the peritoneal cavity. A huge mass was seen involving the posterior abdominal wall on the right side of the vertebral column, extending from right hypochondriac down to the right iliac region. The growth also crossed the midline at the third lumbar vertebra to the left lumbar region. The growth displaced the coils of small intestine. Outer surface of the growth was smooth, pale coloured and firm in consistency. Posterior peritoneum was incised and a small fragment of the growth was removed for microscopic study. Black necrotic material came out on incising the posterior peritoneum. Peritoneum was sutured and abdomen was closed.

Histology (Fig. 5): The tumour is a papillary cystic adenocarcinoma consisting of numerous papillary projections which in transverse section look like small isolated islands. Most of the papillary processes possess a highly vascular core. The space between the papillae contain plenty of R.B.C. Round cell infiltration in the stroma is seen occasionally but in most places there is no such infiltration. The papillae are covered by several layers of epithelial cells, mainly cuboidal but more polygonal or columnar forms are present in places. Nuclei of the cells are large, in places hyperchromatic and the occurrence of vacuoles in the cytoplasm and intercellular clear spaces are seen scattered all throughout (Fig. 6). Coalescence of the vacuoles at places formed large intercellular cystic spaces. Mitotic figures are frequent. Stroma is invaded by more solid groups of epithelial cells of varying sizes. A diagnosis of

Fig. 6.

Section shows intracytoplasmic vacuoles and intercellular clear spaces a characteristic finding in mesonephric carcinoma. (H & E x 100)

Fig. 7.

Embryonal carcinoma showing large clear cells with dark stained round, oval or elongated nuclei and abundant mitotic figures. (H & E x 270)

cystic papillary adenocarcinoma of mesonephric origin was made. The patient left the hospital at his own risk after healing of the abdominal wound.

CASE 4.

P.D., aged 45, Hindu, female was admitted to the National Medical College Hospitals on March 24, 1955 with complaints of a constant vague pain in the abdomen with paralysis of both the lower limbs for four months. She also complained of a rapidly increasing swelling in her abdomen for about a month and a half. She had burning sensation during micturition for a fortnight and absolute constipation for six days. She had her menopause one year back.

On examination the patient was found to be anaemic and cachectic. Abdominal veins were prominent. Abdomen was rigid and tender specially over the right lumbar and umbilical regions. Liver was palpable four fingers below the right costal margin. An ill-defined mass was felt in the right lumbar region. Complete paraplegia of the lower extremities with loss of sensation was found upto the third lumbar vertebra. Palpation from the back revealed rigidity and tenderness over the third and fourth lumbar vertebrae. There were no enlarged lymphnodes in any part of the body. Lung sounds were impaired with occasional rales. The patient expired on the seventh day of admission.

Post-mortem findings: A big fusiform mass was found occupying the right of the vertebral column extending to the left at its upper part. Above, the growth extended behind the liver upto the diaphragm and below on the right side upto the pelvis and on the left side upto the pelvic brim crossing over the vertebral bodies. Psoas muscles were superficial to the growth but infiltrated by it. Inferior vena cava was enlarged and completely solidified with the tumour tissue extending above upto the right atrium and below upto its bifurcation into common iliac veins. On further dissection it was found the inferior vena cava gave way at the level of the third and fourth lumbar vertebrae, destroyed both of them and formed a big mass. Both the renal veins were solidified with the tumour tissue and became cord-like. There were several discrete nodules over the pancreas and one on the fundus of the

Fig. 8.

Embryonal carcinoma showing multinucleated masses of cytoplasm and extreme degree of anaplasia. (H & E x 100)

Fig. 9.

Another area of embryonal carcinoma showing papillary adenocarcinomatous pattern. (H & E x 100)

gall-bladder. Gall-bladder was fixed to the liver and contained five small pigment stones. The small firm nodule of the gall-bladder measured 1 cm. in diameter. Mucous surface of the gall-bladder did not reveal any ulceration. Enlarged mesenteric lymphnodes could not be detected. Liver was enlarged but no metastatic nodule could be found in it. Kidneys were congested. Other abdominal organs appeared to be normal. Peritoneal cavity contained 40 c.c. of straw coloured clear fluid. Lungs showed no apparent abnormality. Right atrium contained fragments of tumour tissue. Brain appeared to be normal.

Histology: The tumour consisted of sheets of loosely arranged round, oval or elongated cells which vary in size but were generally fairly large. The cytoplasm was abundant, pale eosinophilic and often clear or transparent. The nuclei were large, round, oval or elongated and stained heavily with haematoxylin. Mitotic figures were present in fair number (Fig. 7). The cell outline was generally easily seen in most of the areas. Certain areas showed marked cellular pleomorphism and plenty of giant cell formation. The giant cells looked as dark mono or multinucleated masses of cytoplasm like those of chorionepithelioma (Fig. 8). Many layers of more or less elongated cells arranged in a papillary pattern with central vascular core were observed in some areas (Fig. 9), still others showed the picture typical of adenocarcinoma. Liver, kidneys and lungs, though they appeared normal on gross examination, microscopical examination revealed plenty of tumour cells in all of them. In kidneys certain glomeruli were replaced by tumour cells. Small groups of tumour cells were also seen in between the renal tubules as well within the blood vessels. The neoplastic tissue was excluded from the glomerular cavity by the intact, bowman capsule (Fig. 10). In lungs tumour cells were seen deposited within the alveoli in a linear pattern along their walls (Fig. 11). At places tumour cells were seen within the pulmonary vessels. Pancreatic nodule on section showed complete replacement of the acini by tumour cells, the islet cells and the fibrous septa remaining intact. Eosinophilic masses were seen in small sheets in between the tumour cells as well as in large whorl arrangement near about the tumour cells. Marked cellular pleomorphism and giant cell for-

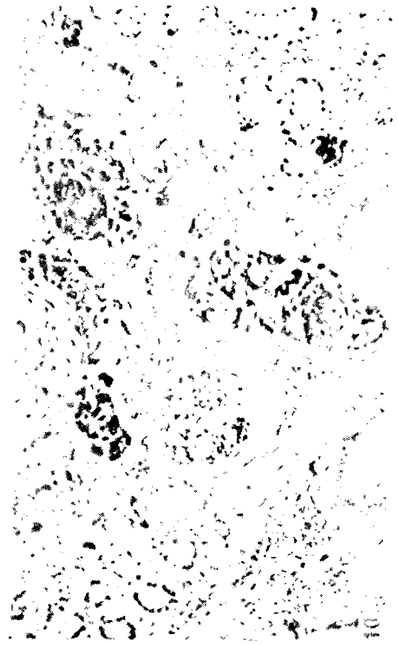


Fig. 10.

Metastasis in kidney. Some of the glomeruli are completely replaced by the tumour cells. Bowman capsule is intact. (H & E x 60)

Fig. 11.

Metastasis in lung. Tumour cells are deposited in the lung alveoli in a linear pattern. (H & E x 100)

mation were noticed particularly near about these eosinophilic masses. Section from the gall-bladder nodule showed diffuse masses of tumour cells infiltrating the muscle and subserous coat of the gall-bladder. Small groups of tumour cells were seen in the subepithelial tissue of the gall-bladder mucosa, the mucous membrane being destroyed at places (Fig. 12). Vertebral bodies and psoas muscles were extensively infiltrated and destroyed by the tumour. Section of the inferior vena cava close to its destroyed part showed invasion of all the coats by tumour cells with occlusion of the lumen by tumour mass. Tumour cells were mingled with unorganised thrombus in the lumen, and there were fresh cells with mitotic figures and irregular giant cells. The renal veins showed partial occlusion of its lumen by tumour cells lying mingled with unorganised thrombus. The tumour cells were healthy and mitotic figures were present in them (Fig. 13). Sections from the ovary, uterus, tubes, urinary bladder, suprarenals and brain showed no evidence of metastases. A diagnosis of embryonal carcinoma originating from primitive sex cell was made.

CASE 5.

R.D., aged, 37, Hindu, female was admitted to the National Medical College Hospitals on January 15, 1955 with a three months history of a right sided, rapidly growing abdominal mass; weakness and mild epigastric discomfort. Examination revealed a firm mass in the medial aspect of the right upper quadrant. It was tender and fixed to the posterior abdominal wall. A barium series showed expansion of the duodenal loop by a mass behind it. Intravenous pyelogram revealed good function of the kidneys. Exploratory laparotomy showed a large, grayish-white, firm lobulated mass on the right side of the vertebral column just behind the third part of the duodenum and pancreas but separate from them. Inferior vena cava and the mesentery were firmly adherent to the tumour mass. Being inoperable due to dense adhesion a piece of tissue was removed for microscopical examination and the abdomen was closed. The patient expired on the eleventh day of operation with sudden distension and appearance of free fluid in the abdomen.

Fig. 12.

Metastasis in gall-bladder. Tumour cells are deposited in the subepithelial tissue of the gall-bladder mucosa. (H & E x 30)

Fig. 13.

Intravascular tumour cells lying by the side of unorganised thrombus in a renal vein. (H & E x 35)

The piece of tissue removed measured 3 cm. x 1.5 cm., firm grayish-white in colour with a homogeneous cut surface.

Histology: (Fig. 14) Paraffin sections stained with haematoxylin and eosin showed interlacing bundles of smooth-muscle cells with elongated, palisaded and blunt ended nuclei showing variation in size, shape and staining. Scattered myofibrils were noted. Occasional bizarre forms and mitoses were seen. The fibrous stroma was scanty and highly vascularised. In places, there was moderate amount of degeneration. A diagnosis of leiomyosarcoma was established.

Discussion

Incidence: It is evident from the literature that the incidence of retroperitoneal tumour is not so uncommon as was formerly believed (Hansmann & Budd[26] - 1931, Pemberton & McCauhen[56] - 1933, Stromme & Stander[67] - 1946, Donnelly[11] - 1946, Patel & Tubiana[53] - 1947, Herdman[28] - 1953, Melicow[42] - 1953, Johnson etal[31] - 1954, Vecchiati etal[70] - 1955). Rather due to its frequent occurrence stress has now-a-days been given to consider this neoplasm in the differential diagnosis of an unexplained abdominal mass. During the two years period, January, 1955 to December, 1956 inclusive, five retroperitoneal tumours were met with at the National Medical College Hospitals, Calcutta. Of these five, three were in males and two in females. Literature reveals no sex predilection of these tumours. Melicow[42] - (1953) found male preponderence in carcinoma, lymphoma, fibrosarcoma and nerve cell tumours. The only blood vessel tumour in his series, the haemangiopericytoma occurred in a girl of 11 years but myomatous and lipomatous tumours of his series occurred predominently in the female. The ages of the five patients in the present series were 51, 35, 36, 45, and 37 years but cases have been

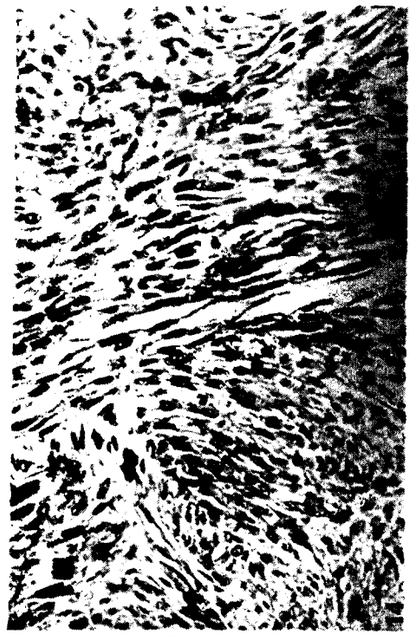


Fig. 14.

Leiomyosarcoma showing interlacing bundles of smooth muscle cells with irregular nuclei. (H & E x 100)

described at all ages. The extreme ages in the series of Melicow [42] - (1953) were 1 month (Teratoma) and 82 years (Liposarcoma) and those in the series of Johnson etal [31] - (1954) were 5 days and 73 years. Farbman [14] - (1950) in his series of lipomatous tumours observed age variation from 2 years to 86 years. It is apparent from the literature that teratomas are particularly common in children (Melicow [42] -1953, Frank [17] - 1938).

Symptoms : Symptoms of retroperitoneal tumours are usually vague. A common presenting complaint however, is gradual or rapidly enlarging abdominal swelling. Abdominal pain is the next common symptom (Pemberton & McCaughan [56] - 1933, Deweerd etal [9] - 1952, Johnson etal [31] - 1954, Melicow [42] - 1953). All the five patients of this series complained of lump in the abdomen and four complained of abdominal pain. The character and intensity of pain varies from mild non-descript one to sudden severe pain with rise of temperature (case No. 2 of this series). This sudden severe pain may occur due to degeneration and haemorrhage within the tumour (Gummer [22] - 1953, Deweerd etal [9] - 1952, Melicow [42] - 1953). Retroperitoneal space is a clinically silent region and tumours usually grow there to a big size filling the whole abdomen without producing any symptoms. Case No. 2 of this series, on exploration showed a huge tumour filling the whole abdomen, but the patient complained of symptoms of only four months duration. Due to this silent latent period, patients very often come to the hospital with an inoperable abdominal mass. All the patients of this series had inoperable growth though the duration of symptoms were in months. Retroperitoneal neoplasms expand anteriorly due to soft yielding abdominal viscera, the posterior expansion usually being resisted by the rigid muscle and bony wall. In the advanced stage, particularly the highly invasive malignant neoplasms may involve the muscles and vertebrae (Melicow [42] - 1953, case No. 2 of leiomyosarcoma). Case No. 4 of the present series had paralysis of both lower limbs and on post-mortem examination both the psoas muscles and 3rd & 4th lumbar vertebrae were found to be invaded and destroyed by the tumour tissue. Other symptoms often complained of by the patients were loss of weight, rise of temperature, epigastric pain, nausea and vomiting, oedema of legs, urinary and bowel troubles. In the present series two patients complained of rise of temperature, one patient epigastric pain and another burning sensation during micturition and the other two complained of troubles of the bowel-one diarrhoea and another constipation. Unusual symptoms of retroperitoneal tumours are often reported in the literature. Such unusual symtoms are fatal azotemia due to obstruction of both the ureters (McLaughlin & Sharpe [41] - 1938, Sweetser [68] - 1942), difference of surface temperature of the two lower limbs caused by the pressure on the abdominal sympathetics (Hesse [21]), glycosuria due to pressure on the pancreas

(Leichner [35]), hydronephrosis due to gradual compression of the ureter (Morgan & Stone [46] - 1938, Chown [7] - 1939, Melicow [42] - 1953). Symptoms in relation to anatomical sites of various retroperitoneal tumours have been excellently dealt with by Melicow [42] (1953).

Histological picture : A wide variety of tumours with diverse histologic picture occur in the retroperitoneal region. Melicow [42] (1953) in his critical study and review on retroperitoneal neoplasms classified his 162 cases according to the tissue of origin, connective tissue tumours being the overwhelming majority. Three of the five patients in the present series had malignant connective tissue tumours — angiosarcoma, embryonal liposarcoma, and leiomyosarcoma. Of the two epithelial tumours one was embryonal carcinoma and another papillary cystic adenocarcinoma — similar to those found in the genitourinary organs. Tumours, similar to those found in the adult urogenital apparatus have been described in the retroperitoneal space (Hansmann & Budd [26] - 1931, Stromme & Stander [67] - 1946).

Diagnosis : Although accurate final diagnosis can only be obtained by surgical exploration and histologic study of a portion of the growth, a careful investigation and bearing in mind the possibility of such neoplasms in all cases of undiagnosed abdominal lump, very often enables one to come to a preoperative diagnosis of retroperitoneal tumour. All the five cases in this series were diagnosed provisionally as retroperitoneal tumour before exploration. Barium meal or enema examination and pyelography are of great assistance in establishing the diagnosis (Gummer [22] - 1953, Deweerd [10] - 1954, Sheinmell etal [62] - 1951, Schulte etal [58] - 1931). In the present series barium-meal examination and I.V. pyelography were done in case No. 5 only, the remaining four cases were diagnosed clinically as retroperitoneal tumours. I.V. pyelography showed normal functioning kidneys and barium series showed widening of the duodenal loop. Other investigations advocated are aspiration with a needle to exclude ascites, retroperitoneal pneumograms (Duff etal [13] - 1952) and aortogram to demonstrate the local tree.

Prognosis : Irrespective of their nature retroperitoneal tumours have a grave prognosis. This is because they remain silent for a long time and patients seek medical advice very late, difficulties in their diagnosis and above all apparently benign tumours have a great tendency to recur and the recurrent growths are very often malignant. It is evident from literature that retroperitoneal tumours are frankly or potentially malignant. Benign tumours particularly lipoma, fibroma and fibroleiomyoma have a great tendency to recur after an apparent complete excision. Such recurrent tumours are very often malignant. Two explanations have been discussed by Donnelly [11] (1946) for this recurrences. The first is the persistence of the satellite growth, overlooked at operation which continues to grow and appears as recurrence of the primary growth. The second exaplation is the missing of malignant area present in the tumour due to incomplete histologic study. The former view is supported by the report of cases having several tumours found at operation (Von Wahlendorf [71] - 1921, Miller [44] - 1936).

Angiosarcoma : Angiosarcoma is a very rare tumour. During ten years period at Memorial Hospital, New York, McCarthy & Pack [39] (1950) met with only 20 cases of angiosarcoma. Out of 153 soft tissue tumours Cade [5] (1951) observed only 10 cases of angiosarcoma. Site of angiosarcoma observed by McCarthy & Pack [39] - (1950) were lower extremity (37%), paranasal sinus (25%), upper extremity (20%) breast (10%) and head and neck (10%), but none in the retroperitoneal region. Angiosarcoma and metastasizing haemangioma has been reported in liver (Gray [21] - 1921), spleen (Wright [77] - 1928, Paine [52] - 1931, DeNavasquez [8] - 1936), lungs (Wollstein [75] - 1931, Hall [24] - 1935) and bones (Carter etal [6] - 1956). The case No. 1 of the present series is of special interest due to its retroperitoneal origin. Marazzini [38] - (1949) reported a case of

pararenal angiosarcoma. Other blood vessel tumours observed in the retroperitoneal region are haemangiopericytoma (Melicow [42] - 1953, Herdman [28] - 1953, Ackman cited by McCormack etal [40] - 1954, and cavernous heamangioma (Ward & Stewart [72] - 1950). Angiosarcoma occurs in comparatively younger age group. 75% of the cases of McCarthy & Pack [39] (1950) were found before the age of 40. The age of the present case was 51 years. Angiosarcomas are usually single with moderate rapid rate of growth and commonly show degeneration and haemorrhagic cyst formation (McCarthy & Pack [39] - 1950). The tumour of the present case was cystic and the cyst contained blood. Some of the angiosarcomas of the soft tissues, observed by Cade [5] (1951) were cystic and filled with blood. From the complex microscopic picture and various nomenclature as endothelial sarcoma, malignant haemangioendothelioma, highly vascular round and spindle cell sarcoma, it is apparent that the microscopic diagnosis of angiosarcoma is a difficult one. Highly vascular sarcomas are often misdiagnosed as angiosarcoma.

Most of the patients in the series of McCarthy & Pack [39] (1950) died within 3 years with metastases in the lungs, viscera, bone and lymphnodes. No evidence of metastases could be found in the present case during exploratory laparotomy. This patient was treated with deep therapy and at the last follow up (1 year after operation) found him symptomfree with no evidence of residual growth.

Embryonal liposarcoma : Willis [74] (1953) is of opinion that malignant adipose tissue tumours are rare and the term liposarcoma should be restricted to tumours consisting of malignant lipoblast cells. Knowles [32] (1954) defined a liposarcoma as a malignant mesenchymal tumour, the cells of which tend to differentiate into fat cells. Liposarcoma is undoubtedly a rare tumour. Harnett [27] (1952) found only two such cases out of 205 soft tissue sarcomas. Stout [66] - (1947) found 73 cases out of 432 sarcomas of the soft parts. Cade [5] (1951) found only 6 cases (4%) in his series of 153 soft tissue tumours. Sirsat [63] (1956) found 7 cases (4·8%) out of 146 soft tissue tumours. Adair etal [3] (1932) met with only one case in their series of 134 lipomatous tumours. Von Wahlendorf [71] (1921) found 14% of 168 collected lipomatous tumours as examples of liposarcoma. Johnson etal [31] (1954) found none in their series of 72 retroperitoneal tumours. Melicow [42] (1953) met with 14 such examples in his series of 162 primary retroperitoneal tumours. During the period of 37 years Stout [65] (1944) found 43 cases of liposarcoma in the Surgical Pathology Laboratory of Columbia University and reviewed 134 cases reported in the literature.

Some believed that liposarcomas predominently occur in male (Skjoldborg [64] - 1953, Stout [66] - 1947) but it is apparent from literature that both sexes are equally involved (Willis [74] - 1953, Melicow [42] - 1953, Deweerd etal [9] - 1952). Though reported in children (Senftleben [61] - 1858, Pack & Anglem [51] - 1939, Kretschmer [34] - 1940, Goeters [18] - 1941, Knowles [32] - 1954) and new-born (Fichman [16] - 1940), ilposarcoma is the tumour of advanced age group and the peak of incidence in most of the reported series is between 40 to 60 years (Stout [65] - 1944, Farbman [14] - 1950, Newman & Pinck [49] - 1950, Deweerd etal [9] - 1952, Melicow [42] - 1953).

Common site of liposarcoma is the lower limb and retroperitoneal tissue (Stout [65] - 1944). Liposarcoma is the commonest form of all retroperitoneal sarcomas (Ackerman [2] - 1953). Lipoblast grows steadily in the 'silent' retroperitoneal region without producing any symptoms for a long time. The abdominal viscera remarkably get adjusted to the increasing tumour which gradually occupies the whole abdominal cavity. The tumour liposarcoma of this series occupied whole of the abdomen but the patient had no complaints referring to the abdominal organs, except occassional diarrhoea. Usually liposarcomas grow slowly for years and in extreme cases it has been found to grow for a period of 40 years (Skjoldborg [64] - 1953). The tumour of this series had comperatively rapid growth and the patient expired within four months of

developing symptoms. This patient gave the history of a sudden attack of epigastric pain with rise of temperature followed by the development of a mass in the abdomen. It is more likely that the attack of pain drew the attention of the patient to the already existing symptomless mass in the abdomen. Sudden severe pain is due to haemorrhage and necrosis within the tumour and this was evident in the present case from the central cystic degeneration of the tumour. Deweerd etal [9] - (1952) met with one such case with central cystic degeneration and another with an abscess formation. Outer surface of the present tumour was nodular with knob-like projections. Twothirds of the lipomatous tumours in the series of Deweerd etal [9] (1952) had such nodular appearance.

Microscopical picture of liposarcoma is variable, from fully differentiated adipose tissue to complete anaplastic sarcomatous cells. The various tumours mistaken for liposarcoma are myxoma, adipose tissue infiltrated by cellular tumour of any kind, anaplastic tumour with cells containing droplets of fat due to degeneration or sarcomatous change in the fibrous element of a lipoma (Willis [74] - 1953). Case No. 2 of this series is an example of embryonal liposarcoma. The tumour consists of both uniglobular ordinary fat cells and multiglobular element of brown fat together with various transitional form between undifferentiated sarcoma cells and well developed fat cells. Stress has been laid on the presence of reticulin fibres which are distributed in a pericellular pattern or in bundles around groups of cells (Shaw [61] - 1936, Haagenson & Krehbiel [23] - 1936), but others (Willis [74] - 1953, Knowles [32] - 1954), no doubt correctly gave little importance to the reticulin stain in the diagnosis of a tumour. A distribution of reticulin fibres in the present tumour was variable at places and they were dense and pericellular while at others they were scanty and showed irregular arrangement around groups of cells. Microscopical diagnosis of liposarcoma is not very difficult if sufficient amount of tissue is obtained for fat stain. Skjoldborg [64] (1953) has rightly pointed out the fact that misdiagnosis of liposarcoma is more due to lack of experience of such tumour resulting from its rare occurrence than due to the actual difficult histologic picture.

Metastasis is said to be less frequent in liposarcoma than other types of sarcomas. Sometimes multiple liposarcomas are present (Fahr & Lubarsch [15] - 1925, Neinhuis [59] - 1925, Goormaghtigh etal [20] - 1936-37, Ackerman [1] - 1944). Whether these multiple tumours are metastases or independent primary growths is debatable. Seigmund [59] (1934) described a case of liposarcoma in the thigh which at autopsy was found to be generalised in its distribution. He concluded it to be a systemic malignant disease of adipose tissue similar to lymphosarcomas of lymphoid tissues and this view was later supported by Willis [74] (1953). Metastases from liposarcoma by haemic dissemination occur in the lungs, liver, bone, brain and other organs (Stout [65] - 1944, Knowles [32] - 1954). In the present case there was extensive metastasis in the liver. As autopsy examination was not available a valuable observation on metastasis is missed.

The principle of treatment of liposarcoma is surgical removal wherever possible, followed by radiotherapy to prevent recurrence which is very common. Being a tumour of immature fat cells, embryonal liposarcomas are highly radiosensative (Skjoldborg [64] - 1953). The patient of this series came with very advanced condition of the disease and expired before any therapeutic measure could be attempted.

Embryonal carcinoma : A number of retroperitoneal tumours designated by various names such as indifferent carcinoma, embryonal carcinoma, anaplastic carcinoma undifferentiated neoplasms etc. has been reported in the literature. They are highly malignant, do not show any definite histologic pattern and have a tendency to spread by invasion of veins. These invasive friable tumours consist mainly of large round cells, similar to those of the testicular undifferentiated carcinoma. The case No. 4 of this series was a similar one and was diagnosed as embryonal carcinoma. The

tumour consisted of large, round or elongated cells with pleomorphism at places and adenomatous arrangement at others. There were extensive metastases particularly by venous invasion and the various organs showed mainly microscopic metastases. The growth invaded the wall as well as the lumen of the inferior vena cava with partial occlusion of the renal veins by tumour cells. Intraluminal healthy tumour cells with mitotic figures suggest their progressive multiplication. Tumour cells were mingled with unorganised thrombus. Willis[73] (1952) says "unorganised intravascular blood clot constitute a suitable culture medium for many kinds of tumour cells, is attested by the healthy appearance of the cells and the presence of mitotic figures in them". Gross and microscopic picture of the metastatic nodule in the gall-bladder suggests it to be haematogenous in nature. Willis[73] (1952) found only two instances of gall-bladder metastasis and referred to 21 recorded cases in the literature. The primary tumour of the 23 recorded cases were melanotic tumour (14), carcinoma lung (4), carcinoma kidney (1), carcinoma oesophagus (1), a doubtful tumour (1) carcinoma of the nasophrynx (2). Pulmonary metastasis is interesting due to the intravascular spread of tumour along the inferior vena cava to the right atrium as a solid column and thence extend to the lung along the pulmonary artery. Though no gross change was observed in the lungs, microscopic metastases were found in both lungs. Metastatic areas in pancreas show persistence of islet cells within the cancer cells. This explains the absence of diabetic symptoms in cancerous pancreas (Pearce[55] - 1904). Retrograde extension along the renal veins from the tumour within the inferior vena cava is rare (Willis[73] - 1952). The present case showed unusual retrograde extension from the inferior vena cava along both the renal veins, which were almost completely solidified with tumour cells. Both the kidneys showed only microscopic metastases with no apparent gross change.

Leiomyosarcoma: This is the second most common primary sarcoma of the retroperitoneal region (Ackerman[2] - 1953). Incidence of plain-muscle tumours in the retroperitoneal region is comparatively rare. Out of sixty plain-muscle tumours of gastrointestinal-tract found during the period of 26½ years, Golden & Stout[19] - (1941) observed only 8 cases of retroperitoneal leiomyosarcoma and out of 1018 collected cases they observed only 43 (4.5%) in the retroperitoneal region including omentum and mesenteries. Retroperitoneal leiomyosarcomas are found in people of advanced age group like other sarcomas of that region, the peak of incidence being between 40 to 60 years. The age incidence of 17 cases reported by Melicow[42] (1953) ranges from 13 months to 69 years, the average being 43 years. The age of the patient in the present series was 37 years. Leiomyosarcomas like other tumours of retroperitoneal region attain a huge size and may show cystic degeneration (Lumb[37] - 1951). They recur very commonly and directly extend to the vital structures. The tumour in the present case had dense adhesions with the inferior vena cava and mesentery which made attempt at surgical removal impossible. Barium series and pyelography can only localise a tumour, actual diagnosis is not possible before exploration and histologic study of a portion of the tumour. Histologic criteria of malignancy so far as plain-muscle tumours are concerned is unreliable. Clinically a metastasizing and invasive leiomyoma may show a perfectly benign microscopic picture (Hunt[30] - 1923, Melnick[43] - 1932, Golden & Stout[19] - 1941, Willis[74] - 1953). Willis correctly emphasized the fact that invasive and metastasizing tumours are sarcomas, however well differentiated their structure may be. The case of the present series had typical histologic picture of leiomyosarcoma, at places well differentiated and at others showing pleomorphic appearance with bizarre giant cells. Presence of bizarre or monster cells indicate either atypical character of growth or degeneration (Golden & Stout[19] - 1941). Regional metastasis is frequent. Haemic dissemination to distant sites are commonly seen in liver, lungs and vertebral body (Golden & Stout[19] - 1941, Melicow[42] - 1953).

TABLE 1

RETROPERITONEAL TUMOURS

Case	Age in Years	Sex	Symptoms	Duration in months	Description & Location	Histology	Histogenesis	Remarks
1 R.B.A.	51	M	Lump abdomen.	8	Large, cystic & haemorrhagic mass in the right upper quadrant. Adherent with duodenum, ascending colon & great vessels.	Angiosarcoma	Vesoformative Mesenchyme	Treated with deep X-Ray. Living
2 M.H.	35	M	Sudden attack of severe abdominal pain with rise of temperature followed by a lump in the abdomen. Occassional diarrhoea.	4	Large grayish-white, friable mass with nodular surface. Scattered areas of degeneration & central cyst formation present Occupies whole of the abdomen, more on the right side.	Embryonal Liposarcoma	Embryonal adipose tissue	Dead
3 A.M.P.	36	M	Lump & pain abdomen with low rise of temperature.	?	Large pale & firm mass filling entire right posterior wall pushing the intestines forwards. Black necrotic material came out on incising the mass.	Papillary Cystic adenocarcinoma	Woolfian rest	Untraced in follow up
4 P.D.	45	F	Lump & vague pain in the abdomen with paralysis of both lower limbs Burning sensation during micturition & Constipation.	4	Fusiform mass filling entire right posterior wall extending to left at 4L vertebra. 3L. 4L vertebrae & psoas muscles were destroyed. I.V.C. solidified by the growth & showed extensive metastases.	Embryonal carcinoma	Sex cell	Dead
5 R.D.	37	F	Lump abdomen with epigastric pain.	3	Large lobulated firm mass on the right side of vertebral column just behind the 3rd. part of duodenum & fixed with inferior vena cava.	Leiomyosarcoma	?	Dead

The case under discussion had no apparent metastasis as observed during exploratory leparotomy.

SUMMARY

1. Five cases of malignant retroperitoneal tumours found in a general hospital during a two year period have been reported with clinicopathologic features.

2. Histologically the tumours were angiosarcoma, embryonal liposarcoma, papillary cystic adenocarcinoma, embryonal carcinoma and leiomyosarcoma. The ages were 51, 35, 36, 45, and 37 respectively. Three occurred in males, two in females.

3. The incidence, clinical history, histogenesis, gross and microscopic picture of

the individual tumour is detailed and available literature reviewed.

4. Post-mortem findings of the case of embryonal carcinoma with extensive metastases is described. This case showed an unusual metastasis in the gall-bladder by haemic dissemination.

5. Three of the cases died soon after the admission, one case left the hospital and remained untraced, the remaining one (angiosarcoma) was treated with radiotherapy and is living for one year symptomless.

ACKNOWLEDGEMENT

We wish to express our sincere thanks to Dr. P. Dutta-Choudhuri of Chittaranjan Cancer Hospital, Calcutta for reviewing our histological diagnosis. Our thanks are also due to Dr. M. N. Sarkar, Superintendent, National Medical College Hospitals for kindly allowing us to see the hospital records and publish the paper.

REFERENCES

1. Ackerman, L. V.: Multiple Primary Liposarcomas. Am. J. Path. **20**: 789, 1944.
2. Ackerman, L. V.: Surgical Pathology, St. Louis, The C. V. Mosby Company, 1953, p. 721, 724, 750.
3. Adair, F. E., Pack, G. T. and Farrior, J. H.: Lipomas. Am. J. Cancer. **16**: 1104, 1932.
4. Arey, L. B: Developmental Anatomy, 5th. edn. W. B. Saunders, Philadelphia, and London, 1946, p. 364.
5. Cade, S.: Soft Tissue Tumours: Their Natural History and Treatment. Proc. Roy. Soc. Med. **44**: 19, 1951.
6. Carter, J. H., Dickerson, R. and Needy, C.: Angiosarcoma of Bone: A Review of the Literature and Presentation of a case. Ann. Surg. **44**: 107, 1956.
7. Chown, B.: Extraperitoneal Lipoma in a child. Am. J. Dis. Child. **57**: 401, 1939.
8. DeNavasquez, S.: Angioblastoma of the Spleen with Metastasis in the Liver. J. Path. & Bact. **42**: 651, 1936.
9. DeWeerd, J. H. and Dockerty, M. B.: Lipomatous Retroperitoneal Tumours. Am. J. Surg. **84**: 397, 1952.
10. DeWeerd, J. H.: Lipomatous Retroperitoneal Tumours: Urographic Findings. J. Urol. **71**: 42, 1954.
11. Donnelly, B. A.: Primary Retroperitoneal Tumours. Surg., Gynec. & Obst. **83**: 705, 1946.
12. Douglas, R.: A Study of Retroperitoneal Neoplasms with Special Reference to Diagnosis. South. Surg. & Gynec. Tr. **10**: 34, 1898.
13. Duff, J. and Kenyon, H. R.: Retroperitoneal Pneumography with Pyelography. New York State J. Med. **52**: 1790, 1952.
14. Farbman, A. A.: Retroperitoneal Fatty Tumours and Review of the Literature from 1937 to 1947. Arch. Surg. **60**: 343, 1950.
15. Fahr, T. and Lubarsch, O. In: Henke, F. and Lubarsch, O.: Handbuch der Speziellen pathologischen Anatomie und Histologie. J. Springer, Berlin, 1925, **6**: pt. 1, 603.
16. Fichman, A. M.: Congenital Malignant Tumour of Skin in Newborn; Report of a case. Am. J. Surg. **48**: 456, 1940.
17. Frank, R. T.: Primary Retroperitoneal Tumours; Report of 3 cases and 107 cases from Literature. Surg. **4**: 562, 1938.
18. Goeters, W.: Bosartige Mischgeschwulst des Ductus Choledochus bei einem Kleinkind. Arch. f. kinderheilk. **122**: 217, 1941.
19. Golden, T. and Stout, A. P.: Smooth Muscle Tumous of the Gastrointestinal Tract and Retroperitoneal Tissue. Surg., Gynec. & Obst. **73**: 784, 1941.
20. Goormaghtigh, N., Vanderlinden, P. and de Puysseleyr, R.: Lipocytomes et lipocytoses (lipoblastomes et lipoblastoses) Contribution a l'etude des liposarcomes profonds. Cancer, Bruxelles **13**: 3, 1936-37.
21. Gray, J.: Case of Malignant Haemangioendotheliomatous endothelioma. J. Path. & Bact. **32**: 337, 1929.
22. Gummer, J. W. P.: Retroperitoneal Sarcoma (with Report of Four Cases). Brit. J. Surg. **40**: 494, 1953.
23. Haagensen, C. D. and Krehbiel, O. F.: Liposarcoma produced by 1: 2 Benzpyrene. Am. J. Cancer. **27**: 474, 1936.
24. Hall, E. M.: Malignant Haemangioma of Lung with Multiple Metastases. Am. J. Path. **11**: 343, 1935.
25. Handfield-Jones, R. M.: Retroperitoneal Cysts: Their Pathology, Diagnosis and Treatment. Brit. J. Surg. **12**: 119, 1924.
26. Hansmann, G. H. and Budd, J. W.: Massive Unattached Retroperitoneal Tumours. Am. J. Path. **7**: 631, 1931.
27. Harnett, W. L.: A Survey of Cancer in London, London, British Empire Cancer Campaign, p. 639, 1952.

28. Herdman, J. P.: Primary Retroperitoneal Tumours. Brit. J. Surg. **40**: 331, 1953.
29. Hesse, E.: Quoted by Frank.[17]
30. Hunt, E. L.: Leiomyoma of Stomach. Boston M. & S. J. **188**: 349, 1923.
31. Johnson, A. H., Searl, H. H. and Grimes, O. F.: Primary Retroperitoneal Tumours. Am. J. Surg. **88**: 155, 1954.
32. Knowles, C. H. R.: Liposarcoma: with Report of a case in a Child. J. Path. & Bact. **68**: 235, 1954.
33. Kolliker, A.: Zur Entwicklung des Fettgewebes. Anat. Anz. **1**: 206, 1886.
34. Kretschmer, H. L.: Retroperitoneal Lipofibrosarcoma in a Child. J. Urol. **43**: 61, 1940.
35. Leichner: Quoted by Donnelly.[11]
36. Lobstein (1829): Quoted by Johnson et al.[31]
37. Lumb, G.: Smooth-Muscle Tumours of the Gastro-Intestinal Tract and Retroperitoneal Tissues presenting as Large Cystic Masses. J. Path. & Bact. **63**: 139, 1951.
38. Marazzini, A.: Angiosarcoma pararenale. Urologia. **16**: 482, 1949.
39. McCarthy, W. D. and Pack, G. T.: Malignant Blood Vessel Tumours. Surg., Gynec. & Obst. **91**: 465, 1956.
40. McCormack, L. J. and Gallivan, W. F.: Hemangiopericytoma. Cancer. **7**: 595, 1954.
41. McLaughlin, C. W., Jr. and Sharpe, J. C.: Malignant Fatty Tumours of the Retroperitoneal Region: Report of Two Cases. Am. J. Surg. **41**: 512, 1938.
42. Melicow, M. M.: Primary Tumours of the Retroperitoneum. J. International Coll. Surg. **19**: 401, 1953.
43. Melnick, P. J.: Metastasizing Leiomyoma of Stomach. Am. J. Cancer. **16**: 890, 1932.
44. Miller, J. R.: Retroperitoneal Pelvic Tumours encountered by Gynecologist. Am. J. Obst. & Gynec. **32**: 652, 1936.
45. Morgagni: Quoted by Pemberton, J. and Whitlock, M.: Large Retroperitoneal Lipoma: Report of a case. S. Clin. North America. **14**: 601, 1934.
46. Morgan, E. K. and Stone, C. M.: Primary Retroperitoneal Leiomyosarcoma. J. Urol. **39**: 63, 1938.
47. Murray, M. R. and Stout, A. P.: Characteristics of a Liposarcoma Grown in Vitro. Am. J. Path. **19**: 751, 1943.
48. Murray, M. R. and Stout, A. P.: Cultural Characteristics of a Haemangioendothelioma. Am. J. Path. **20**: 277, 1944.
49. Newman, H. R. and Pinck, B. D.: Primary Retroperitoneal Tumours: A summation of Thirtythree cases. Arch. Surg. **60**: 879, 1950.
50. Nienhuis, J. H.: Ein lipoplastisches Sarkom mit Metastasen. Ztschr. f. Krebsforsch. **22**: 435, 1925.
51. Pack, G. T. and Anglem, T. J.: Tumours of the Soft Somatic Tissues in Infancy and Childhood. J. Pediat. **15**: 372, 1939.
52. Paine, C. G.: Malignant Neoplasm of Spleen and Bone marrow with Metastases in Liver. J. Path. & Bact. **34**: 139, 1931.
53. Patel and Tubiana.: Quoted by Herdman.[28]
54. Pattison, A. C.: Discussion on the article of Johnson et al. Am. J. Surg. **88**: 160, 1954.
55. Pearce, R. M.: Cancer of the Pancreas and Glycosuria. Am. J. Med. Sci. **128**: 478, 1904.
56. Pemberton, J. De J. and McCaughan, J. M.: Intrarenal and Perirenal Lipomata. Surg., Gynec. & Obst. **56**: 110, 1933.
57. Sabin: Quoted by Wright.76
58. Schulte, T. L. and Emmett, J. L.: Urography in the Differential Diagnosis of Retroperitoneal Tumours. J. Urol. **42**: 215, 1939.
59. Seigmund, H.: Lipoblastische Sarkomatose. Virchows Arch. f. path. Anat. **293**: 458, 1934.
60. Senftleben: Quoted by Knowles.[32]
61. Shaw, A. F. B.: Embryonal Liposarcoma. J. Path. & Bact. **43**: 277, 1936.
62. Sheimnel, A. and Mednick, E. A.: The Roentgen Diagnosis of Upper Abdominal Retroperitoneal Space Occupying Lesions. Am. J. Roent. & Rad. Therapy. **65**: 77, 1951.
63. Sirsat, M. V.: Soft Tissue Sarcomas of the Extremities and Trunk. Indian J. Surg. **18**: 251, 1956.
64. Skjoldborg, H.: Embryonal Liposarcoma. Acta Radiol. **39**: 242, 1953.
65. Stout, A. P.: Liposarcoma—The Malignant Tumour of Lipoblasts. Ann. Surg. **119**: 86, 1944.
66. Stout, A. P.: Sarcomas of the Soft Parts. J. Missouri M. A. **44**: 329, 1947.
67. Stromme, W. B. and Stander, H. J.: Retroperitoneal Tumours simulating Genital

Tract Neoplasms. Am. J. Obst. & Gynec. 52 : 456, 1946.

68. Sweetser, T. H. : Retroperitoneal Tumours Influencing Kidneys and Ureters. J. Urol. 47 : 619, 1942.

69. Teilum, G. : Histogenesis and Classification of Mesonephric Tumours of the Female and the Male Genital System and Relationship to Benign so-called Adenomatoid Tumours (Mesotheliomas). Acta Path. et Microbiol. Scand. 34 : 431, 1954.

70. Vecchiati, R., Carretti, D. and Virgillo, G. : I tumori primitivi retroperitoneali (Statistica di 23 case). Boll. Soc. med.-chir. Modena. 55 : 495, 1955.

71. Von Wahlendorf, L. : Uber Retroperitoneale Lipoma. Arch. f. klin. Chir. 115 : 751, 1921.

72. Ward, G. E. and Stewart, E. H. : Retroperitoneal Cavernous Hemangioma. Am. J. Surg. 80 : 470, 1950.

73. Willis, R. A. : The Spread of Tumours in the Human Body. Butterworth & Co. Ltd., London 1952, p. 14, 195, 219.

74. Willis, R. A. : Pathology of Tumours, 2nd. ed. London, Butterworth & Co. Ltd., London 1953, p. 664, 665, 733, 760, 761.

75. Wollstein, M. : Malignant Hemangioma of Lung with Multiple Visceral Foci ; Report of a Case. Arch. Path. 12 : 562, 1931.

76. Wright, A. W. : Primary Malignant Hemangioma of the Spleen with Multiple Liver Metastases. Am. J. Path. 4 : 507, 1928.

Received for publication on 24-8-'57.

MANAGEMENT OF BLUNT INJURIES OF THE CHEST WITH A SPECIAL REFERENCE TO THE 'CAVE-IN' INJURIES

by S. S. ANAND and WARYAM SINGH, Amritsar.

Fractures of the ribs are amongst the most common injuries met with in civilian practice. As a rule they are dismissed as trivial injuries. However, they can be accompanied, especially if there are multiple fractures, by profound physiological and pathological changes in the respiratory mechanism. In most of the reports published in the literature in the last decade there is a greater appreciation of the fact that about 10 to 20 per cent of cases of blunt or 'closed' injuries of the chest have a fatal ending. Road accidents especially the automobile and 'run over' injuries, account for most of these cases. It is obvious therefore that the number of such cases is bound to increase in our country too with the increasing pace of industrialisation. Of these, the 'stove-in' type of injuries of the chest are the most important because of their gravity. The review of literature shows that this form of injury is uniformly fatal unless prompt and proper treatment is given to the patient to restore his physiological balance, viz., the rapid control of shock and haemorrhage, provision of a clear air-way, drainage of chest cavity, if indicated, and the stabilization of the chest wall.

During the years 1952 to 1957 seventy-five cases of blunt injuries of the chest have been treated in our surgical unit. Ten of these cases had paradoxical respiration and five of them had 'stove-in' or 'flail' chest. These latter injuries would be discussed in detail as most of the reports in literature pertain to a single case (Joslow 1946, Williams 1948, Henry 1957, Cooper 1957) except the presentation of eleven cases by Carter and Ginseffi (1953), of five cases by Bickford and Grant (1956). Proctor and London (1955) and Hulman (1957) have also described two cases each. The review of the literature shows that the 'cave-in' injuries of the chest are not very common. Heray and Eggleston (1951) reported that 63 cases of blunt injuries of the chest were admitted in their hospital in one year, 1949, with 8 cases of paradoxical respiration, and out of these only 4 cases needed surgical intervention. Proctor & London (1955) analysed 344,000 cases of injured people treated at the Birmingham Accident Hospital during nine years from 1944—1952 with paradoxical respiration in eight cases requiring surgical intervention. Of these eight operated cases only one survived. Our 75 cases of blunt injuries could be classified as follows : —

TABLE I

CLASSIFICATION OF 75 CASES OF CLOSED INJURIES OF CHEST

1.	'Blunt injury' chest (Pain on deep breathing and coughing) ..	24
2.	Fracture-rib — uncomplicated (X-ray evidence, crepitus or positive springing test) ..	22
3.	Fracture rib with surgical emphysema ..	8
4.	Fracture ribs, surgical emphysema and obliterated costophrenic angle ..	2
5.	Fracture ribs with haemopneumothorax ..	3
6.	Fracture rib with delayed pulmonary embolism ..	1
7.	Fracture ribs with tension pneumothorax ..	2
8.	Fracture rib with extensive contusion lung ..	1
9.	Multiple fracture ribs with paradoxical respiration ..	5
10.	'Stove-in' chest	
11.	Diaphragmatic herni... lowing closed injury ch...	
	Total ..	

Most of the cases were in the second, third and fourth decade of life, as seen in Table II.

TABLE II

DISTRIBUTION OF AGE

Age	*No. of patients*
0— 5 years	1
6—10 years	5
11—20 years	9
21—30 years	15
31—40 years	15
41—50 years	17
51—60 years	6
61—70 years	5
Over 70 years	2

The mode of injury is shown in Table III.

TABLE III

MODE OF INJURY

Fall from a height	27
Fight with blunt weapons	25
Compression force (by tonga, cart, tractor, debris, etc.)	17
Auto accident	6

It may be emphasised that the five cases of 'stove-in' chest were produced by:

(i) struck by shaft of a tonga
(ii) crushed by a bullock cart
(iii) crushed between a loaded trolley and a wall
(iv) run-over injury by a tractor
(v) head-on collision between a scooter and a bus.

The other associated injuries were as follows:—

TABLE IV

ASSOCIATED INJURIES

Fracture of other bones	12 fractures (in eight patients)
Head injury	3 cases
Fracture of pelvis	2 cases
Ruptured diaphragm	2 cases

In fact the associated injuries like a severe head injury with intra-cranial haemorrhage may be the cause of death as happened in our case no. 5. The rupture of the diaphragm is worth commenting upon. It was seen in two of our cases. This injury is not common in blunt or closed injuries of the chest and is generally missed. The diagnosis is, however, not difficult provided this complication is kept in mind. In both cases of rupture of the diaphragm we were able to obtain a successful repair after thoracotomy.

Pathology of 'stove-in' chest:

'Stove-in' chest has been described as 'flail chest' or 'crushed chest' or 'steering wheel' injury. This is associated with multiple fractures: either anterior when the sternum or costal cartilages may be fractured, lateral: when many ribs may be fractured in two or more places, or posterior when there are multiple fractures of the ribs on either side of the vertebral column. The last type of injury is the most uncommon. This causes a portion of the chest wall to become flail and to 'cave-in' during inspiration producing paradoxical respiration. The paradoxical respiration interferes with normal thoracic respiratory mechanism. This leads to decreased ventilation in the lung and increased respiratory effort resulting in an internal shunt of air between the two lungs producing tendency to anoxia and cyanosis. Besides, the paradoxical and laboured breathing reduces the venous return to the heart and hence results in a diminished cardiac output. This is further aggravated by the pain at fracture sites which produces difficulty in expectoration. Initially the lungs are dry unless there is a co-existing parenchymal injury but within 12 to 24 hours the vicious circle, described above, leads to increased bronchial secretion and the patient develops the clinical picture of a 'wet lung', described by Brewer and his co-workers (1946) who have emphasised that injury to lung produces bronchial spasm and increased secretion. The pain renders the cough ineffectual leading to a tendency for atelectasis and consolidation with infection. This still further interferes with the gaseous exchange. These symptoms produce cyanosis, tachycardia, anxiety and restlessness. The clinical picture may be further aggravated if there is haemothorax, pneumothorax or associated injuries of other parts of body. If these symptoms are not relieved soon, it may lead to death.

In our series of 75 cases the following complications were noticed:—

TABLE V

COMPLICATIONS

Wet lung	6 cases
Haemothorax	5 ,,
Tension pneumothorax	4 ,,
Paradoxical respiration	10 ,,
Diaphragmatic hernia	2 ,,
Acute dilatation of stomach	1 ,,

Emergency treatment:

The most important thing to remember in cases of crushed injuries of the chest is the immediate provision of life-saving measures, viz., adequate air-way, treatment of shock and decompression of haemopneumothorax or tension pneumothorax. The patient can be quickly intubated and aspirated, or immediate tracheotomy may be a life-saving measure as shown by Carter and Ginseffi (1953). A portable X-ray will be helpful in giving the extent of haemopneumothorax but may not show the multiple fractures. Tension pneumothorax may be relieved by a needle in the pleural cavity connected to a water seal. Later on the needle can be replaced by an intercostal catheter connected to a water seal: this is better than a needle and prevents injury to the lung when it re-expands. Massive transfusion of blood will be needed in most of the cases of 'stove-in' chest.

Management of simple injuries:

In ordinary fractures of the rib relief of pain is all that is required. Strapping and narcotics which were used in the past have been completely abandoned. Strapping does not relieve pain and may even cause embarrassment to breathing and circulation. Intercostal block or paravertebral block relieves pain and permits the patient to cough easily.

Accumulation of blood and fluid:

Five cases had blood in the pleural cavity. Simple aspiration was used in three of these cases. No case needed decortication.

Emphysema is much more common than pneumothorax. Subcutaneous emphysema is an index of puncture of the lung. It rarely requires any treatment. When associated with pneumothorax the best form of management is the use of an intercostal catheter, through a trocar, connected to a 'water seal' bottle. We had four cases of tension pneumothorax. They were treated with intercostal aspiration with a needle connected to a tube under water seal.

Management of 'cave-in' chest:

In order to understand the aim of treatment we should emphasise the pathological problems confronting the surgeon:—

(i) Paradoxical movements: with its ill-effects.
(ii) Severe pain from movements of fractured ribs.
(iii) Excessive tracheo-bronchial secretion.

In other words our aim is to provide adequate respiration to break the vicious circle. This can be achieved by the restoration of the integrity of the chest wall to maintain intra-thoracic physiology. Coleman and Caleman (1950) have emphasised the need of internal fixation of multiple fragments of the ribs by wire sutures. We have used sutures of strong silk in one case and stainless steel wire in the second case of cave-in chest which survived by surgical intervention. The ribs can be approached for this purpose either by a para-scapular incision or by a vertical incision in the anterior axillary line (Fig. 1). The stability obtained by this method is quite satisfactory. Coleman has recommended intra-medullary fixation of ribs. We have not felt any necessity of

Fig. 1.
Shows the line of incision employed in our cases.

using any traction. Traction has been advised by many surgeons and many methods have been used for this purpose. Sternum has been fixed by modified cup-hook (Proctor and London, 1955), coat hanger-hooks (Jaslow, 1946). Hudson (1957) has preferred soft tissue traction by passing long metal pins under pectoralis major and serratus anterior muscle: traction being applied with the help of an overhead frame.

Shock is treated by the use of blood, dextran and other intravenous fluids. Pain is relieved by intercostal or paravertebral block or the use of pethidine hydrochloride. If the blood pressure is below 90 mm. of Hg., pethidine is avoided as it may further lower the blood pressure. In such cases procaine is a better analgesic, and is given intravenously: 1 gm. being dissolved in 500 c.c. of saline and given at the rate of 160 drops per minute, i.e. 20 mgms. of procaine should be administered per minute to obtain relief of pain. However morphia in doses of 1/8 to 1/6 gr. can be given every 6 to 8 hours and this relieves the pain without depressing the respiratory centre. Oxygen is administered with the help of an intra-nasal catheter at the rate of 3 litres per minute.

Carter and Ginseffi (1953) have emphasised the use of a tracheotomy in the cases of 'cave-in' chest. They emphasise that tracheotomy provides certain physiological advantages:

(i) Reduction in volume of dead space by 100 c.c. involved in the respiratory tract, in the nasal passage, mouth and pharynx.

(ii) Decrease in resistance to inspired and expired air, as this resistance is mainly in larynx and upper nasal passages.

Besides tracheotomy reduces paradoxical movements, alleviates pain by decreasing the movement of fractured ribs, and provides an easy and ready method for aspirating the tracheo-bronchial tree without taking recourse to the use of a bronchoscope in cases of 'wet-lung'. Carter and Ginseffi have used this method of treatment since 1949 and have reported eleven cases of 'cave-in' chest with two deaths. Hulman (1957) has also reported similar results in two cases. Avery, Head and Hudson (1957) have emphasised the use of tracheotomy in every case, along with the hyperventilation of the chest with the help of a Morsch respirator attached to the tracheotomy tube. We have no personal experience of tracheotomy in these cases.

CASE REPORTS

CASE 1.

M.R., 35 male, electrician, was admitted on 20-2-1952. An hour before admission he was struck in the right side of chest by the shaft of a tonga. He was experiencing severe pain in the region of impact and had expectorated blood. *On examination*, the patient was found to be well-built and well nourished. There was no cyanosis, pulse rate was 90 per minute, respiration 26 per minute, B.P. 120/75 mm. Hg. There was a diffuse swelling on right side of chest with caving-in of the middle part which showed paradoxical movement. Surgical emphysema was present. Percussion note on right side was impaired. Breath sounds were diminished over right side of chest. Medium crepitations were present.

X-ray chest showed pleural fluid on right side with multiple fractures of 3rd to 7th ribs (Fig. 2).

Right side of chest immobilised by sand bags. Oxygen inhalation started.

On 21-2-1952 operative fixation of the ribs was undertaken. A curved incision starting over 7th rib in front rising to the level of the 4th rib in right axilla was made. 3rd to 7th ribs were broken into multiple fragments. Some of the jagged ends being pushed into chest cavity causing an irregular tear in the middle lobe. The

Fig. 2.
Case 1. M.R. Skiagram of chest showing surgical emphysema, haemo-pneumothorax and fractures of 3rd to 7th ribs on right side with wide displacement of fragments.

Fig. 3.
Case 2. K.S. Skiagram of chest showing haemothorax on left side and multiple fractures of 2nd to 9th ribs with wide displacement of fragments outside.

lung was collapsed. Tear in the lung was repaired by interrupted sutures. 4th rib was brought into alignment by three sutures of stainless steel wire. Other ribs were so mutilated that their repair was impossible, so the smaller fragments were removed. A flap of pectoralis muscles was turned down from above to cover the partially repaired chest wall. It gave a satisfactory covering. Wound closed in layers over a drainage tube in the pleural cavity. At the end of operation bronchoscopic aspiration was done.

Except for slight pain in the chest patient did not have any trouble in the post-operative period. On the 17th post-operative day 200 c.c. of blood-stained fluid was aspirated from the chest. Discharged after 5 weeks with fully expanded lung. Followed up for 6 months - except for slight pain in operation scar bed no complaints.

CASE 2.

K.S., 35 male, admitted on 1-4-1957. He was run over by the wheel of a tractor on 31-3-1957 and was experiencing severe pain in the left side of the chest with difficulty in breathing.

On examination, the patient was found to be a well-built hefty individual. He was in acute respiratory distress, with fairly deep cyanosis and a rapid pulse. Respiration was 56 per minute and pulse 128 per minute. Left side of the chest, on the side and anteriorly, showed obvious paradoxical movement. Trachea and heart were shifted to the opposite side. Moist sounds were present on both sides. X-ray revealed collection of fluid on the left side with multiple rib fractures from the 2nd to the 9th rib. The fragments were lying in an outwardly displaced position (Fig. 3).

The chest was immobilised with sand bags and oxygen inhalation intranasally started. But the patient's condition did not improve and the moist sounds in the chest increased. Four days later thoracotomy was performed, through a curved incision over the front and side of left chest, under controlled respiration endotracheal anaesthesia. 2nd to 9th ribs showed multiple fractures and as many as 18 fragments were counted. Fragments with the intervening intercostal bundles were lying in a displaced position. These were replaced as accurately as possible and fractured ends brought together by strong silk sutures passed through drill holes in the adjacent surfaces. The wound was closed in layers.

Patient had a rather stormy postoperative period. There was gradual lessening of cyanosis and clearance of tracheo-bronchial secretions. The paradoxical movement was very slight after the fixation. He was maintained on intermittent oxygen inhalation till respiratory and pulse rates subsided to normal. A collection of blood in the left chest was tapped on 9th post operative day. He was discharged five weeks after admission, in a perfectly fit condition.

Fig. 4.
Case 4, T.S. Skiagram of chest showing opaque left side, pneumothorax and fractured ribs on right side.

Fig. 5.
Case 5, K.R. Skiagram of chest showing pneumothorax on right side with partial collapse of right lung.

CASE 3.

F.C., 35 male, was admitted on 30-4-1957 having been run over by the wheel of a cart. He was in a state of shock and there was caving-in of the chest on the left side. Surgical emphysema was present over the left side of the chest and he was markedly tender all over this side.

He was given 400 c.c. of plasma I/V. The chest wall was immobilised by sand bags. The pulse at this stage was 120 per minute, respiration 28 per minute and blood pressure 130/80 mm. Hg. Portable X-ray picture of chest did not reveal any fractured ribs.

Conservative treatment was continued. On the second day he developed acute dilatation of stomach. A Ryle's tube was introduced and half hourly gastric suction done. Intravenous 5% glucose saline drip started to replace the aspirated fluid.

The respiratory rate remained high and on the third day both sides of the chest became moist. There was difficulty in expectoration. Both lung bases revealed coarse crepitations. His condition was considered too poor for operative fixation of the broken ribs. Expired on 3-5-1957.

Comments :

This case shows that an early surgical intervention is valuable in these cases. In retrospect an immediate tracheotomy may have saved this patient's life.

CASE 4.

T.S., 25 male, labourer by profession, was admitted on 21-1-1957 in a semicomatose condition with surgical emphysema of most of the body surface and marked respiratory embarrassment. He had been sandwitched between a loaded trolley and a wall, half an hour before admission.

Examination revealed extensive surgical emphysema and fairly marked cyanosis. Pulse rate was 112 per minute, respiration 50 per minute and blood pressure 110 ? mm. Hg. There was caving-in of the right side of the chest with marked paradoxical respiration. X-ray revealed fractures of the 5th, 6th, 7th and 8th ribs on the right side while the left side was opaque (Fig. 4).

An airway was introduced into the mouth immediately and oxygen inhalation started. Repeated aspiration of the pharynx were carried out. A wide bore needle was introduced into the right pleural cavity through the 2nd intercostal space and attached to a water-seal bottle, when air started bubbling out with each breath.

The patient's condition worsened and towards the evening he became comatose. He expired 10 hours after admission.

Comments :

This case again shows that delay in taking surgical measures may be fatal. In fact with the passage of time the patient's condition deteriorates and surgery may not be possible at all.

Fig. 6.
Same case as in Fig. 4. Skiagram of chest showing expanded lung after relief of tension pneumothorax by needle introduced in 3rd i.c. space and attached to a water seal bottle.

Fig. 7.
Case 6, S.L. Skiagram of chest showing presence of gas and fluid in left pleural cavity. Outline of left diaphragm is not defined.

CASE 5.

K.R., 65 male, was admitted on 1-1-1953 with a history that he had been pinned down under his bullock cart 3 hours before admission, and had since then developed marked breathlessness with pain on the right side of his chest and over the back.

Examination revealed a patient of moderate build and nourishment. There was no cyanosis, respiration was 28 per minute, pulse 120 per minute and blood pressure 120 85 mm. Hg. Paradoxical movements were present over lower part of right side of the chest. Percussion revealed a hyperresonant note on the right side, with distant breath sounds on auscultation. Heart and trachea were shifted to the opposite side. A diffuse, tender, 5" x 4" swelling was present over the dorsolumbar spine. Spinal movements were not possible; there was no paresis or sphincter derangement. X-ray of the chest revealed pneumothorax on the right side (Fig. 5). X-ray of the spine showed compression fracture of the second lumbar vertebra.

He was placed on a fracture bed and the paradoxical movements of the right side of chest controlled by immobilising with sand bags. A wide-bore needle was introduced into the right pleural cavity through the third intercostal space anteriorly, and connected to a water-seal bottle; air started bubbling out immediately. The patient was feeling much improved in a short while. The needle was removed after 5 days, when crepitations appeared over bases of both the lungs and patient had difficulty in coughing out. After this air under positive pressure was withdrawn from the right pleural cavity on a number of occasions till 18 days after admission, when expansion of the lung occurred (Fig. 6). The paradoxical movements of the chest wall, had by this time become of a very minor degree. The patient was discharged after seven weeks and advised to lie on a hard bed for a further period of 7 weeks.

CASE 6.

S.L., 31 male, a University teacher, was admitted on 30-10-1957, with a history that on 3rd August 1957, the patient slipped over a stone while holidaying in Kashmir and fell against a large boulder while a heavy stone fell over him. He immediately experienced difficulty in breathing with pain and heaviness over the left chest, the pain increasing on deep breathing and coughing. He was diagnosed, at a local hospital, as having fractures of 9th, 10th and 11th ribs on the left side. He also had separation of the symphysis pubis with fracture of pelvic bones for which a plaster jacket was applied. His chest pain gradually improved.

Fig. 8.
Same case as in Fig. 6. Bairum enema reveals shifting of splenic flexure into left pleural cavity.

Fig. 9.
Same as in Fig. 6 and 7. Post-operative skiagram of chest showing an expanded left lung. There is a minimal amount of fluid at the costophrenic angle.

Examination on admission revealed the presence of fluid in the left side of chest along with a pleural rub over the left lower part of the chest. An X-ray showed presence of gas and fluid in the peripheral lower part of the left side of the chest (Fig. 7). A diaphragmatic hernia was suspected and was confirmed by a barium enema which revealed the shifting of splenic flexure of the colon into the left chest. (Fig. 8).

Thoracotomy was performed on 5-11-1957, opening up the left chest through the 8th intercostal space. Splenic flexure, most of the stomach, part of the spleen and a bit of the left lobe of liver were occupying most of the left pleural cavity. The left lung was partiaily collapsed. A big triangular rent was found in the anterior part of the left diaphragm, where the diaphragm had been detached from its anterior costal attachment, leaving a gap about 6" x 4". There were no adhesions between the prolapsed abdominal contents and the diaphragm. The viscera were returned to the abdomen and the rent in the diaphragm repaired, with some difficulty, by strong interrupted sutures of silk. The chest was closed over a drainage tube brought out through the lower intercostal space. The postoperative period was smooth, except for some collection of fluid in the left pleural cavity, which was aspirated twice. The left lung expanded (Fig. 9). The wound healed by primary intentions.

Results

75 cases of blunt injury have been treated. There were five deaths.

Table VI

MORTALITY

1.	'Stove-in' chest with wet lung and acute dilatation of stomach ..	1
2.	'Stove-in' chest with tension-pneumothorax and opposite haemothorax ..	1
3.	Severe head injury with intracerebral haemorrhage along with 'cave-in' chest ..	1
4.	Tension pneumothorax with head injury and fracture of forearm ..	1
5.	Fracture rib with delayed pulmonary embolism ..	1
		5

Of the five cases of 'cave-in' chest only 2 cases were submitted to surgery for stabilisation of the chest with recovery in both the cases. The other three cases died: one case died an hour after admission in the hospital due to associated fracture of the skull with massive intra-cranial haemorrhage. The second died after 10 hours of associated tension pneumothorax on the same side as cave-in chest and massive haemothorax on opposite side. The third patient died after 3 days of wet lung and acute dilatation of stomach.

Discussion

Blunt injuries of the chest can be a serious surgical problem specially if there is a 'cave-in' chest injury. It is important, therefore, in cases of paradoxical chest to restore the normal physiological respiratory mechanism, either by the restoration of the integrity of the chest wall or by an early tracheotomy, otherwise there is a great danger of a fatal outcome by the development of a 'wet-lung' with all its complications. The ease of respiration was noticed in two of our cases in which fixation of the ribs has been obtained by silk or stainless steel wire sutures. External traction is not needed in such cases if a satisfactory fixation of the rib fragments has been obtained.

Summary

1. 75 cases of blunt injuries of the chest have been analysed.

2. The pathology and clinical features of the 'stove-in' chest have been discussed.

3. Emphasis has been laid on the early management of these cases by emergency measures to restore a normal air-way and blood-volume to prevent cyanosis and anoxia.

4. Advantage of stabilisation of the chest wall in cases of 'flail chest' has been stressed to provide a normal physiological respiratory function.

5. Stress has been laid on the use of inter-costal or para-vertebral block for the relief of pain. If this fails intra-venous procain should be given at the rate of 20 milligrams per minute. This relieves anxiety also.

6. An early tracheotomy may be a life-saving measure in many cases of crushing injuries of the chest.

References

1. Avery, E. E., Head, J. R. and Hudson, T. R.: Am. Jour. Surg. **93**: 540, 1957.
2. Belsey, R.: The Practitioner. **170**: 134, 1953
3. Bickford, B. J. and Grant, A. F.: Am. Roy. Coll. Surg. **19**: 371, 1956.
4. Brewer, et al.: Ann. Surg. **123**: 343, 1946.
5. Cameron, D. A., O'Rourke, P. U. and Burt, C. W.: Am. Jour. Surg. **75**: 668, 1949.
6. Carter, N. and Ginseffi, J.: Surg., Gynec. & Obst. **96**: 55, 1953.
7. Coleman, F. P. and Coleman, C. L.: Surg., Gynec. & Obst. **90**: 129, 1950.
8. Cooper, E.: B.M.J. 1357, Aug. 31, 2, 525.
9. Guenkdjian, S. A.: B.M.J. 1957, Oct. 12, 2 884.
10. Henry, L.: B.M.J. 1957, Aug. 10, 2, 339.
11. Heroy, M. W. and Eggleston, F. C.: Ann. Surg. **133**: 135, 1951.
12. Hulman, S.: Lancet, 1957, March 2, 1, 1454.
13. Hoslow, I.: Am. Jour. Surg. **72**: 753, 1946.
14. Jaslow, I. A.: Am. J. Surg. **72**: 753, 1946
15. Proctor, H. and London, P. S.: Brit. Jour. Surg. **42**: 622, 1355.
16. Rhind, A. S.: B.M.J. 1957, Aug. 24, 2, 470.
17. Williams, M. H.: Ann. Surg. **128**: 1006, 1948.

Received for publication on 24-1-'58.

LYMPHANGIOPLASTY FOR FILARIAL LYMPHOEDEMA

*by U. MOHAN RAU, Madras.**

Chronic lymphoedema of the inferior extremities, a disabling and disheartening condition to the patient, still continues to be one of the most disappointing in its treatment. From time to time several surgical attempts have been made to relieve the inconvenience and deformity caused by this condition. One of the earliest operations carried out (as early as 1908) was Sampson Handley's lymphangioplasty, where he used subcutaneously buried strands of silk to act as wicks to drain away the lymph from the lymphoedematous area. His were cases of "brawny arm of breast cancer." The procedure about to be described here is a modification of this operation, using nylon strands instead of silk.

Pathological changes underlying this operation.

The term lymphoedema here refers to oedema resulting from obstruction to the lymphatic flow. In South India, one of the commonest causes of chronic lymphoedema of the interior extremities is obstruction of the lymph conduits and lymph glands draining the extremities by filarial infection; there is usually a superadded pyogenic component.

The investigations of Bhaskara Menon [2], of Acton & Rao [1] and others have shown that the skin and subcutaneous tissues were chiefly involved in the pathological changes that were produced as a result of this lymphatic obstruction and back pressure. *Microscopically* in the initial stages there was a marked dilatation of the *superficial lymph capillaries*: these vessels, hardly visible normally, became very prominent and appeared as irregular slits lined by flat endothelium. There was widening of the tissue spaces due to oedema. *Later on*, there was excessive development of fibrous tissue in the subcutaneous region and fibrotic thickening of the dilated lymphatics.

Anatomy of the lymphatics.

All the lymphatics of the normal skin and subcutaneous tissues below the level of the umbilicus drain into the inguinal group of lymphatics and lymph glands. The lymphatics above the level of the umbilicus drain into the axillary glands on the corresponding side (Fig. 1).

The aim of the operation was to drain the lymph contained in the dilated lymph capillaries and subcutaneous spaces of the diseased limb into a lymphatic field where drainage was not obstructed. This was achieved by burying long strands of nylon from the subcutaneous tissues of the inferior extremity across the groin, into the subcutaneous regions of the upper portion of the abdominal wall and lower portion of the chest.

Technique of the operation.

A. Lymphangioplasty. Under general anaesthesia a small incision was made into

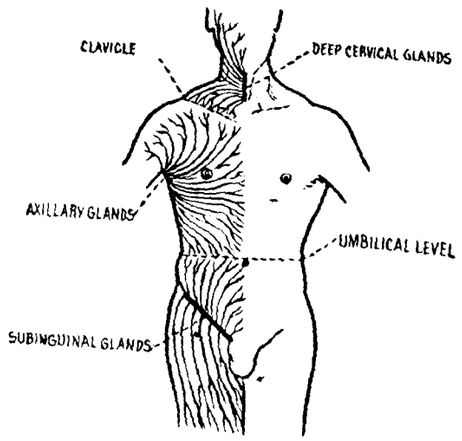


Fig. 1.
A diagramatic representation of the superficial lymphatic "fields". (After Megregor)

* From a surgical unit, Govt. General Hospital, Madras.

Fig. 2-A.
Before lymphangioplasty.

Fig. 2-B.
Soon after lymphangioplasty.

Fig. 2-C.
9 months later. The improvement seen in 2-B has not been maintained.

Fig. 2-D.
Soon after excision of excess tissue and excess skin from the legs.

Fig. 2: Case No. X.
(Measurements are given in Table 4)

Fig. 3-A.
Before lymphangioplasty.

Fig. 3-B.
8 months later.

Fig. 3: Case No. VIII.
(Measurements are given in Table 2)

Fig. 4-A.
Before lymphangioplasty.

Fig. 4-B.
3 years later. There is complete regression of lymphoedema.

Fig. 4: Case No. IX.
(Measurements are given in Table 3)

the subcutaneous tissue near the nipple on the side of the lymphoedema. Through this, a long eyed-probe on which two long (40″) strands of nylon had been threaded was introduced. The tip of the probe was pushed subcutaneously in a downward direction, as far as it would go. Then a second incision was made over the tip of the probe and the probe and nylon were pulled out from the subcutaneous region through this second incision. The tip of the probe was then re-introduced through the same (second incision) and pushed through the subcutaneous tissue in a downward direction, as far as it would go. A third incision was made over the tip of this probe and then the probe and nylon delivered through this as before. This process of burying the nylon strands through the subcutaneous tissues was repeated till the region of the ankle was reached, thus burying two long strands of nylon from the chest to the ankle, subcutaneously. There was no necessity to fix these strands in the subcutaneous region. Usually six strands of nylon, in groups of two each, and about an inch apart were buried and for each pair 4 small ($\frac{1}{2}$″) incisions were used. For the occasional bleeding from the incisions, haemostasis was procured by manual pressure. The incisions were closed with one stitch for each incision, then dressed, as usual, and the patient returned to the ward.

The above procedure, from above downwards was useful for the *left inferior extremity; on the right side*, the same technique was adopted except for the fact that it was easier for right handed surgeons if the nylon strands were threaded from below upwards i.e. through an initial incision in the ankle region to a final incision in the lower chest. The patient was ambulant from the first post-operative day, though he was advised to support the subcutaneous tissues of the entire extremity by an elastic crepe bandage. Whenever the patient was recumbent he was kept with the foot of the bed raised, as this position facilitated the return of lymph along the nylon strands. Discharge from the hospital was usually on the seventh post-operative day.

B. Lymphangioplasty and excision of the filarial tissues. In three of the later cases, in which there was a lot of hyperplastic filarial subcutaneous tissues and excess of skin, lymphangioplasty was combined with excision of these excess tissues. In the case of the foot, excision was done by a midline dorsal incision, with an extension to the medial and lateral borders of the foot from the lower end of the median dorsal incision. After excision of the subcutaneous tissues, the excess in the skin flaps was suitably trimmed. In the case of the leg, similar procedures were adopted using two longitudinal incisions — one on the inner and another on the outer aspect of the leg (Figs. 5-B & 5-C).

Fig. 5-A.
Before operation.
Fig. 5: Case No. XI.
(Measurements are given in Table 5)

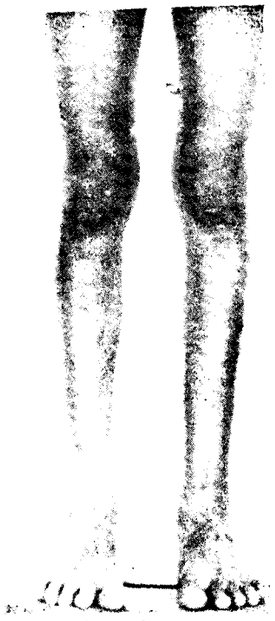


Fig. 5-B.

Fig. 5-C.

Figs. 5-B & 5-C. Antero-posterior and lateral views a month after lymphangioplasty combined with excision of excess tissues. The post-operative scars on the dorsum of the foot and on the lateral aspect of the leg are faintly visible.

Fig. 5: Case No. XI.
(Measurements are given in Table 5)

Fig. 5-D.
4 years later.
Fig. 5: Case No. XI.
(Measurements are given in Table 5))

Results

Total No. of cases operated upon between 1948 and 1952:—

I.	Lymphangioplasty only	11
II.	-do- plus excision of filarial tissue	3
	Total	14

Mortality of these operations:— Nil.

Early Results

I. Early results of lymphangioplasty alone.

(A) *Subjective relief.* The immediate results have been very satisfactory. All the patients felt the condition of their limbs to have improved very much. Though prior to the operation, they used to have some diminution in the size of their diseased limbs after a good night's rest, they all expressed that the shrinkage was very fast in the post-operative period. Heaviness was less, especially at the end of a day and after prolonged standing.

(B) *Clinically*, good shrinkage of the operated limbs was noticed (Figs. 2-A & 2-B).

(C) *Measurements in the immediate post-operative period.* Measurements of the circumferences of the diseased inferior extremities were taken before the operation and in the post-operative period, on several occasions. These measurements were taken at the sites of maximum girth and were constant for each case in the pre-operative and post-operative periods and also later on, during follow-up. For e.g. in Case IV (Table I) the measurements in the upper third and in the lower third of the leg were taken at points 12.5 cm. and 25 cm. respectively below the upper border of the tibial tubercle; the measurements of the foot were taken at a point 10 cms. behind the tip of the great toe.

These measurements confirmed the subjective and objective impressions that the operated limbs did shrink in girth after lymphangioplasty (vide Tables 1, 2, 3, 4 and 6).

II. Early results of lymphangioplasty combined with excision of filarial tissues.

The measurements taken a few days after this operation are bound to show a marked diminution in the circumferences of the diseased limbs because of excision of a large amount of filarial tissue and excess skin (Tables 4 & 5).

Figs. 2C & 2D and 5A, 5B & 5C show the results in two of the cases so treated.

Late Results

I. Cases on whom lymphangioplasty alone had been done.

Eight out of the eleven cases operated upon could be traced post-operatively (cases I, II, IV, VI, VII, VIII, IX & X for 7½ years, 8 years, 8 years, 2½ years, 3 years, 5 years, 4 years and 1 year respectively).

A. *Subjectively*, all these patients reported that the improvement noted soon after the operation had persisted even at the time of the follow up. Walking and running which used to cause a feeling of heaviness in the diseased extremities prior to the operation, were now much easier than before. Movements of the limbs at the ankles were freer than before. But, except case IX (Figs. 4 A & B) all were *disappointed that the diseased limbs were still bigger than the opposite healthy limbs* (E.g. Fig. 2C; Fig. 3B).

B. *Measurements* of the circumference showed satisfactory improvement in case IV (Table 1), case VIII (Table 2), and case IX (Table 3) only. In the other five cases, there was no change whatever when compared with the pre-operative measurements: *the slight improcements noted in the immediate post-operative periods were not maintained later on.*

C. *Clinical photographs*, from case VIII (Fig. 3 A & B) and case IX (Fig. 4 A & B) taken 8 months and 3 years, respectively, after the operation, show the good results.

Comments. Though subjectively almost all the patients felt greatly improved, measurements and other evidence showed that in only three out of the eight cases that could be followed up, were the results fairly good. Even in these three cases, in two, though there was some diminution in the size of the diseased limbs, the limbs *were never restored to the dimensions of the opposite healthy limbs.*

II. Late results of cases on whom lymphangioplasty and excision of tissues had been done.

All the three cases (case X, XI & XIV) were followed up. Two, cases X and XI (Fig. 5 D) were quite happy and felt that their limbs were almost normal. Case X, who was operated upon on 16-7-52 succumbed to a virulent attack of gastro-enteritis on 26-11-55. But he was fit and happy and the limb was normal till the time of his death.

Case XI who used to have frequent recurrent attacks of filarial fever prior to

the operation had been free from these pyrexial attacks for four post-operative years; however in November '56 he reported with a mild attack of lymphangitis in the diseased extremity.

Measurements of the circumference of the limbs in these two patients (Tables 4 & 5) revealed great improvement in the girth of the operated limbs even after the lapse of $1\frac{1}{4}$ years and $4\frac{1}{2}$ years respectively.

Case XIV was very badly disappointed. He had had recurrent attacks of fever with painful swelling of the extremity operated on, on several occasions. The heaviness and discomfort in the extremity were the same as before. After one of the attacks in January '56 he reported with several sinuses discharging pus, the sinuses being along the course of some of the nylon strands.

His clinical photographs (Fig. 6 A & B) show the very poor result.

Discussion

It is worthwhile considering some aspects of nylon lymphangioplasty.

A. *Do nylon strands act as lymphatic wicks soon after the operation?*

The following observations prove that monofilament nylon strands buried in the subcutaneous tissues act as wicks for drainage of lymph fluid from these tissues:—

(i) *Clinical experiences of other authors.*
(a) Ranshoff[5] has reported a case of lymphoedema of the right upper extremity, which was relieved of the lymphoedema by lymphangioplasty using long nylon strands.

(b) Zieman[7] has had splendid results using a special technique of nylon lymphangioplasty in several cases of lymphoedema of the extremities.

Fig. 6-A.
Before operation.

Fig. 6-B.
One year later — to show the poor result. Th badly healed post-operative scars are visible the leg.

Fig. 6: Case No. XIV.

Fig. 7-A.
15 minutes after injection of "Pyelosil".

Fig. 7-B.
2 hours after injection of "Pyelosil".

Fig. 7: Case No. X.
Lymphangioplasty done on right side — one month ago.

Fig. 8-A.
15 minutes after injection of "Pyelosil".

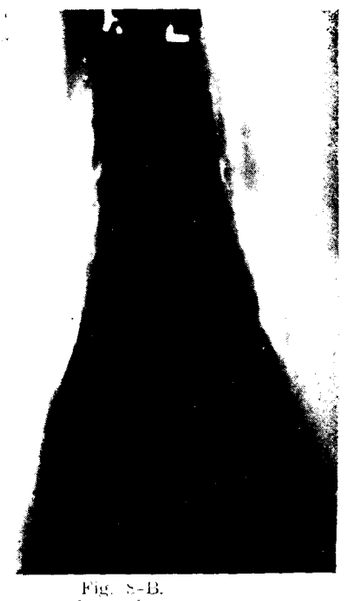


Fig. 8-B.
2 hours later.

Fig. 8: Case No. XI
Lymphangioplasty done on left side — one month ago.

Fig. 9-A.
15 minutes after injection of "Pyelosil".

Fig. 9-B.
2 hours later.

Fig. 9: Case No. VIII.
Lymphangioplasty done on left side — 8 months ago.

(ii) *Experiences in the series of cases herein reported*:

(a) All these patients were unanimous in their appreciation of the almost dramatic relief of some of their symptoms in the post-operative period. As already reported in this article, all of them felt that walking with the diseased, heavy and "water-logged" limbs was very much easier than before. Probably this was because of the rapid drainage of lymph from the subcutaneous tissues, along these strands as soon as fresh lymph was formed.

(b) Measurements (Tables 1, 2, 3, 4 & 6) of these limbs in the post-operative period confirm the diminution in the size of these limbs.

(c) *Time taken for the disappearance of radio-opaque solution.* The main principle underlying the operation of lymphangioplasty was to drain the stagnant fluid from the subcutaneous filarial tissues, along the nylon strands. A visual, though a crude method of demonstrating this rapid draining of fluid from the subcutaneous tissues was adapted from Rose[6]. *Technique.* The patient was recumbent in the supine position, on the X-ray couch. Two identical spots were selected on the lateral aspects of each of the thighs, about their middle. 10 c.c. of "Pyelosil" mixed with 5 c.c. of 1% Novocain was injected into the subcutaneous tissues on either side; after withdrawal of the needle, gentle pressure (& not massage) was applied to the puncture points for a few seconds, to prevent any leakage of the injected fluid.

With the patient lying in this position X-ray pictures of the soft tissues of the thighs were taken, at intervals till the shadows cast by the radio-opaque solution became very indistinct.

Apart from slight to moderate discomfort at the time of, and at the site of injection, all the patients who have had these injections had no complications.

As the radio-opaque solution was bound to be diluted by filarial odematous fluid, the injections were all made in the thigh so as to avoid the legs and feet, where there was lymphoedema. For a similar reason, the injections into the thighs were not made till at least a month had elapsed after the lymphangioplasty. This period was considered to be sufficient (as judged by local clinical signs) for the complete subsidence of post-operative reactionary oedema. All the factors having remained the same, it was presumed that the quicker

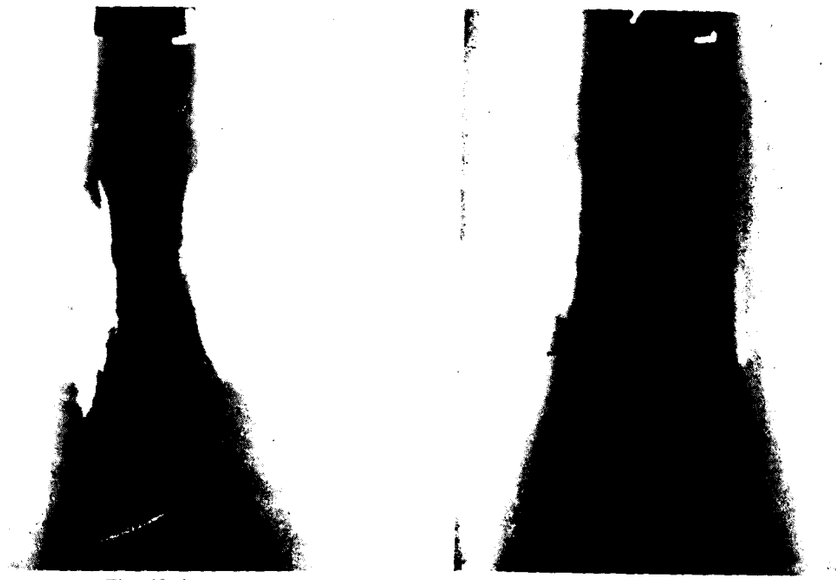


Fig. 10-A.
15 minutes after injection of "Pyelosil".

Fig. 10-B.
2 hours later.

Fig. 10: Case No. IX.
Lymphangioplasty done on left side — 3 years ago.

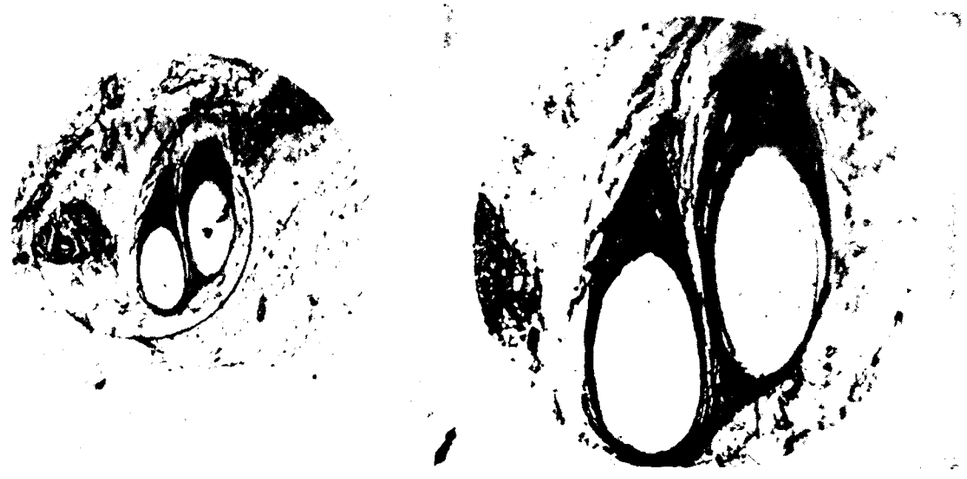


Fig. 11-A. (x 240)

Fig. 11-B. (x 480)

Fig. 11.
Photomicrographs from a slide taken from a block of tissue removed by operation from Case No. I, three years after lymphangioplasty.

disappearance of the radio-opaque solution on any one side, indicated quicker drainage of the fluid from the subcutaneous tissues of that limb.

Results.

This was tried in six out of these 14 cases. In every one of them the *radio-opaque solution disappeared quicker on the side of lymphangioplasty than on the non-operated healthy side.*

Two illustrative series are appended herewith : —

Fig. 7 A & B Case No. X.
Fig. 8 A & B Case No. XI.

Comments.

(i) *It is a probability* that the radio-opaque solution disappeared faster on the side of lymphangioplasty because of the solution diffusing both upwards and downwards along the nylon strands, and not because of any capillary action sucking the tissue fluid proximally along the nylon strands. Even if this is so, it proves that the lymph fluid can diffuse along these strands. With the increased pressure of the lymph in the lymphatics and tissue spaces of the filarial leg, the flow is bound to be proximally along these nylon strands and away from the inferior extremity, especially during recumbency.

(ii) It has been commented that the quicker diffusion of radio-opaque solution from the subcutaneous regions of the *thighs did not necessarily prove* that the lymph and tissue fluids from the *distal leg and foot* were also drained away equally well. But the work of Kinmonth [4] and others has demonstrated the extensive lymphatic intercommunications in an elephantoid limb ; hence efficient drainage from one area of this lymphatic network must also mean efficient drainage from the rest of the area.

B. *Do the nylon strands act as lymphatic wicks several months after the operation ?*

(i) *Subjective.* From the late follow-up results presented hitherto, it will be seen that ten patients reported that walking and running which used to cause a feeling of heaviness in the diseased extremities prior to the operations were now as easy as it was in the immediate post-operative period.

(ii) Five of the fourteen patients operated upon gave a pre-operative history of recurrent attacks of fever, with inflammation in the elephantoid leg. It was gratifying to note that four out of these five patients were free from these attacks for nearly eighteen months, post-operatively. Two of these four, where results were not satisfactory, have had subsequent febrile attacks ; but the attacks have occurred at very much longer intervals and have been milder. The investigations of Homans and Drinker [3], of Acton and Rao [1], have shown that one of the commonest causes of the recurrent attacks of fever in these patients with lymphoedematous limbs, was recurrent pyogenic infection of the stagnant lymph in the diseased limbs. The remarkable diminution in the febrile episodes post-operatively, in some of our cases was probably due to an efficient draining away of lymph from the elephantoid limbs *via* the nylon strands.

(iii) *Diffusion of radio-opaque solution.* For lack of co-operation from the patients, it was difficult to carry this out in all the patients. Only four patients were willing to have the radio-opaque solution injected and to have the pictures taken. In these four cases the Roentgenograms were taken on five occasions — in case IV, in case VIII, in case IX, and case XI (twice), 4 years, 8 months, $4\frac{1}{2}$, and 1 year and $4\frac{1}{2}$ years respectively after the lymphangioplasty.

All these cases showed the radio-opaque solution diffusing much faster on the side of lymphangioplasty than on the non-operated side.

The roentgenograms of 2 typical results are reproduced here : —

Fig. 9 A & B Case VIII.
Fig. 10 A & B Case IX.

TABLE 1

Measurements of circumference in centimeters.
Case IV (operation on 15—3—49)

Date	Leg (upper 1/3)	Leg (lower 1/3)	Foot
10— 3—49	35	32	30
25— 3—49	31.2	29.5	30
6—10—49	32.5	30	30
30—11—56	28.7	25	25

TABLE 2

Measurements of circumference in centimeters.
Case VIII (operation on 8—5—51)

Date	Leg (upper 1/3)	Leg (lower 1/3)	Foot
	— Lt		
7— 5—51	32.5	25	23.7
10— 5—51	30	22.5	23
13—10—51	30.2	23	23.2
10— 5—53	30	25	23
26— 2—56	30	24.5	23
	— Rt		
	27	18.8	23

TABLE 3

Measurements of circumference in centimeters.
Case IX (operation on 13—10—51)

Date	Leg (upper 1/3)	Leg (lower 1/3)	Foot
	Lt		
8—10—51	23.7	21.3	25
26—10—51	21.9	18.1	23.2
26—12—55	20.5	17.7	22
	Rt		
	20.2	17.7	20.7

TABLE 4

Measurements of circumference in centimeters.
Case X (operation on 3—11—51
Lymphangioplasty done)

Date	Rt. leg (upper 1/3)	Rt. leg (lower 1/3)	Rt. foot
1—11—51	30.6	24.4	25
21—11—51	26.1	21.2	22.5
14— 7—52	30.6	24.4	25
Excision of filarial tissue done on 16—7—52.			
7— 8—52	26.1	22.5	22.5
20—11—54	26.1	22.5	22.5

TABLE 5

Measurements of circumference in centimeters.
Case XI (operation on 13—11—51)
Lymphangioplasty and excision of filarial tissue)

Date	Leg (upper 1/3)	Leg (lower 1/3)	Foot
	Lt		
4—11—51	27.1	24.4	26.2
27—11—51	23	21.3	22.5
12— 2—56	24.5	21.5	23
	Rt		
	24.5	20	23

TABLE 6

Measurements of circumference in centimeters.
Case XII (operation on 11—12—51)

Date	Leg (upper 1/3)	Leg (lower 1/3)	Foot
	Lt		
2—12—51	31.5	24.4	23.7
10—12—51	26.2	23.7	23.7
3— 5—52	30	23.7	23.7
	Rt		
	23.1	17.5	20.6

C. *Do these nylon strands remain unabsorbed in the filarial tissues and do they give rise to any violent inflammatory reaction?*

An excellent opportunity was afforded when Case I which was operated upon in February 1948, presented himself for an operation for bilateral hydrocele in March '51. With his permission a block of tissue around two of the buried strands of nylon was excised.

Macroscopically there was very little of scarring around these nylon strands, *which were still in situ and appeared unchanged.*

Microscopically (Fig. 11) the histologist reports:—

"Apart from some fibrous and sparse collection of chronic inflammatory cells, there appears to be very little pathology. Cross-section of nylon strands are easily made out in clear, well defined spaces".

Conclusions

Our observations carried out for nearly *six years on a very small series of* 14 *cases* show that nylon lymphangioplasty has given quite satisfactory results only in three cases, which had mainly lymphoedema (Case Nos. IV, VIII & IX). In the other patients who had a lot of hyperplastic subcutaneous tissues and excessive skin besides lymphoedema, *mere lymphangioplasty was not satisfactory*; even though we have indirect evidences to show that the lymph was being efficiently drained away, the excess tissues did not regress. In 3 cases of this type, lymphangioplasty combined with excision of the excess skin and the hyperplastic subcutaneous tissues was done; in two of these, there were good short and long term results. Cases Nos. X & XI).

Almost all the cases that were operated upon were from an economically poor class of patients, who worked and walked about bare-legged and bare-footed and hence could not have elastic supports for the diseased limbs. Some of them were very neglectful of the hygienic care of the oedematous limbs. If these precautions had been taken, the percentage of good results might have improved in our series.

References

1. Acton, H. and Rao, S. S.: "The Pathology of Elephantiasis of filarial origin". Indian M. Gaz. **68**: 305-315, 1933.
2. Bhaskara Menon, T.: "Problems in Filariasis". Thompson & Co. Ltd., Madras. 1935. Pp. 46 & 47
3. Homans, J., Drinker, C. K. and Field, M.: "Elephantiasis and Clinical implications of its experimental reproduction in animals". Ann. Surg. **100**: 812-831, 1934.
4. Kinmonth, J. B.: "Lymphangiography in Clinical Surgery and particularly in the treatment of lymphoedema". Ann. Roy. Coll. Surgeons, England. **15**: 300-314, 1954.
5. Ranshoff.: "Surgical Treatment of Lymphoedema". Arch. Surg. **50**: 269-270, 1945.
6. Ross, S. S.: "Discussion on the treatment of chronic oedema of the leg". Proc. Roy. Soc. Med. **43**: Section on Surgery No. 4. 1057-1058, 1950.
7. Zieman, S. A.: "Re-establishing lymph drainage for lymphoedema of the extremities". J. Internat. Coll. Surgeons. **15**: 328-331.

Received for publication on 23-9-'57.

WAX PLOMBAGE THORACOPLASTY IN PULMONARY TUBERCULOSIS

by K. K. CHATURVEDI, Ranchi.

Introduction

In the treatment of Pulmonary Tuberculosis, sanatorium regime, which was introduced over fifty years back, still forms the back bone of our treatment inspite of the fact that chemotherapy with various antibiotics has very decidedly changed the past gloomy outlook into one of hope, and has also changed a very strict past regime into one more liberal. Surgery, in its various forms, has been an important therapeutic contribution in the management of pulmonary tuberculosis during the last 30 years, and is still used extensively in all the progressive institutions all over the world. Time has proved its worth in restoring to health a large number of patients, who were otherwise doomed to an inevitable end.

The growth of surgery has been more rapid during the last 20 years. Before that it was used occasionally, and by a few physicians only. Today we find that nearly 50 to 80 per cent of all cases in leading tuberculosis centres are offered some sort of surgery [1]. The various surgical procedures used today can be divided into two main groups:—

I. Resection Surgery — which aims at extirpation of the foci of infection and the disease bearing area. It is an ideal procedure as far as its aims are concerned, though in practice we cannot apply the same principles in all cases. Resection Surgery according to its extent is further subdivided into —

(a) Pneumonectomy, in which an entire lung is removed.

(b) Lobectomy, in which an entire affected lobe is resected.

(c) Segmentectomy, in which one or more affected segments of a lobe or lobes are resected.

II. Collapse Therapy Measures — These include nearly ten different types of operative procedures which had been used singly or in various combinations such as, artificial pneumothorax, with or without internal pneumonolysis, pneumoperitoneum, phrenic interruption, extrapleural pneumonolysis with air or other solid filling materials, and various forms of thoracoplasties. Time has shown the comparative value of each one of these procedures; and some of them which were used extensively before, such as artificial pneumothorax, have only a very limited use now, whereas for the others the indications have been much extended as a result of wide application of chemotherapy.

The aim of the various forms of collapse measures is to provide relaxation and rest to the constantly moving lung, an important factor on sound surgical principles to promote healing of the tissues which is not possible only by bed rest alone. Resection surgery, in properly selected cases, has further widened our field of therapy and has shown encouraging results; and some of the clinics in the U.S.A. are practising it nearly to the exclusion of practically all collapse measures. How far they are justified in their decision, time will only prove. However, resection surgery too has its own limitations and cannot be applied in any and every case; and thus there are still quite a large number of cases which need some sort of collapse therapy to help them.

Thoracoplasty of the modern paravertebral type has been the operation of choice in a large percentage of patients with pulmonary tuberculosis where surgical therapy is indicated, and in these cases it has decidedly helped the otherwise hopelessly advanced cases to a condition of amelioration of their symptoms and restoring them to a useful and comfortable

life. This operation has now withstood the test of time during the last 30 years, and from the results published from various institutions all over the world, it has become definitely established that this procedure has arrested the disease in a large percentage of patients. Further, when the procedure is carried out in properly spaced multiple stages the risk of operation is minimal and complications very few.

Each successive generation of surgeons, since the time of de Cerenville of Lausanne, who performed the first operation of thoracoplasty in 1885, has tried to improve on the technique of the older methods and make the operation safer and more effective and less traumatizing, bringing the mortality rate to a very low figure of less than 2%. But in spite of the various improvements in the technique, there have been still definite drawbacks which leave room for further improvement, such as—

(a) Post operative deformity, a thing rather resentful to the fair sex, and definitely deleterious in young growing children.

(b) Paradoxical movements of the lungs with its inherent danger of spread to unaffected areas of the lungs.

(c) Multiple stages of the operation, a deterrent factor in the poor class of patients with its consequent prolonged hospitalization and increased cost of treatment. Also psychologically the patients feel more nervous with a prospect of repeated surgical procedures.

(d) Re-expansion of the collapsed lung post-operatively in a number of patients, leading to re-opening of the cavities and increasing morbidity with positive sputum for T.B. and invariably calling for further surgery in the form of thoracoplasty or resection with its attendant surgical risk.

History of Evolution

In order that the benefits of surgical collapse may be further improved, a number of auxilliary procedures have been employed from time to time. The success of these measures has been variable. Some of these procedures have been Extrapleural in type, whereas others are Subcostal or Supra-periosteal interventions.

Shortly after the introduction of thoracoplasty, Tuffier [12] was the first to suggest in 1891 the operation of Extrapleural Pneumonolysis by separating the lung and both leaves of pleurae from the thoracic wall. In 1893 he performed an Extrapleural pneumonolysis without filling [13] for a case of severe haemoptysis, which was thereby stopped. In 1901 Sarfert [9] performed an extrapleural pneumonolysis with gauze filling, and in 1907 Schlange [10] used the same operation. Tuffier was the first to use a filling of fat in 1910. Paraffin was used first as a filling by Baer [3] in 1913. Since then various types of filling materials were used by various workers; thus muscle graft by Hedblom [5] rubber sheeting by Lilienthal [7] and plastic materials by Wilson [14]. It should be admitted that these procedures have proved useful in properly selected cases with specific types of lesions. An unwarranted extension of their use has been the cause of discredit in many cases.

Extrapleural pneumonolysis, with air refills and with various types of filling materials, as mentioned above, came into use as a result of acceptance of the principles of collapse therapy; but which could not be utilized satisfactorily in a number of cases of artificial pneumothorax, because of pleural adhesions and a consequent unsatisfactory and non-selective collapse of the lung. This operation was performed without a concomitant thoracoplasty, and the parietal layer of the pleura was separated from the chest wall through the endothoracic fascia. In 1914, Sauerbruch reported on the result of a number of cases of this procedure; but in all of them the post-operative reactions were marked and there was a good deal of sero-sanguineous effusion, and in a number of cases infection and pleural tears complicated the post-operative picture. Foreign body reaction was acute in some of these cases, and there was a constant search to find out a material with the least possible reaction on body tissues (Buhl [4]).

It was soon realized that this foreign body reaction was not actually the cause of some of the serious post-operative complications, but that it was mainly due to opening up of a highly vascular area in between the chest wall and the parietal pleura, leading to infection of the whole of the newly created space. Thus the failure and difficulties experienced by early workers were more or less due to wound infection rather than the actual filling material. The reaction from the use of foreign bodies made many workers hesitant to use them, and this led to the use of filling materials derived from the body tissues itself without any definite improvement in the end results. For an ideal plombage material, to be acceptable, the following properties are necessary:—

(a) It should be non-irritating to the tissues and non-antigenic.

(b) It should be non-carcinogenic if it is to be retained indefinitely in the body tissues.

(c) It should be of light weight, insoluble in tissue fluids and chemically non-reactive in body tissues.

(d) It should preferably be a radiolucent substance.

(e) It should be capable of being moulded in any shape to fit in body-cavities.

So far no foreign body has been found to fulfil all the above requirements, although in the search for one a number of synthetic materials have been developed, such as Ivalon or polyvinal alcohol formalinized, synthophil, Lucite or methylmethacrylate and methyline polystan etc.; but none of them could satisfy the needs for which they were developed. However, they have been all given trials with varying results.

Complications after an Extrapleural pneumonolysis such as penetration of the filling material into thin walled cavities with a resultant infection of the bed of the plombe (Nissen), sero-sanguineous fluid accumulation increasing the tension in the wound, infection of the wound, tuberculous or non-tuberculous, pleuropulmonary fistula (Graf), and bleeding (Maurer) led to a great loss of enthusiasm for the procedure. In view of these complications, a number of workers realized that the type of operation could be modified in such a way that an effective collapse may be maintained with markedly reduced chances of infection and other complications. Graf of Dresden in 1937 modified the extrapleural pneumonolysis into extraperiosteal plastic pneumonolysis. This contributed largely to the safety of the operation.

When the lung is separated from the thoracic cage by the freeing of portions of the ribs from their periosteum, and thereby permitting the lung, the pleurae, the periosteum and the intercostal muscle bundles to fall away from the ribs the operation is termed Supra-periosteal (subcostal) pneumonolysis. Here again, in the space created, various filling materials have been used, such as gauze-pack (Lilienthal [7]), muscle-graft (Alexander [2]), rubber bag (Sherer [10]), and plastic material (Lucas [8]). Adams et al [1] used this procedure in nearly 65 cases with very satisfactory results.

In a conventional type of modern thoracoplasty sero-sanguineous fluid collects in the area of collapse and the chest wall post-operatively. In the couse of time, as this fluid gets absorbed gradually and is replaced by fibrous tissue the underlying pulmonary tissues get partially expanded, resulting in the reopening of collapsed cavities in quite a significant number of cases, necessitating a repetition of the operation, or the use of a plombe, or a resective procedure. In the operation described below, these drawbacks of a conventional thoracoplasty led to the blending of the two operations, the Extrapleural pneumonolysis and the multiple-stage modern thoracoplasty with the final evolution of Plombage Thoracoplasty which has the ad-

vantages of both without the disadvantages of either.

Object

The object of this paper is to deal with the Operation of Wax Plombage Thoracoplasty, without resection of ribs and thereby preventing any post-operative deformity using Paraffin Plombe subcostally, extraperiosteally as performed by us in the J. J. Mehta Tuberculosis Hospital, Amargadh, along with a comparative review of cases of conventional thoracoplasty as well as those of Ball Plombage (Lucite balls or Ping-pong balls) done earlier. The total number of cases presented is 130. Conventional Thoracoplasty — 72 cases; Ball-plombage — 28 cases, and Wax-plombage thoracoplasty — 30 cases.

We do not contribute to the widespread hypothesis of deleterious "foreign body effect" nor in that of late expulsion of the plombe due to increasing intraplombage pressure or a malignant tissue growth. Baer, A. Eiselberg and Hans Alexander [2, 3] reported necropsies on patients who had had paraffin pneumonolysis from six weeks to five years previously; and found the tuberculous cavities collapsed to smooth walled clefts and that the paraffin was closely surrounded by a fibrous capsule from one to three millimetre in thickness. No dead spaces were seen and the paraffin had the same appearance as when it was introduced.

Clinical Material and Selection of Cases

The clinical material dealt with in this review consists of 130 patients of both sexes and between the ages of 16 years to 55 years, who were treated in this hospital. All cases were treated for a period of at least three months with bed rest and antibiotics before they were selected for any major surgical procedure. In every case on admission a complete clinical examination, chest Roentgenograms both P.A. and lateral, a complete laboratory examination including sputum, blood, urine and stools were done; and repeated thereafter monthly. Similarly a weekly weight record was also maintained throughout the stay of each patient in the hospital. These records provided a good comparative study of a patient at every stage of his or her treatment. All patients, who were candidates for any major surgical procedure, were allowed out of bed for a period of at least two weeks prior to operation, thereby assuring them a smoother post-operative period with regard to cardio-respiratory adjustments.

Patients selected for operative treatment generally belonged to the group where consecutive serial skiagrams showed a pretty well stabilized lesion with or without cavitation, where sputum was positive or even negative to T.B. and the general condition satisfactory with a fair amount of gain in weight. These have been used as the working rules, but there have been a number of exceptions where all the conditions could not be fully satisfied, and we felt it necessary in the interest of the patient to perform the operation. No patient was selected for operation, who exhibited definite changes in the serial roentgenograms showing increase of the disease in one or both lungs.

We had a number of patients in whom the sputum was converted to negative, preoperatively, although the cavities were clearly visible on the skiagrams. This was the result of sterilization through the constant use of antibiotics and we did not defer the operation on account of that. We have not been using artificial pneumothorax lately during the last three years, but pneumoperitoneum has been used in a fairly good number of patients especially with bilateral lesions. Some of the patients were admitted with artificial pneumothorax done elsewhere. There were again some patients who had previous treatment with phrenic interruption or a combination of pneumoperitoneum with phrenic paralysis either on the ipsilateral or on the contralateral side. A detailed study of these is tabled in the accompanying charts.

Table I

Showing number of patients treated with different procedures, their sex, and the side operated on with the stages of operation.

Type of Operation	Total No. patients	No. of Stages	Males	Females	Side Operated on Rt.	Lt
Conven. Thoraco	72	160	48	24	103	57
Ball Plombage Thoracoplasty	28	28	24	4	17	11
Wax Plombage Thoracoplasty	30	30	22	8	18	12
Total	130	218	94	36	138	80

Table II

Showing age-groups of the Patients

Type of Operation	11-20	21-30	31-40	41-50	51-60	Total
Conven. Thoraco	10	42	12	4	4	72
Ball-Plombage Thoracoplasty	3	12	7	4	2	28
Wax-Plombage Thoracoplasty	1	15	8	5	1	30
Total	14	69	27	13	7	130

Table III

Showing stage of disease and its site.

Type of Operation	Site of Lesion	Minimal	Mod. Ad	Far Ad	Total
Conven. Thoracopl.	Unilateral	5	17	2	24
	Bilateral	1	25	22	48
Ball-Plombage Thoracoplasty	Unilateral	0	6	1	7
	Bilateral	0	12	9	21
Wax-Plombage Thoracoplasty	Unilateral	2	4	0	6
	Bilateral	0	12	12	24
Total		8	76	36	130

Table IV

Showing pre-operative procedure and treatment.

Types of Operation	A.P.	Pn. P.	Phrenic Interrup	Thoraco. I stage	Thoraco. 2 or more stages	Total No. of cases
Conven. Thoraco.	12	20	28	52	16	72
Ball-Plombage Thoracoplasty	0	8	3	6	0	28
Wax-Plombage Thoracoplasty	0	12	8	0	0	30

Note: All the above patients had a course of antibiotics for a period of 1½ months to 6 months prior to surgery. Our patients were grouped into three categories with regard to antibiotic treatment. These were as follows:

(a) P.A.S. 10 gms per day with I.N.H. 200 mgm per day.

(b) P.A.S. 10 gms per day with Ambystrin 1 gm biweekly.

These combinations were used in Minimal and moderate advanced cases only.

(c) P.A.S. 10 gms a day with Ambystrin 1 gm biweekly and I.N.H. 200 mgm daily.

This was used as a routine in all far advanced cases.

Table V

Post-operative results and sputum conversion.

Type of Surgery	Total No patients	Pre-oper. sputum T.B. Posi.	Post. Ope. sputum T.B. Neg.	Disease Arrest %	Disease Worse %	Died %
Conven. Thoraco.	72	92%	88.2%	88.2	4.4	5.6
Ball-Plombage Thoracoplasty	28	94.6	96.4	96.4	0	0
Wax-Plombage Thoracoplasty	30	94.8	99	99	0	0

Note: The post-operative period of observation extends from 4 months to 2½ years.

TABLE VI
Showing post-operative complications.

Complications	Conventional Thoracoplasty	Ball-Plombage Thoracoplasty	Wax-plombage Thoracoplasty	Total
Pleural tear	3	1	2	6
Effusion Needing aspiration	1	8	0	9
Wound Infection	2	0	0	2
Secondary Sutures	2	0	0	2
Hemiplegia*	1	0	0	1
Superficial Suture infection	2	1	0	3
Cardiac failure	1	0	0	1

*The patient had preoperative luetic history. This cleared up after appropriate treatment, and a second stage was done after that.

Table I shows the number of patients treated by the different procedures, the number of operations done either in single stage or in multiple stages, their sex and the side operated on.

Table II shows the age groups of the patients under the head of each operative procedure.

Table III shows the types of lesions and their site whether unilateral or bilateral.

Table IV shows the various preoperative procedures and the definitive operative procedures in the group.

Table V shows the early post-operative results.

Table VI gives a list of the various complications met with during these surgical procedures.

The majority of our patients had a previous trial of phrenic interruption or a pneumoperitoneum where indicated prior to their selection for any one of the three major procedures given above. In a number of bilateral lesions, pneumoperitoneum was continued post-operatively as well.

INDICATIONS AND CONTRA-INDICATIONS FOR PLOMBAGE THORACOPLASTY

In general, these are the same as for a conventional type of thoracoplasty or a ball-plombage. A few qualifying remarks however, will not be out of place here.

1. In a country like ours, where a large population is suffering from pulmonary tuberculosis, and where poverty is still so rampant among masses, any surgical procedure which can bring relief by cutting down the cost of treatment is welcome, and surgeons contemplating any operative procedure have to bear this in mind. As such Wax-plombe Thoracoplasty offers a wider possibility of its application, as the operative procedure in a large majority of cases can be accomplished in one stage.

2. The costly multiple stages of a conventional thoracoplasty with its attendant mutilation and post-operative deformity are completely avoided. Naturally we see that it is definitely more acceptable to the fair sex, especially in the young age group as well as among the children who are in their growth.

3. Cases of large and medium size cavities have a better chance of closure with early conversion of sputum to negative thus reducing morbidity period.

4. Poor risk patients, who are not good candidates for a multiple stage thoracoplasty can be given the benefit of this operation with a fairly good chance of ultimate recovery without undue post-operative risk.

5. The operation is indicated in both, the unilateral or bilateral lung lesions, as also in cases of residual cavities after conventional thoracoplasty, especially in the old age group.

6. Haemoptysis per se is not a definite indication, but when it continues inspite of less severe measures, it calls for definite operative procedures to check it and undermine the patient's general health.

The procedure is contraindicated in extensive bilateral pulmonary lesions, and

specially in those cases where the pulmonary functional reserve is inadequate. So also the patients with decompensated cardio-vascular lesions are not suitable except probably those in whom the disease is retrogressive and the chances of ultimate recovery fairly certain. Emphysema, bronchial asthma (unless it is periodical and can be controlled with bronchodilators) are other contraindications. In general the contraindications are not so many here as in cases which are to be selected for a conventional multiple-stage thoracoplasty, specially the border line cases.

PRE-OPERATIVE CARE

In our series, all cases have been observed for a minimum period of about three months, before surgery was decided on. The only exceptions were those who were admitted with a complete follow up from other institutions; but even in these cases we preferred to observe at least for a period of nearly a month before they were brought for surgery. This allowed us enough time for a good follow up study with regard to the previous treatment and the stability of the lesions an evaluation of the general condition of the patient along with a complete laboratory check up, and any special study of the roentgenograms, which were indicated. Further, this also gave us ample opportunity to make pulmonary function studies, bronchoscopic examinations or bronchograms with lipiodol where found necessary.

As already stated, almost all the patients were allowed out of bed for a period of nearly two weeks and thus giving their cardio-vascular and respiratory systems a better chance of readjustment postoperatively. Some of the patients with large cavities were given postural treatment prior to operation, and we were happy to see that in a large percentage of these cases the amount of sputum decreased considerably and in some the cavities were also reduced in size to a certain extent. We feel that this should be given further trial to properly estimate its value as a pre-operative adjunct.

For a week prior to operation we increased the vitamin contents of the daily rations, supplementing occasionally with multivitamin tablets or even injections. Patients liked to have fresh fruit juices pre-operatively, and we found that this did help quite a bit in their post-operative period.

A plain warm saline enema was given as a routine to all the patients the night previous to operation, and after that no solid food was allowed by mouth. A capsule of Nembutal 0.1 gm. was given at bed time and again repeated 2 hours before operation in the morning. This was followed by an injection of Atropine Sulphate 0.04 mgm. with Demerol 50 to 75 mgm. subcutaneously.

ANAESTHESIA

We have used Procaine Hydrochloride, 0.5% solution for skin infiltration and 1% solution for paravertebral block. Usually not more than 0.6 gm. of the drug was needed in an average patient and the results were quite satisfactory. On other occasions we have also used Anethaine or Pantocaine in the strength of 1 : 2000 for skin infiltration and 1 : 1000 for intercostal anaesthesia or a paravertebral block. The results were very satisfactory with either. We hardly had any trouble during our operative procedure, and the patients cooperated very well without complaint of any severe pain or discomfort. Occasionally in some of the nervous patients, we had to fortify the effect of local anaesthesia with intravenous Pentothal Sodium, especially when stripping the periosteum from off the ribs; and this additional measure was sufficient in practically all our cases to give necessary anaesthetic effect to complete the operation. We did not use any gaseous anaesthesia in any one of these patients, and the cooperation of the patients throughout the operative procedure as well as post-operatively was very gratifying indeed, without any respiratory complications so often reported when gaseous anaesthetics are used.

Operative Technique

The patient is put in the usual lateral decubitus position with the operation side up, and a rubber cushion is put under the lower arm pit, and a rubber pillow under the head. The patient is fixed in between two rubber cushions covered with towels and having two cross-tapes tied on which pass under the arm-pit and then tied with each other. This maintains the position of the patient during operative procedures. A strong tape binder is passed over the hips and this further keep; the patient steady. The arm on the side of operation is allowed to hang down and is tied loosely to the table. The area of the operation field is thoroughly prepared with ether and then with alcohol, and finally painted with Tincture Citavalon 1% and then sterile drapings are applied.

The incision is more or less parabolic in shape and extends from the level of the second thoracic vertebra down-along the vertebral border of the scapula about three centimeter lateral to the spine, and is carried up to the inferior angle of the scapula. The skin and the underlying tissues are incised, bleeding vessels caught with haemostats and skin towels are then applied. The muscles are then divided in the line of incision and the bleeding points caught. The scapula is then mobilised with blunt dissection and is held up by a self-retaining retractor. The slips of serratus posterior superior and the serratus anterior from their attachment with the upper three ribs are carefully dissected off the ribs thus permitting a better working space. All the intercostal nerves from above downwards (usually upper five or six and often seven) are then infiltrated with procaine solution 1%. The bleeding vessels are then electro-coagulated, and those which still persist in bleeding are ligated with cotton No. 00. According to the preoperative decision with regard to the extent of the disease, the ribs are stripped off their under surface periosteum. On the upper surface the periosteum is maintained and this helps in keeping the nutrition intact. The extnt of the ribs thus stripped is carefully regulated in every case according to the needs and with a view that as much as possible of the functioning lung tissue is preserved. The intercostal muscle bundles are then divided in between clamps as far backward as possible. This allows a good relaxation of all the structures, and the lung falls down away from the rib cage and a space is thus created. Earlier, we used to resect a piece, about 5 to 6 centimeters long from the third or the fourth or both these ribs to give enough space for moulding wax; but later on we found that it was not necessary, and we could preserve these ribs as well without disturbing the natural anatomy. This is definitely advantageous, and the patients appreciated it. The space created is then washed out well with warm sterile saline, and sprayed with a solution of Penicillin 600,000 units and streptomycin 1 gm., and then paraffin wax* previously prepared was carefully moulded in the space without trying any forcible collapse of the lung. While the wax is being prepared it is definitely advantageous to pack the space with moist gauze packs to avoid any paradoxical movements of the lung. This is specially important when the extent of the operation is to the level of six or seven ribs. The general toilette of the wound is now attended to, and then it is closed in anatomical layers, using Cotton thread No. 0 for the muscles, 00 for the subcutaneous tissue and No. 000 for skin. We prefer interrupted sutures. No drain is used. Sterile dressings are now put on and fixed with elastoplast and adhesive plaster strips. These provide good support to the wound and the post-operative pain is minimised.

We did not use blood transfusion as a routine, but it is a definite improvement on the less satisfactory methods of Glucose and Saline infusions only. Most of our patients required from 2000 to 3000 cubic centimeter of Glucose and Saline post-operatively.

Post Operative Care

Post operatively the patient is kept in 30 degree Trendelenbergh position till his condition stabilizes. This rule is more strictly adhered to when general ansesthesis has been used during the operative procedure. A careful record of the pulse, respiration and blood pressure is also maintained every half hour or even every 15 minutes, till the patient's condition is satisfactory and he is well stabilized. Oxygen has not been used by us as a routine, but in every case where we had reason to exhibit its use, and in all post-operative dyspnaeic cases it has been freely used, varying from 4 to 5 litres per minute; and in these cases it is definitely useful.

Cough :—Coughing is painful and the nurses have instructions to help the patient to cough out all the secretions raised. Occasionally, mixtures containing Ammonium Chloride along with Ephedrine are also very helpful in bringing out the tenacious secretions. Since, most of our patients were operated upon under local anaesthesia, they did not have much difficulty as regards coughing.

Pain :—Every patient does complain of pain post-operatively, but most of them could easily tolerate it. Often they needed some extra help, and in these cases demerol 50 mgs. has been found quite satisfactory. It also assures them a good sleep at night, and in majority of cases this was usually given at night, also during the day if it was needed.

Vomiting :—We did not have post operative vomiting, except in a few patients only. Avomine was found helpful in these cases.

Rest and movement :—We always encouraged our patients, not to take the post-operative period too seriously, and allowed them out of bed as soon as they felt fit to do so, usually after the third or fourth day. It is our impression that this materially helps in restoring them to an early ambulation, and reduces considerably post-operative comlications. This rule is only relaxed in those patients who show dyspnaea post-operatively. In these cases they are allowed to be out after the dyspnea has settled down.

Bowels :—In those cases which do not have regular bowel motions after 48 hours of operation, a soap enema is usually given.

Complications

1. Rupture of the parietal pleura is not very uncommon, unless stripping of periosteum is done with care. We met this complication five times in our series, but excepting for one case, in all the others the tear was very small in size and could be repaired without difficulty. In one of the cases as mentioned above, the tear was about five centimeters long and could not be repaired properly. This patient was originally fixed for a wax-plombage thoracoplasty, but we were forced to convert it into a conventional thoracoplasty. There was no further complication excepting that he had to be aspirated twice to remove the collected fluid, which subsided after that.

2. *Effusion* :—Post-operative effusion is common in practically all patients due to reaction of the tissues to the foreign substance, but we never had occasion so far to aspirate out this fluid as this was invariably absorbed within a course of few days, leaving no complications behind. Among the cases, operated on for a conventional thoracoplasty, we had one case of post-operative effusion and this needed no special care except for aspirations done on two occasions. Effusion was more troublesome after ball-plombage thoracoplasty. In those cases where we used ping-pong balls, the effusion was not so marked as with lucite balls. These cases required several aspirations each, and we gave up the procedure in favour of wax-plombage.

3. *Wound infection* :—We were fortunate not to have any case of wound infection after plombage thoracoplasty, except one superficial wound infection after ball plombage, which was treated after removal of a stich in that area, and applying sterile dressings. In our series of thoracoplasty we had two cases of wound infection which took some time to clear up. The source of infection could be detected very soon, and

* We have used Merck's paraffin with a melting point 52-53° C.

after that there was no case of wound infection. Should this happen in cases of plombage, the best course to adopt is to open out the wound and remove all plombage material, and later on convert it into a conventional thoracoplasty.

4. *Atelectasis* :—This is a fairly common complication after thoracoplasty, especially when the operation is performed under general anaesthesia, and among those cases where the amount of expectoration raised is in large or moderate amounts. We took special care to see that the mechanism of expectoration is maintained in its best possible form throughout the immediate post-operative period, and for some time till the patient is able to bring out his sputum himself. We did not have any case with this complication, but should this happen the usual treatment for atelectasis, such as bronchial aspiration, Oxygen inhalation etc. should be immediately instituted.

Advantages of wax-plombage thoracoplasty over a conventional thoracoplasty or ball-plombage

(a) Maintenance of a better collapse of tuberculous lesions since the lung is prevented from springing out post-operatively as is so often observed in conventional thoracoplasty operation.

(b) The collapse is more selective, and in that way permits more functioning lung tissue, a factor of considerable importance specially in bilaterl disease with considerable decrease in the pulmonary reserve.

(c) There is no post-operative deformity (scoliosis). This is a matter of considerable importance in young women and growing children.

(d) No paradoxical movements, and thus a greater safety from post-operative spread of the disease.

(e) One stage operation becomes less expensive and the hospitalization period is considerably reduced. Also indirectly this leads to less psychic trauma to the patient.

(f) There is much less post-operative effusion, and hence post-operative care becomes much simplified.

(g) There is a definitely wider field of application of this procedure, specially in those cases not fit to undergo a multiple stage modern type of thoracoplasty.

The observation period, post-operatively, for the patients treated with this procedure, is however still too short to judge the long range merits of the procedure; but the early results so far obtained have given encouraging results, and it needs further trial on a larger scale.

Discussion

In the evaluation of this type of plombage-thoracoplasty, we believe, that the figures which have been presented, although not very large, still permit us definitely to draw a few conclusions.

1. That this procedure is based on sound surgical principles combining the advantages of a conventional thoracoplasty as well as of an Extra-pleural pneumonolysis, and at the same time eliminating the disadvantages of both including a number of post-operative complications.

2. The control of the localised lesions in the lungs is obtained in the minimum possible period, and thus definitely bringing down the cost of treatment and the period of morbidity, a point of considerable importance from the point of view of poor labouring class of patients. An early conversion of sputum also allows an early rehabilitation.

3. The maintenance of blood supply to the tissues through the preservation of periosteum and the intercostal musculature helps in avoiding many of the complications. Further the sacrifice of functioning pulmonary tissue is minimum and consistent with the selective collapse desired. Avoidance of all undue flapping of the lungs is again an important feature in preventing post operative complications.

4. The mutilating multiple stages of a thoracoplasty are avoided, as well as the deformity so common after these operations, a significant feature in the young age group.

5. With the use of antibiotics the indications are very much extended, and the operation can be safely performed in localised bilateral lesions.

6. Post operative complications have been very much reduced and as such the post-operative care becomes much simplified.

7. Wound closure in these patients has to be done with great care, and in all cases attempt should be made to preserve the natural anatomy by closing in layers. No drainage is used in these cases.

8. In every case the plombe should be carefully worked out preoperatively by a good study of postero-anterior and lateral skiagrams of the chest. Further, no attempt should be made to increase the collapse by pressure of the plombe. The moulding should be snug in the space created. In the majority of our cases we have used from 200 to 450 gms. of wax depending upon the extent of the operation.

Summary

The use of supra-periosteal extramuscular paraffin pack as substitute for a conventional thoracoplasty with rib resection is described.

Its advantages over a lucite-ball or ping-pong ball plombage are compared, and are shown to include, (1) the cosmetic advantages over a conventional thoracoplasty; (2) better and more selective collapse; (3) reduction in total cost of treatment; (4) preservation of more functionating pulmonary tissue; and (5) a lack of post-operative complications and deformity.

References

1. Adams, W. E., Lees, William M. and Fritz, James M.: Subscapular Paraffin Pack as a supplement to Thoracoplasty in the treatment of Pulmonary Tuberculosis. Jour. Thor. Surg. 22: 375-385, Oct. 1951.
2. Alexander, John: Collapse Therapy of Pulmonary Tuberculosis. Charles C. Thomas, Springfield, Ill. Pp. 402-406.
3. Baer; Gustav: Die extrapleural plombirung bei lungentuberculose; Munchen. Med. Wchnschr. 68: 1582-, 1921.
4. Buhl, K.: Extrapleural Pneumonyse: Rosinkilde & Bagger Copenhagen 1948.
5. Hedblom, C. A.: The surgical treatment of Pulmonary Tuberculosis. Illi. Med. Jour. 54: 134, 1928.
6. Lees, William M. et al.: Results in 278 patients who had the modern type of thoracoplasty for tuberculosis. Jour. Thor. Surg. 22: 329-340, Oct. 1951.
7. Lilienthal, Howard: Tuberculosis of the lungs, Apicolysis by two different methods. Surg. Clin. North America. 8: 235, 1928.
8. Lucas, B. G. B. and Cleland, W. P.: Thoracoplasty with plombage. Thorax. 5: 248. 1950.
9. Sarfert, H.: Die operative Behandlung der Lungenschwind sucht: Leipzig- Johann Ambrosius Barth, 1901.
10. Scherer: Zentralbl. f. d ges. Tuber. Forsch. 22: 353, 1924.
11. Schlange: Chirurgenkongress 1907, Verhandlungen, p. 80.
12. Tuffier, Thodore.: Etat actuel de la chirurgie intrathoracique. Paris. Mason et Cie. 1914. Pp. 90-105 and 163-172.
13. Tuffier, Thodore.: Decollement pleuro-parietal en chirurgie pleuro-pulmonaire. Arch. Med.-chir. de l'appareil res. 1926, pp. 1-28.
14. Wilson, D. A.: Extrapleural pneumonolysis with lucite plombage. Jour. Thor. Surg. 17: 111, 1948.

Received for publication on 31-7-'57.

SQUAMOUS METAPLASIA AND METAPLASTIC EPITHELIOMATA *

(A Clinico-Pathological Study)

by D. J. REDDY, K. GOPALAKRISHNA GUPTA and V. KAMESWARA RAO, Guntur.

Surgeons and Pathologists are deeply interested in the study of morbid conditions associated with squamous-cell metaplasia. The recognition of squamous metaplasia in certain chronic inflammatory and malignant lesions of some organs made the pathologists conjecture a causal relationship between the two. Clinical and experimental data for and against such conclusion continue to appear periodically in medical literature. Gynaecologists and Pathologists are aware of the frequent association of squamous metaplasia in the cervix in cervicitis, endometrium with or without adenomyosis or fibromyomata and at least in some cases metaplasia has been attributed to supposed oestrogen excess. This has been confirmed in experiments with rats. The senior author [2] while reviewing the literature on epidermadisation of the cervix, added reports of his cases and observed no case of malignant transformation in them. We have for the last thirty months encountered in the biopsy material, squamous metaplasia of both the cervix and endometrial epithelium and barring a single case of doubtful malignancy, the rest presented features of benign metaplasia (Fig. 1).

We are of opinion that squamous metaplasia cannot be dismissed as merely of fortuitous coincidence when associated with chronic inflammatory lesion. The occurrence of this change has occasionally been reported in cystic mastitis of the breast, myoepithelial hyperplasia of the prostate, infarction of the prostate, bronchiectasis, bronchitis, and of the nasal mucous membrane in inflammatory conditions. Similar benign metaplasia was found by us in a Bartholin's cyst (Figs. 2, 3, 4, 5 & 6). The pathologist usually exercises abundant caution to rule out even the remotest possibility of malignant change in the above mentioned lesion.

Squamous-cell metaplasia gained importance in recent years because of the observation of pathologists that the change invariably precedes the onset of bronchogenic carcinoma. Although this finding is disputed by Niskanen [14], Black and Ackerman [4], Weller [16], and Valentine [15] produced clinical and pathological data in support of it. Many have made a categorical statement that squamous metaplasia is only seen in carcinoma of the gall bladder, pancreas, breast, etc. and rarely met with in normal or benign lesions of the organs. More over through a process of prosoplasia, the transitional-cell carcinoma of the renal pelvis and urinary bladder may transform to metataplastic epitheliomata. Prolonged irritation at these sites are alleged to lead to chronic inflammatory reaction, and metaplasia of the lining epithelium. We have encountered in the biopsy material metaplastic epitheliomata of renal pelvis, urinary bladder, and prostate. Squamous metaplasia was spotted in an adenocarcinoma of gall bladder as an incidental finding at necropsy. Calculi were observed in the epithelioma of the prostate and also in adenocarcinoma of gall bladder. The clinico-pathological findings of these four cases are recorded with a view to focuss their significance to the surgeons.

CASE REPORTS

CASE 1. (Metaplastic Epithelioma Kidney)

V.S.R., male, aged 40 years was admitted in Govt. General Hospital, Guntur, for a swelling in the left loin on 6-6-1956. A lobulated tumour was felt filling the loin and appeared to be close to the left subcostal zone. Intravenous pyelography revealed no evidence of excretion. Cystitis was made out through cystoscopic examination. Blood was seen ejecting through the left ureteric orifice. Screening of the chest showed no deposits. Nephrectomy was done on 28-6-1956.

* From the Department of Pathology, Guntur Medical College, Guntur.

Fig. 1.

Photomicrograph illustrates squamous metaplasia of the glands of the cervix in a case of third degree prolapse for which amputation of cervix was done. Associated cervicitis was observed. (H & E x 60)

Fig. 2.

Stratification of ductal epithelium usually precedes squamous metaplasia, observed in adenosis of breast. (Female aged 35 sought aid for a small lump and blood stained discharge, nipple.) (H & E x 270)

Morbid anatomy and histology: (943-946 J 56)

Kidney is enlarged and greyish white in colour. It is lobulated. Sectioned surface disclosed papillomatous processes and circumscribed white nodules (Fig. 7). In places the pelvis of the kidney showed ulcerated areas and raised white plaque like areas. Multiple sections from the tumour mass disclosed transitional-cell carcinoma in which clear zones of well and highly differentiated squamoid change is noticed (Figs. 8 & 9). Dense fibrosis and round cell infiltration around the renal parenchyma is noticed.

Comment:

The gross and histological appearances of the renal neoplasm are consistent with transitional-cell carcinoma with areas of metaplastic epithelioma. Keratinized epidermoid carcinoma of the renal pelvis is a rare tumour and is often associated with infection and renal calculi. Gabagan [8] and Reed [5] believe that there is causal relationship between calculi, and leukoplakia often observed in cases of metaplastic epithelioma of the kidney. Recently Bhaskara Reddy and Venkateswara Rao [3] recording two cases of epidermoid carcinoma of the renal pelvis associated with calculi asserted that metaplasia is to be viewed as precancerous and that chronic irritation often initiates such a change. We have not found calculi in our case and we feel the nests of squamous carcinoma observed by us is to be viewed as prosoplastic change in transitional-cell carcinoma. Nicholson [13] clearly pointed out this distinction in metaplastic neoplasms.

Fig. 3.

Photomicrograph illustrates squamous metaplasia of one of the large sized bronchioles studied in routine sections from necropsy material of a male who died of tuberculosis.
(H & E x 60)

Fig. 4.

Details of squamous metaplasia of the bronchiole shown in figure 3 are magnified.
(H & E x 324)

CASE 2. (Squamous-cell Carcinoma of the Urinary Bladder)

Y.S.R., male, aged 57 years was admitted into Govt. General Hospital, Guntur for retention of urine on 21-2-1957. Prior to this the patient noticed passing of blood in urine. Gives a history of having suffered from gonorrhoea twenty years back.

Inguinal lymph nodes were enlarged. The prostate appeared to be enlarged. Catheter could not be passed to relieve retention of urine. Suprapubic cystotomy was done and a friable growth was felt within the bladder. Biopsy bit was taken.

Biopsy Report: (405-407/57)

Well differentiated squamous-cell carcinoma, in places keratinization was observed (Fig. 10).

Other Laboratory Data:

Urine Culture: B. Coli and Pseudomonas aerogenosa grown.

Alkaline Phosphatase: 4.4 K.A. Units.

Acid Phosphatase: 2.8 K.A. Units.

V.D.R.L.: Positive in 16 dilutions.

Blood Urea:

	22-2-57	13-3-57	19-3-57	29-3-57
mgms%	66	50	33	27

Urea Clearance Test:

Blood urea: 60 mgms%.

Urine urea: 627 mgms%.

Volume of urine cleared per minute 0.92 c.c.

Volume of blood cleared of urea per minute 12 c.c. (normal is 23 c.c.).

On 29-3-1957 abdomen of the patient was opened by a subumbilical incision. A hard globular tumour was seen filling the pelvic cavity. It arose from the bladder. It had pushed the sigmoid colon upwards and to the right. Peritoneum was not involved. Liver appeared to be free from secondaries. In view of the large size of the tumour, almost filling the pelvic cavity, excision of the tumour was not undertaken.

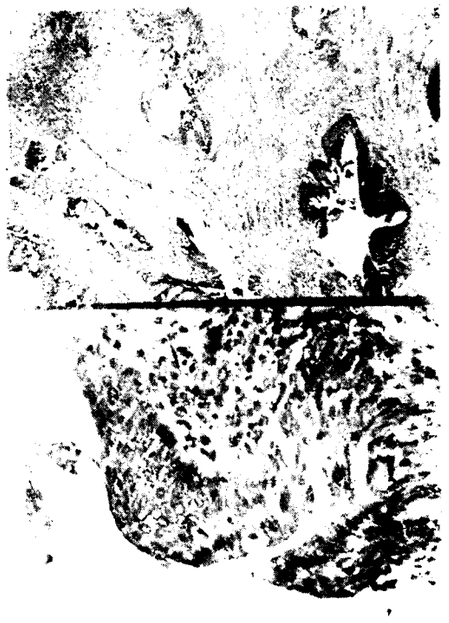


Fig. 5.

Photomicrograph illustrates benign squamous metaplasia of prostatic ductal epithelium. Sections are from the prostatectomy specimen of a male aged 55, who sought aid for retention of urine. (H & E x 324, 60)

Fig. 6.

Photomicrograph illustrates well differentiated squamous metaplasia of the ducts of Bartholin's cyst. (The cyst excised in female aged 40 contained brownish mucoid material.)
(H & E x 60, 72)

Comment:

The laparotomy and biopsy findings are consistent with an inoperable squamous-cell carcinoma of the urinary bladder. The most frequent malignant tumour of the bladder is papillary transitional-cell carcinoma. Meyer [12] in an analysis of 2,500 specimens and biopsies of the bladder found that 11.4 percent are accounted for by metaplastic epitheliomata. Bonser [5] in 1956 studied 1,100 bladders of mouse following surgical implantation of paraffin wax pellets containing various chemicals. She observed concretions in 7 percent, squamous metaplasia in 23 percent and malignant change in 14 percent of 467 mice bladders histologically studied. Squamous metaplasia was associated with the presence of concretions and also infection. The squamoid change was also observed in a portion of the tumour and majority of the induced tumours were of the transitional-cell type. Only occasionally metaplastic epitheliomata were noticed arising in areas of squamous metaplasia. But she observed squamous change adjacent to or covering the transitional-cell carcinoma. In our case metaplastic epitheliomata seem to have developed from pre-existing transitional-cell carcinoma. Bonser [5] believes that in the presence of concretions squamous metaplasia as reaction to irritation is usually seen but squamous metaplasia in a neoplasm is of chemical origin. This needs further clinical and experimental elucidation.

Fig. 7.

Case Report 1. Photograph illustrates papillary, nodular and plaque like carcinomatous lesions of the renal pelvis.

Fig. 8.

Case Report 1. Photomicrograph illustrates transitional-cell carcinoma appearances seen in most parts of the tumour. (H & E x 72)

Fig. 9.

Case Report 1. Areas of well differentiated squamous-cell carcinoma seen in the renal tumour area illustrated by the photomicrograph. (H & E x 476)

Fig. 10.

Case Report 2. Photomicrograph shows well differentiated and cornifying squamous-cell carcinoma of the urinary bladder. (H & E x 270, 40)

Fig. 11.

Case Report 3. Reduction roentgen picture of prostate illustrating calculi in the prostate in line with the symphysis pubis indicated by the mark C.

Fig. 12.

Case Report 3. Photomicrograph illustrates squamous-cell carcinoma of the prostate with cell-nests. (H & E x 120)

CASE 3. (Squamous-Cell Carcinoma of the prostate)

K.B., male, aged 55 years was admitted in Govt. General Hospital for retention of urine of one day's duration on 1-10-1956. Since 15 days the patient noticed difficulty in passing urine and blood in the urine. He used to void urine in drops and not in the form of a continuous stream. He had observed passing gravel in the urine and his urine was milky in consistency and colour.

All the systems normal. Blood pressure: 130 80 mm. of Hg.

Laboratory Data:

Urine: Albumin trace only seen.

Blood Urea: 63 mgms%.

Alkaline Phosphatase: 4.7 K.A. Units.

Acid Phosphatase: 3.4 K.A. Units.

Urine Culture: Bact. Aerogenes growth seen.

X-ray of the lower abdomen: Disclosed small calculi in the prostate (Fig. 11).

On 2-10-1956 catheter passing was attempted but failed and suprapubic cystotomy was done. The medial lobe of the prostate was found enlarged and hard. There were no calculi in the bladder. The catheter was retained. Biopsy bit of the prostate was taken.

Biopsy Report: (1572 56). Highly differentiated squamous-cell carcinoma of the cornifying type (Fig. 12).

The patient's condition inproved on chemotherapeutic treatment. Under spinal anaesthetic supplemented with general, through a paramedian incision, abdomen was opened up and as the right ureter could not be traced the operation was given up.

Comment:

The clinical and biopsy findings are consistent with epidermoid carcinoma of the prostate. Kahler[10] in a large series of prostatic tumours observed 2 to 4 percent

incidence of epidermoid carcinoma. Dixon and Moore [6] found in a review of 500 carcinomas of the prostate in the files of the Armed Forces Institute of Pathology only one epidermoid carcinoma and the tumour was of low grade malignancy with many keratinized pearls. We feel that this rare and unusual tumour type is derived from the transitional epithelium of the prostatic urethra and utricle. We are not able to assign a causal role to the calculi noticed in our case for initiating cancerous process or inducing metaplastic change of the prostatic epithelium. We wish to caution the pathologists to exclude squamous metaplasia not uncommonly encountered in prostate, result of either infarct or following oestrogen therapy, before a certain diagnosis of epidermoid carcinoma of the prostate is made.

CASE 4. (Adenocarcinoma of the Gall Bladder associated with squamous metaplasia)

N., male, aged 60 years, was admitted in Govt. General Hospital, Guntur on 21-1-1956 in a moribund state. He was anaemic, and oedema of the feet and puffiness of the face were noticed. Heart sounds were feeble. He expired the following day.

Chief necropsy and morbid histological findings: (P.M. no. 5/56)

Oedema of the legs was confirmed. Free fluid in the abdomen and pleural effusion of the rt. side were observed. Supracondylar fracture of the left humerus was seen. Bilateral caseous tuberculosis of the lungs observed.

The gall bladder contained 4 small faceted pigment stones and considerable whitish thickening giving the appearance of a solid growth was seen at the fundus of the gall bladder (Fig. 13). Sections from the growth of the gall bladder showed adenocarcinomatous picture (Fig. 14). In places squamous metaplasia of the neoplastic glands was observed (Fig. 15). The metaplastic epithelium did not show unequivocal features of malignancy.

Comment:

Adenocarcinoma of the gall bladder observed by us is an incidental necropsy finding since the deceased while alive did not complain of symptoms pertaining to gall bladder disease. Cholecystitis and cholelithiasis antidate the occurrence of malignant disease of the organ and are said to be predisposing factors. Gall stones have been reported in 90 percent of cases of carcinoma of gall bladder and we believe that the stones present in our case must have played a similar carcinogenic role. Barlow [1] in 1912 said that gall stones from these cases are radioactive and suggested that the radium contained in these gall stones is closely bound up with the occurrence of carcinoma around them. Recently Fortner [7] experimentally induced carcinoma of the glandular, glandulo-squamous type by implanting methylcholanthrene pellets into the gall bladders of cats lasting for 23 to 24 months. For the same period dogs subjected to identical experimental investigation did not develop gall bladder neoplasms. He suggests that the above findings lend theoretical support to the possibility that cancer of the extrahepatic biliary tract in the human might be caused by a chemical excreted in bile that occurs as a result of an abberation in the metabolism of either bile acids, cholesterol or other steroids. This needs further verification through experimental and clinical investigations.

Squamous metaplasia in adenocarcinoma of the gall bladder is reported in 10 percent of the cases. Fortner [7] in experimentally induced carcinoma of the gall

Fig. 13.

Case Report 4. Photograph shows exposed surface of the gall bladder containing four gall stones and much thickened whitish solid fundus the site of carcinoma.

Fig. 14.

Case Report 4. Photomicrograph illustrates adenocarcinoma of the gall bladder. (H & E x 72)

Fig. 15.

Case Report 4. Photomicrograph illustrates squamous metaplasia of the epithelium in one of the glands of adenocarcinoma of gall bladder. (H & E x 324)

bladder found squamous metaplasia in association with adenocarcinoma as well as an independent squamous-cell carcinoma and he believes that squamous metaplasia precedes malignant change. Although clear transitions between metaplastic epithelium and its change into metaplastic epithelioma have not been as yet demonstrated, the relationship is convincing and rarely one sums up courage to contest the concept. This is further substantiated by the reports of Hicks and Cowling [9] of a squamous-cell carcinoma of the ascending colon, probably due to chronic mechanical irritation of faecal concretions and also of the report of Krag and Alcott of a combined squamo-glandular metaplasia in the renal pelvis, the kidney of which was the site of calculus hydro-nephrosis. The latter group of authors hint that the glandular metaplasia observed is a forerunner of adenocarcinoma of renal pelvis. As such we recommend that it is wise to eradicate all causes of irritation or inflammation in organs which by experience are known to develop or possess metaplastic potentialities and thus avert the future onset of carcinoma.

Summary

1. Pertinent literature regarding squamous-metaplasia and metaplastic epitheliomata is reviewed.

2. Case reports of metaplastic epitheliomata and also illustrations of benign squamous metaplasia noticed in some of the more common sites are recorded.

3. Clinical material is brought in evidence to support the view that calculi,

chronic irritation and hyperplasias predispose or antedate the onset of malignant change.

ACKNOWLEDGEMENT

We thank Drs. M. Muniswamy, B.A., M.S., N. Balakrishna Reddy, F.R.C.S. (Edin.) for the case notes, Dr. Ramseshagiri Rao, D.M.R., etc., for the radiograph and Dr. D. Bhaskara Reddy, M.D. for providing us with some references. With pleasure we acknowledge the help rendered by our photoartists Venkateswara Rao and Narasimha Rao.

REFERENCES

1. Barlow.: Quoted by Forner in ref. no. 7.
2. Bhaskara Reddy, D., Surya Bai, B., Ratnavati, C. and Reddy, D. J.: Evolution and Histogenesis of Epidermadisation in Uterine Cervix. Jour. Ind. Med. Assn. XXIII. 11. 1954. 481-483.
3. Bhaskara Reddy, D. and Venkateswara Rao, N.: Squamous-cell carcinoma of the renal pelvis with the calculus of the kidneys. Jour. Ind. Med. Prof. II. 7. 1955. 821-
4. Black, H. and Ackerman, L. V.: The importance of Epidermoid Carcinoma in situ in the histogenesis of carcinoma of the lung. Ann. Surg. 130. 1952. 44-
5. Bonser Georgiana, M. and Jull, J. W.: The histological changes in the mouse bladder following surgical implantation of paraffin wax pellets containing various chemicals. Jour. Path. & Bact. LXXII. 2. 1956. 489-
6. Dixon Frank, J. and Moore Robert, A.: Tumours of the male sex organs. Atlas of Tumour Pathology. Section VIII. Fascicle 31 b and 32. Armed Forces Institute of Pathology. Washington D. C.
7. Fortner Joseph, G.: Carcinoma of the gall bladder. The experimental induction of primary cancer. Cancer. 8. 4. 1955. 689-
8. Gahagan, H. Q. and Reed, W. K.: Squamous-cell carcinoma of the renal pelvis. Three case reports and review of literature. J. Urol. 62. 139. 1949. 151-
9. Hicks, J. D. and Cowling, D. C.: Squamous-cell carcinoma of the ascending colon. Jour. Path. & Bact. LXX. I. 1955. 205-212.
10. Kahler, J. E.: Carcinoma of the prostate gland. A pathologic study. J. Urol. 41. 1937. 557-574.
11. Krag Daniel, O. and Alcott Donald, L.: Glandular Metaplasia of the renal pelvis. Report of a case. Am. J. Clin. Path. 27. 6. 1957. 672-
12. Meyer M. Melicow.: Tumours of the urinary bladder a clinico-pathological analysis of over 2,500 specimens and biopsies. J. Urol. Baltimore. 74. 1955. 498-
13. Nicholson (the late) G. W. de. P.: Studies on tumour formation. Butterworth & Co. Publishers. London. 1950.
14. Niskanen, K. O.: Observation on metaplasia of the bronchial epithelium and its relation to carcinoma of the lung, patho anatomical and experimental researches. Acta Path. et microbiola.
15. Valentine Eleanor, R.: Squamous metaplasia of the bronchus. A study of metaplastic changes occurring in the epithelium of the major bronchi in cancerous and non-cancerous cases. Cancer. 2. 10. 1957. 272-
16. Weller, R. W.: Metaplasia of bronchial epithelium. A postmortem study. Am. J. Cl. Path. 23. 1953. 768-774.
17. Willis, R. A: Pathology of Tumours. 1948. Butterworth & Co. Publishers. London.

Received for publication on 14-9-57

EXPERIMENTAL HYDRONEPHROSIS — III

by B. N. BALAKRISHNA RAO and P. N. GHEI, Gwalior.

Work on experimental animals (rats and dogs) by Balakrishna Rao et al has shown that hydronephrosis invariably develops if the ureter is suddenly and completely obstructed. This has been reported in the two preceding articles of the series. The technique of decompressing the hydronephrotic kidney has been described by the authors in a previous paper (Experimental Hydronephrosis-II).

This paper deals with determination of the critical time period for reversal of hydronephrotic changes. Guyon and Albarran (1897) observed that in human beings, the kidney ureter of which has been occluded for a long period will begin to secrete when the obstruction is removed. Hinman and Morrison (1934) concluded from experimental observation that a kidney which has been obstructed for some weeks fails to secrete when the obstruction has been removed, not because of atrophy, but because of the phenomenon of renal counterbalance. Under stress of obstruction a stage is reached by the kidney when even if the obstruction is removed, recovery does not follow. It is interesting and clinically important to assess the time when after decompression functional recovery can take place. The importance of the determination of this critical time of reversibility is obvious, as it will help to decide the nature of surgical intervention under stress of complete obstruction.

Methods, Materials and Observations

(a) The technique of draining the hydronephrotic sac by ureterovesical implantation has been described in a previous paper of this series.

TABLE No. I

Results of kidney function tests (Indigocarmine)

Name of Dog	Date of ligation	Date of ureterovesical implantation	Date of right side nephrectomy	Date of administration of 10 ml. 0.4 indigocarmine	Remarks
S	30 9 55	-		30—9 55	Dye appeared in 2 minutes 55 seconds and maximum intensity in 3 minutes 45 seconds.
R	21 8 55	-	-	21 9—55	do.
Q	25 8 55	3—10 55		3 10 55	No dye appeared from the left ureter upto 15 minutes, but appeared from right ureter.
M	30 5 55	15- 9 55	—	15 - 9 55	do.
I	5 3 55	20 5 55	23 - 9 - 55	23 - 9 55	do.
G	17 2 55	10 - 8 55	29- 9 -55	29- 9 55	do.
U	18 10 55	7 11 55	29- 11 55	18 10 55 29—11- 55	do.
Y	28 11 55	12 12 55		12—12 55	do.
E_1	27 12 55	2 1 56		2— 1 56	Dye appeared in 7 minutes.
H_1	29 12 55	5 1 56		5 1 56	Dye appeared in 9 minutes.

TABLE No. II

Results of kidney function test (Phenolsulphonphthalein)

Name of Dog	Date of ligation	Date of uretero-vesical implan-tation	Date of right side nephrec-tomy	Date of admini-stration of 6 mg. (10 ml.) of P.S.P.	Remarks
T	4-10-55			4-10-55	Dye appeared in 5 minutes.
V	19-10-55			19-10-55	Dye appeared in 5 minutes.
X	28-11-55	12-12-55		28-11-55	Dye appeared in 5 minutes.
				12-12-55	Dye appeared in 9 minutes.
C_1	25-12-55	14-1-56		25-12-55	Dye appeared in 5 minutes.
				14-1-56	Dye appeared in 11 minutes.
G_1	28-12-55	17-1-56	7-2-56	28-12-55	Dye appeared in 5 minutes.
				17-1-56	Dye appeared in 11 minutes.
				7-2-56	Dye appeared in 6 minutes.
L_1	9-2-56	18-2-56		18-2-56	Dye appeared in 7½ minutes.

(b) Kidney function was attempted to be estimated by dye excretion tests. Indigocarmine and Phenol-sulphonphthalein were use.

10 ml. indigocarmine of 0·4% aqueous solution was administered intravenously. The emergence of blue colour through a ureteric catheter was found to be 3 mins. and 45 secs. on an average. 6 mgm. of phenolsulphonphthalein in 1 ml. of water was introduced into a vein and the ensuing efflux collected into a test tube containing dilute sod. hydroxide solution. The production of pink colour was utilised for estimating the excretion time. The average time for a normal kidney was found to be 5 minutes. The findings are tabulated in Table I & II.

With indigocarmine, a six day old hydronephrosis showed excretion time of 7 mins., and 21 days old and of longer duration, no excretion of dye upto 15 mins. With phenolsulphonphthalein dye appeared in 9 mins. in 15 days old hydronephrosis, and in 11 mins. in 21 days old hydronephrosis, and none in hydronephrosis of longer than 21 days duration.

(c) Retrograde pyelography was done by introducing a ureteric catheter and injecting "pyelectan".

A normal retrograde pyelogram (Fig. 1) shows the pelvis of the kidney to lie opposite the transverse process of 1st and 2nd lumbar vertebrae. The capacity of the normal pelvis is 4-7 ml. The calyx shows a cupped extremity. There is a sharp curve between the ureter and lower calyx. Pyelogram of a 15 days hydronephrosis (Fig. 2) shows a change in the pelviureteric angle. There is evidence of development of tubulovenous backflow as seen by the presence of tuft formation in the renal calyces.

A 21 days retrograde pyelogram (Fig. 3) reveals very slight functional renal parenchyma and evidence of presence of tubulovenous backflow. Pyelogram of hydrone-

Fig. 1.
Normal pyelogram (retrograde) of dog.

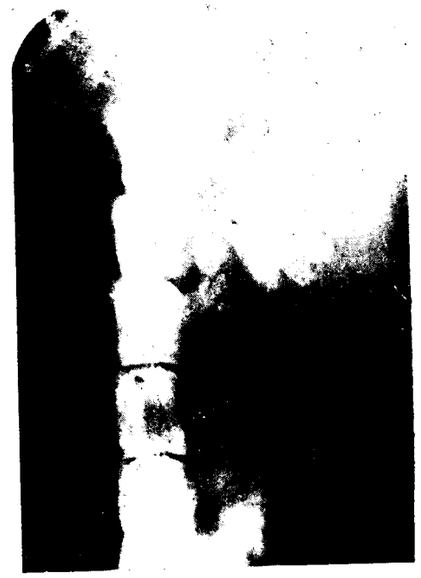


Fig. 2.
Pyelogram of hydronephrosis of 15 days duration.

Fig. 3.
Pyelogram of hydronephrosis of 21 days duration.

Fig. 4.
Pyelogram of 40 days hydronephrosis decompressed by ureterovesical implantation. Note the shrinkage of the pelvis.

phrosis of more than 21 days shows complete absence of functional renal parenchyma and disappearance of the normal shape of calyces. Pyelograms of more than 21 days showed evidence of ptosis of the kidney which is near the 3rd-5th lumbar vertebrae.

With release of obstruction the hydronephrotic kidney pyelogram as compared to one before release of obstruction always revealed shrinkage of the kidney to a size below the normal. A 21 days pyelogram which before obstruction showed a very small amount of functional renal parenchyma showed an increase of the functional renal parenchyma (as there was re-appearance of normal calyces and the ureteropelvic angle had become normal), and the disappearance of the evidence of tubulovenous backflow. All retrograde pyelograms obtained after release of the obstruction showed the kidney shrinking to a size below the normal opposite kidney, but kidney pyelograms of more than 21 days showed no appearance of functional renal parenchyma. (Fig. 4).

(d) Finally, to find the critical time period, after having obtained an approximate idea, it was decided to perform right sided transperitoneal nephrectomy (as hydronephrosis and drainage of ureterovesical implantation was always done on the left side).

(e) Blood urea was estimated by King's technique. Blood urea estimation was done in dogs subjected to right sided transperitoneal nephrectomy. Blood urea after nephrectomy always rose till the dog died of uraemia except in dogs of 21 days and of lesser duration, in which case blood urea gradually rose and then returned fairly to within normal limits. (Graph No. I).

(f) The gross and histological studies were done on drained kidneys. Gross and histological features of drained hydronephrotic kidney are recorded in Experimental Hydronephrosis-II. The histological changes are summarised in Table No. III.

Discussion

It was thought that when a hydronephrotic kidney was decompressed, it was not possible to estimate by kidney function tests and histology alone to assess if the kidney had recovered sufficiently to keep the animal in a stage of health, as the opposite kidney was functioning normally. If such an opposite kidney were removed and the hydronephrotic kidney now relieved of stress of obstruction could keep the animal alive, it was conclusive and critical evidence of the recovery of the decompressed kidney. Therefore, a plan of removing the opposite kidney of all animals with unilateral hydronephrosis and subsequent decompression by ureterovesical implantation, was adopted. The duration of hydronephrosis varied, and by this means the longest period of hydronephrosis that could recover could be critically determined; not only theoretical functional recovery, but enough to sustain the life of the animal on this sole kidney which had undergone previous hydronephrotic changes.

In the present work, it has been found that recovery of the kidney, the ureter of which has been obstructed for about three weeks, occurs if obstruction is relieved. However, it has been observed that only if the normal (opposite) kidney is removed, the hydronephrotic kidney with its obstruction relieved, begins to function. In the presence of normal functioning opposite kidney which has taken on the function of obstructed kidney for about 3 weeks, the relieved hydronephrotic kidney does not recover as quickly or to the same extent, unless demands are made on it. Studies of blood urea strengthens the belief that after a certain time after nephrectomy the blood

TABLE NO. III

HISTOLOGICAL CHANGES IN HYDRONEPHROTIC DOGS DRAINED BY URETEROVESICAL IMPLANTATION

Name of Dog	Duration of hydronephrosis in days	General appearance	Glomeruli			Evidence of hydronephrotic atrophy	Tubules				Remarks
		Distortion of architecture	Crowding	Periglomerular fibrosis	Disappearance		Hypertrophy of corresponding tubules	Colloid cast	Changes in lining epithelium	Inflammatory cell infiltration	
K_1	15	–		Normal		–	++	+	–	–	Evidence of complete recovery.
F_1	21	–		Normal		Patchy	+++++	+	–	–	Evidence of recovery.
U	21	–		Normal		Patchy	+++++	+	–	–	Evidence of recovery.
Q	40	+	++	++	+	+	++	++	–	++	Infection +
R	60	+	++	+	+	+	++	++	+	+	Occasional functioning nephron.
I	76	+	+++	++	++	+	+++	++	–	+	Occasional functioning nephron.
A	174	+	+++	+++	+++	+	+	+	+	+	Occasional functioning nephron.
G	175	+	+++	+++	+++	+	+	+	+	–	Occasional functioning nephron.

urea rose (i.e. the time when kidney was taking over function) and when kidney had taken-up the function, the blood urea started falling. Functionally there was evidence of secretion of P.S.P. by the kidney at the time of doing the nephrectomy (no evidence of secretion of indigocarmine).

The following points appear to be conclusive : —

(i) A review of pyelogram of 21 days (Fig. No. 3) or less hydronephrosis reveals the presence of surviving renal parenchyma and not merely a mass of non-functioning kidney.

(ii) Histologically, recovery of drained kidney of 21 days duration and less. (Fig. Nos. 5 & 6).

(iii) Evidence of excretion of P.S.P. by the 21 days hydronephrotic kidney. (Vide Table No. II).

(iv) Return of blood urea to almost within the normal limits of kidneys of 21 days hydronephrosis and of less duration in which it had initially risen after right side nephrectomy. This initial rise of blood urea for a number of days after nephrectomy can be deduced as the time interval required for the kidney to take the function after the hypertrophied (opposite) kidney has been removed. (Graph No. I).

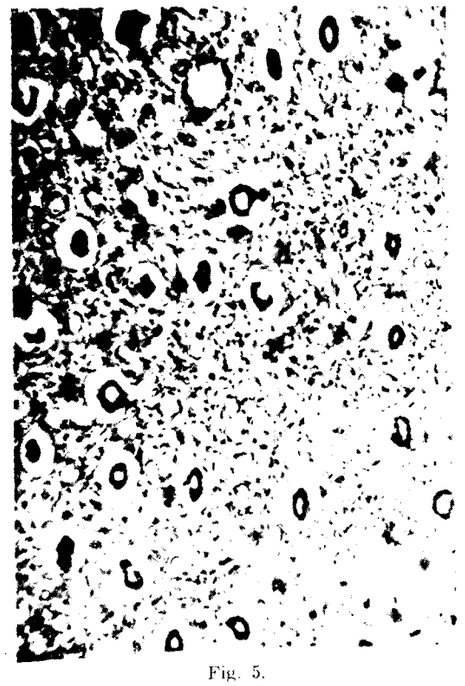


Fig. 5.

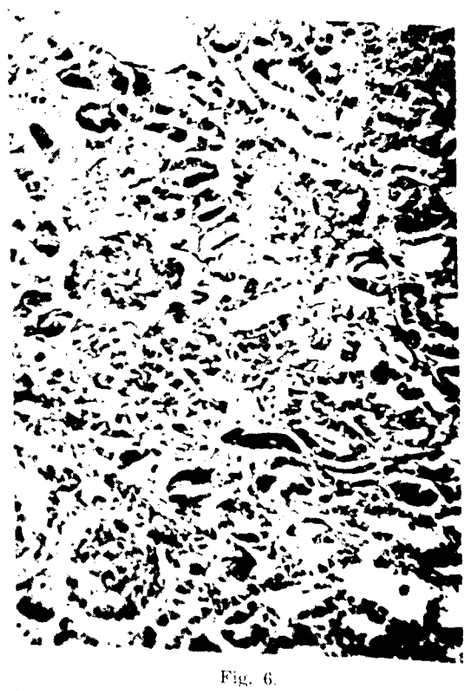
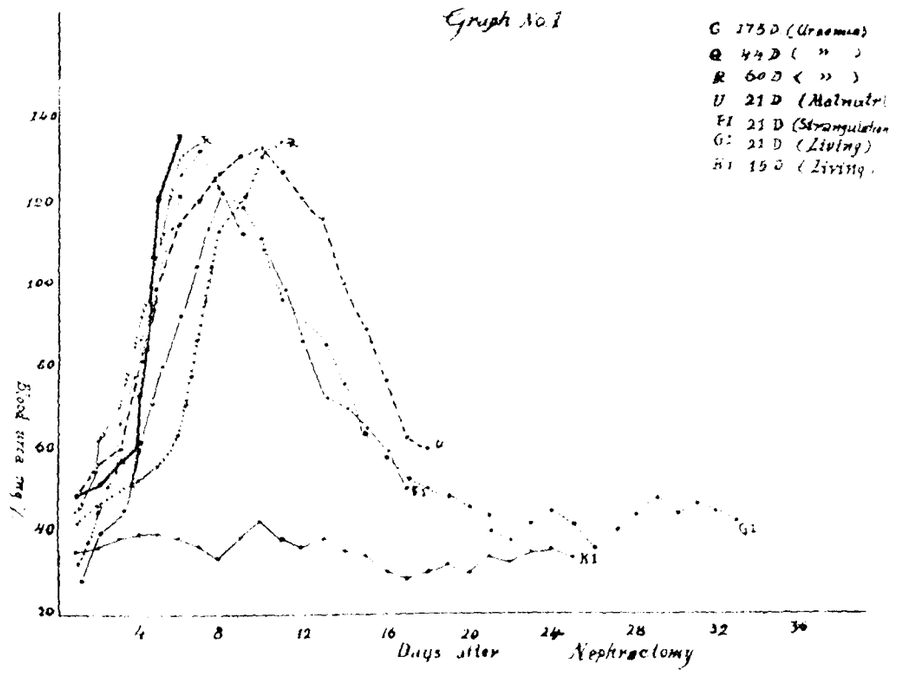


Fig. 6.

Figs. 5 & 6. Section of kidney which had undergone 21 days hydronephrosis and later decompressed showing normal looking glomeruli — low and high power.



From the consideration of the above findings, it is concluded that the critical time period for reversal of hydronephrotic changes is 21 days.

This has an important bearing on the clinical problem of hydronephrosis. If we apply this experimental result to human kidney which has become hydronephrotic due to obstruction to the outflow of urine then such a kidney has a fair chance to reverse if the obstruction is relieved by suitable procedures or by ureterovesical implantation.

Summary

A critical time period of 21 days for reversal of hydronephrotic changes is determined after study of histological, pyelographic and blood urea changes in dogs.

ACKNOWLEDGEMENT

It is a pleasure and privilege to acknowledge the co-operation of numerous workers and colleagues in the Departments of Surgery, Radiology and Pathology. Most of this work has been done under the aegis of the Indian Council of Medical Research, to whom we can only inadequately express our gratitude.

BIBLIOGRAPHY

1. Allen, A. C.: "The Kidney". Grune & Stratton. New York 1951.

2. Anxilotti, e. Fabbrini.: "Contribution allo studio anatomopatologio. e. fisiopatologeoo dell idronifrosi" idopionefrosi, Pisa 1903.

3. Bell, E. T.: "Renal Diseases", Lea and Febige, Philadelphia, 1950.

4. Campbell, M. J.: Urol. 65: 734, 1951.

5. De Victoribs Medori: "Policbnico- Zez Chumujica". Page 1, and Lettereture 1937.

6. Fiori.: "Typographia Velente", Pisa 1903. 'Le clinique Clinyica'. 7: 762, 1904.

7. Ghiron, e. Giacobbe.: "Archnies Ital. de Urol." 8: 91, 1931.

8. Harderoft, W. S.: B. J. Exp. Path. 29: 483, 1948.

9. Hinman, F.: Surg., Gynec. & Obst. 58: 356-376, 1934.

10. Hinman, F. and Morrison, P. M.: Surg., Gynec. & Obst. 42: 209, 1926.

11. Hinman, F. and Hepler, A.: Arch. Surg. 12: 830, 1926.

12. Hinman, F.: Surgery. 17: 816-836, 1946.

13. Hinman, F.: Jour. Urol. 9: 289-314, 1923.

14. Perskey, L., Storaasli, J. P. and Austin, G. Jr.: Jour. Urol. 73: 5: 1955.

15. Ponfick, Beitr.: Z. Path. Anat. U.Zallg. Path. 49: 127, 1910.

16. Rayer, P.: "Traite de maladies des renis", Paris, 1861, J. B. Bailliere et fils.

17. Smith Homer, W.: "The Kidney", Oxford University Press, New York, 1951.

18. Trueta.: "Journ. d'urol." n. IV, 1948.

19. Wolf, A. V.: "The Urinary Function of Kidney", Grune & Stratton Inc., New York, 1950.

Received for publication on 27 8 '57.

SUTURE METHODS OF VASCULAR ANASTOMOSIS *

(An Experimental Study)

by YUDHVEER SACHDEVA and J. R. TALWAR, Amritsar.

The methods of vascular anastomosis have attained great importance because of their use in operative procedures for the correction of congenital cardiovascular disorders, relief of portal hypertension by portacaval and lienorenal shunts, in the surgery of aneurysms, arteriovenous fistulae, peripheral vascular disease and in restoring the continuity of the blood vessel after trauma.

Numerous methods of vascular anastomosis had been studied from time to time with varying results. Crafoord [3] favoured a continuous over and over stitch positioned to avoid intima. Gross [4], Blalock [1] and Shumacker [7] on the basis of their experimental and clinical experience regarded continuous mattress stitch as most reliable. In this small series of experiments, we have attempted to make a comparative evaluation of some of the suture methods of vascular anastomosis. The different methods selected for this study are based on certain fundamental principles of vascular anastomosis. This work was undertaken as a preliminary step to study the problem of transplantation of homografts and silk grafts in large blood vessels.

Material and Methods

Twenty-one dogs weighing 6.5 — 15.4 killograms were used in these experiments and divided into three groups as follows :—

1. Continuous over and over stitch (non-everting with end to end approximation) 7 dogs
2. Continuous mattress stitch (everting with intima to intima approximation) .. 7 ..
3. Alternating interrupted horizontal mattress and simple single stitches (everting with intima to intima approximation) .. 7 dogs

Many of the methods not studied by us are either those which are based on the same principle as the above or are not in general use in vascular anastomosis. Such techniques which omit penetration of intima by the sutures have not been studied because these cannot be used successfully in all types of blood vessels, such as veins and arteries of small calibre.

The experiments were done under 2.5% nembutal anaesthesia given intravenously. An average initial dose of 30 mg./kg. body weight was used. The abdominal aorta was exposed below the renal arteries by a midline or left paramedian incision. After mobilisation, the aorta was divided between two Pott's [5] coarctation clamps. The cut ends were washed with normal saline to remove any blood clots. The vessels were kept moist with saline. A small portion of the cut ends of the aorta was denuded of adventitia and then the two ends were brought together by passing three stay sutures according to Carrel's [2] technique of triangulation. The anastomosis was done by one of the above mentioned suture methods and approximating one side of the triangle in successive turns using 5-0 black braided silk swaged on an atraumatic needle (Anacap D & G) as suture material. After finishing the anastomosis, the clamps were removed, first distal and then proximal. Leak, if any, was controlled by slight pressure with a finger or a piece of gauze. Sometimes one or two extra stitches were needed to achieve complete haemostasis. Abdomen was closed in layers. No anticoagulants or antibiotics were used. The experiments were done under aseptic conditions. A watch was kept on the animals in the post operative period

* From the Department of Clinical Surgery, Medical College, Amritsar. Partly supported by a grant from Ram Sarn Das foundation for research.

for any complications. Patency of the anastomosis was judged by the presence of femoral pulsation. After varying intervals the dogs were sacrificed. The aorta including the anastomotic area was examined for any dehiscence, haemorrhage or thrombosis. Longitudinal sections of anastomotic site were made for histological study.

Results (Table I & II)

Out of the twenty-one dogs in these experiments, nine (43%) developed complications. In the rest, anastomoses were successful and complicated.

The complications which developed in nine dogs were :—

(i) Thrombosis in 6 dogs: Three of these had massive thrombosis completely occluding the lumen and these dogs developed paraplegia in the post-operative period.

(ii) Delayed fatal haemorrhage in two dogs.

(iii) Retroperitoneal haematoma with no dehiscence of anastomosis in two dogs.

The incidence of complications in different types of anastomosis was as follows :—

Continuous over and over stitch — 4 out of 7 (57%)

Continuous mattress stitch — 3 out of 7 (43%)

Alternating interrupted horizontal mattress and simple stitches — 2 out of 7 (28.5%)

Incidence of thrombosis: Even slight amount of deposit of fibrin on or near the anastomotic line was taken as thrombosis. With continuous over and over stitch thrombosis occurred in two (28.5%). It completely occluded the lumen and extended above and below the anastomotic line. In both these dogs femoral pulsation was absent and they developed paraplegia. They were sacrificed one and three days after the anastomosis respectively.

With continuous mattress stitch, thrombosis was found in two (28.5). In one only, small flecks of fibrin were present at the anastomotic line. In the second animal who had died of post operative haemorrhage on the third day, post-mortem examination revealed the presence of a small thrombus at the site of anastomosis. In both these dogs, femoral pulsations were quite forceful in the postoperative period.

In the third group of animals where interrupted sutures were used, two dogs (28.5%) developed thrombosis. In one multiple small thrombi were found at the anastomotic line and at the site where proximal clamp had been applied (Fig. 1). Femoral pulsation was normal in the post-operative period. The second animal developed paraplegia and femoral pulse was absent. Post-mortem examination showed that a thrombus completely occluded the lumen of the aorta.

Immediate haemorrhage: The experiments where excessive haemorrhage occurred at the time of anastomosis, were not included in this study. This occurred in the beginning due to faulty operative technique.

Delayed haemorrhage: Occurred in two of 21 experiments (9.5%); in one with continuous over and over stitch on the fourth day and in the second with continuous mattress stitch three days after the anastomosis.

Fig. 1.

Thrombosis at the site of compression by arterial clamp (Sr. No. 19).

Fig. 2.

Aorta opened longitudinally. Continuous over and over stitch. Showing silk sutures and smooth lining (Sr. No. 4).

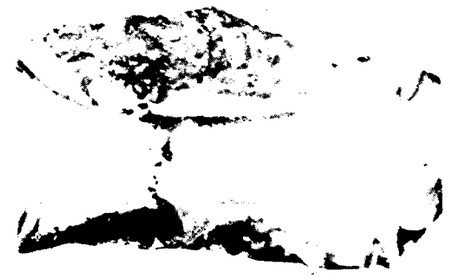


Fig. 4.

Aorta opened longitudinally. Continuous mattress stitch shows smooth inner surface (Sr. No. 10).

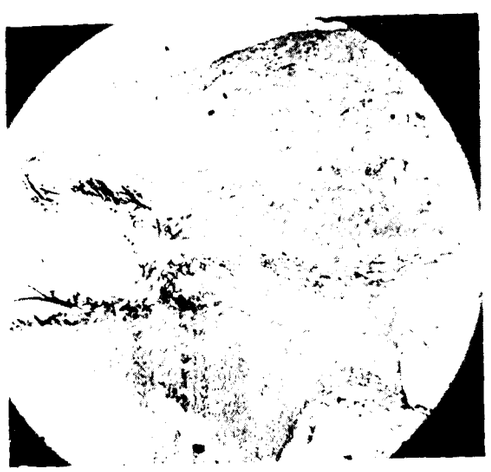


Fig. 3.

Microphotograph (L.S.) same as Fig. 2 showing silk sutures covered by intima.

Fig. 5.

Microphotograph (L.S.) same as Fig. 4 showing healed line of anastomosis with intimal lining.

Retroperitoneal haematoma: Occurred in two (9.5%). In one with continuous over and over stitch and in the second with continuous mattress stitch. Both these dogs were sacrificed, seven days after the operation and haematomas were present in the retroperitoneal tissues firmly adherent to the anastomotic area. Femoral pulsation was good. There was no dehiscence of the anastomosis.

Fig. 6.

Aorta opened longitudinally. Alternating interrupted mattress and simple single sutures. Shows some sutures covered by smooth intimal surface (Sr. No. 17).

Fig. 7.

Microphotograph (L.S.) same as Fig. 6 healed anastomotic area covered by smooth intima.

Discussion

To evaluate the results of these experiments, it is important that except for methods of suturing of blood vessels, all the factors affecting vascular anastomosis are kept constant. In the present study the general operative technique, suture material and the arterial clamps were the same in all the experiments which were undertaken by the same workers.

Thrombosis was equally common with all the methods, but varied greatly in extent. The presentation of suture material in the lumen seems to increase the incidence of extensive thrombosis. Massive thrombosis occurred with the methods in which some amount of suture material presented in the lumen, as in group 1 and 3. Sako et al[6] deliberately exposed excessive amounts of suture material in the lumen to study this point. They felt that this did not appear to be an important factor in thrombus formation thought it could certainly contribute to its occurrence. Smith[4], however, showed that if a fine silk suture was threaded transversely through an artery, tiny clots formed in the centre; these grew in size, till the lumen was completely occluded. When a stitch was placed parallel with the longitudinal axis of the vessel thrombus formation was far less. It was found that when sutures were meticulously placed almost in the same plane as the longitudinal axis of the vessel thrombosis was minimal. On the other hand when the sutures passed irregularly, there was increase in the incidence of thrombosis. Another important factor leading to thrombosis is excessive intimal injury caused by rough handling or even by excessive compression by the arterial clamp. Minute thrombi at the site of anastomosis which formed in the wedge between the everted margins of anastomosed vessels do not appear to be of a serious nature as these possibly get covered by an intimal lining later on. However, the possibility of their extension cannot be ruled out. It is also stated that strands of adventitia going into the lumen can also give rise to thrombosis. In the present

TABLE I

Suture Method	Sr. No.	No. of days after operation	Postoperative condition: Femoral pulsation	Postoperative condition: Complications	Postmortem Findings
1. Continuous over and over stitch	1	1	Absent	Complete paraplegia.	A thrombus completely occluding the lumen.
	2	4	Present	Fatal haemorrhage	Partial dehiscence of the anastomosis
	3	7	Present	Nil	A small retroperitoneal haematoma, intima thickened over the anastomotic area.
	4	15	Present	Nil	Sutures covered by shining intimal lining (Fig 2 and 3)
	5	10	Present	Nil	Anastomatic area covered by intimal lining.
	6	20	Present	Nil	No thrombosis. Anastomotic area covered by intima.
	7	3	Absent	Slight paresis	A large thrombus in the lumen present.
2. Continuous mattress stitch	8	3	Present	Nil	A few small fibrin flecks adherent at the anastomotic line.
	9	10	Present	Nil	Smooth intimal lining covered the anastomotic area.
	10	15	Present	Nil	Anastomotic area covered by smooth intima (Fig. 4 and 5).
	11	3	Present	Fatal haemorrhage	Large amount of blood in the peritoneal cavity dehiscence of anastomosis. A small thrombus at the line of anastomosis.
	12	7	Present	Nil	Anastomotic area covered by slightly thickened Intima
	13	5	Present	Nil	Smooth intimal lining over the anastomotic area.
	14	1	Present	Nil	No intimal lining over the anastomotic area.
3. Alternating interrupted	15	4	Present	Nil	Intima covered the anastomotic area.
	16	1	Present	Nil	No intimal covering present.
	17	20	Present	Nil	Anastomotic area covered by smooth intimal lining (Fig. 6 and 7).
	18	10	Present	Nil	Anastomic area covered with intima.
	19	5	Present	Nil	Small thrombi visible at the anastomotic line and at the site where the proximal arterial clamp was applied. (Fig 1)
	20	3	Absent	Paraplegia	A thrombus 2 cm. in length and occluding the lumen completely.
	21	5	Present	Nil	Anastomotic area covered by smooth intima.

TABLE II

Type of suture	Continuous over and over stitch	Continuous mattress stitch	Alternating interrupted horizontal mattress and simple single stitches	Total
Number of anastomoses done	7	7	7	21
Thrombosis	2 (28.5%) Thrombus completely occluding the lumen	2 (28.5%) Small thrombi over the anastomotic area	2 (28.5%) In one the thrombus completely occluded the lumen, and in the second thrombi were present at the anastomotic line and at the site where proximal clamp was applied.	6 (28.5%)
Paraplegia	2	--		1
Partial dehiscence and delayed fatal haemorrhage	1 (14%)	1 (14%) There was also a small thrombus (listed also under thrombosis)	Nil	2 (9.5%)
Retroperitoneal haematoma with no dehiscence.	1 (14%)	1 (14%)	Nil	2 (9.5%)
Number of anastomoses where complications occurred.	5 (67%)	3 (43%)	2 (28.5%)	9 (43%)

experiments adventitia was removed from the ends. The use of antibiotics and anticoagulants should lessen the incidence of thrombosis.

Immediate haemorrhage was usually not a serious problem in these experiments. It was noticed that in those instances in which excessive leakage occurred from the anastomotic line after removing the arterial clamps, incidence of thrombosis and haematoma formation increased.

Delayed fatal haemorrhage was found to be due to sutures cutting through and thus leading to dehiscence and fatal haemorrhage. Removal of too much of adventitia seems to be one of the causes responsible for this complication. Extensive removal of adventitia leads to interference with the blood supply of the media because blood vessels go through the adventitia to supply the media. Another important factor noticed was excessive tension on certain loops which caused pressure necrosis and thus led to disruption of anastomosis.

With continuous over and over stitch (non-everting) piercing all the layers the complications were more. The incidence of thrombosis was the same with all the three methods, but it was very extensive with this method and led to paraplegia. Leakage at the time of operation and delayed haemorrhage were also more common with this technique. As compared to continuous over and over stitch, complications were less frequent with mattress sutures. Continuous mattress suture has proved to be quite a satisfactory and reliable procedure. However, there is a possibility that the continuous mattress suture may be drawn too tight leading to unequal distribution of disrupting force on different loops in the anastomotic line and thus resulting in dehiscence and haemorrhage. But with some practice in this technique this difficulty can be overcome.

The technique of alternating interrupted horizontal mattress and simple single stitches has given good results but presentation of suture material in the lumen (due to simple stitches) make this method more prone to thrombosis. This method is also more time consuming than the other two methods.

The present study shows that vascular anastomosis may be accompanied by a high incidence of complications irrespective of the suture method used. The number of experiments reported is not sufficient to evaluate the suture methods satisfactorily. Moreover a long term study has not been done to know the late complications of anastomosis. With all the limitations mentioned above, from this small series of experiments it seems reasonable to conclude that the continuous mattress (everting) technique is superior to the other techniques.

SUMMARY

A report on the evaluation of certain methods of vascular anastomosis is presented. The experimental method, the complications encountered with different suture methods and the precautions which should be taken to increase the success in vascular anastomosis are discussed.

ACKNOWLEDGEMENTS

We express our gratitude to Dr. Mohan Singh Sethi, Professor of Pharmacology for providing necessary facilities for this experimental work. Our thanks are also due to Dr. Inderjit Dewan, Professor of Anatomy, for helpful criticism and advice in the preparation of the paper.

REFERENCES

1. Blalock, A. and Taussig, H. B.: Surgical treatment of malformations of the heart in which there is pulmonary stenosis or pulmonary atresia. J.A.M.A. **128**: 189-202. 1945.
2. Carrel, A.: The Surgery of blood vessels etc. Bull. Johns Hopkins Hospital. **18**: 18-28. 1907.
3. Crafoord, C. and Nylin, G.: Congenital coarctation of aorta and its surgical treatment. J. Thoracic Surg. **14**: 347-361, 1945.
4. Gross, R. E. and Hufnagol, C. P.: Coarctation of aorta. Experimental studies regarding its surgical correction. New England. J. Med. **35**: 287-293, 1945.
5. Potts, W. J.: Technique of resection of coarctation of aorta with aid of new instruments. Ann. Surg. **131**: 466-472, 1950.
6. Sako, Y., Chishobu, T. C., Merindino, K. A. and Varco, R. L.: Experimental evaluation of certain methods of suturing thoracic aorta. Ann. Surg. **130**: 363-383, 1949.
7. Shumacker, H. B., Jr. and Lawenberg, R. I.: Experimental studies in vascular repair: comparison of reliability of various methods of end to end arterial sutures. Surgery. **24**: 79-89, 1948.
8. Smith, S.: Studies in experimental vascular surgery. Surgery. **18**: 627-643, 1945.

Received for publication on 31-7-'57.

MECONIUM PERITONITIS *

(A case report with a brief review of the literature)

by B. L. GUPTA, Bombay.

Introduction

Meconium peritonitis is a rare surgical condition in newborn children. The following brief review of the literature and the report have been prompted by a case recently seen. The records of the K.E.M. Hospital, Bombay, do not show a single such case in the last 30 years. Gross [7] in his book "The Surgery of Infancy and Childhood" makes no more than a passing reference to this condition in the chapter 'Intestinal obstruction in the newborn resulting from Meconium Ileus'.

History

Sir James Simpson [16], the earliest authority on this condition, first described it in 1838, with a review of 25 cases.

In 1915, Rudnew [15] reported 40 cases and Abt [1] in 1930 reported a further 60 cases. In 1930, Boikan [2] reported a case with a long article in which he attempted to clear the aetiopathology of the condition. Neuhauser [14], in 1944, described 3 cases of which one survived the operation. The first recorded case to survive the operation in Great Britain was described by Gover [6] in 1950.

Low, Cooper and Cosby's paper [11], the most authoritative in recent times, describes a case diagnosed pre-operatively which survived operation.

Aetio-Pathology

Meconium peritonitis is a definite pathological entity. It is a sterile chemical peritonitis resulting from the escape of meconium into the peritoneal cavity from the lumen of the intestines.

The perforation of the bowel occurs either before, during or just after birth; as the bowel contents become contaminated within 36 to 48 hours of birth, any perforation after this period will lead to a septic rather than a chemical peritonitis.

'Meconium is composed of desquamated epithelial cells, bile salts and pigments and sebaceous material from aspirated amniotic fluid and gastrointestinal juices' (William [18] and DeLee [4]). The appearance of meconium is described in a 130 mm. size embryo by Mall [13]. The majority of workers, however, are of the opinion that it appears in the second trimester.

Aetiology

According to Rudnew [15], 50 per cent of cases are due to a demonstrable cause of intestinal obstruction, like atresia, volvulus, adhesions and intussusception.

Here the explanation of the meconium peritonitis is simple. The meconium, in the intestinal lumen, stimulates peristalsis, which, working against an obstruction, causes perforation with escape of meconium in the peritoneal cavity.

Landsteiner [8] thinks meconium peritonitis to be essentially a complication of meconium ileus, in which there is a lower ileum obstruction with thick putty-like, sticky meconium due to lack of pancreatic secretion.

The other 50 per cent of the cases occur without any demonstrable cause (as in this case report).

According to Zillner [19], trauma is one of the most important aetiological factors. Ulcers of the bowel, Meckel's diverticulum, the appendix and congenital diverticulae are mentioned as sites of perforation.

There are other cases in which no satisfactory explanation can be given as perforation occurs in a clinically normal gut. Thus results the confusion regarding the aetiological factors.

Boikan [2] and Lattes [9] think that antepartum perforation of the ileum is due to marked hypertrophy of the glands of Lieberkuhn. As a result of this hypertrophy, the apices of the glands reach upto the serosa of the bowel causing congenital weakness of the muscle coat of the intestines. Microscopically, it is proved that there is a marked hypertrophy of these glands at the site of perforation.

Whatever may be the cause of perforation, it generally closes soon. Hence it is not usually found at operation, (as in the present case) nor even at autopsy.

Pathology

The escape of sterile intestinal contents into the peritoneal cavity gives rise to minute, scattered foci of foreign body reaction, in which there is calcification, identifiable on X-ray. According to Litten [10], this calcification occurs within 24 to 48 hours after the onset of peritonitis.

Neuhauser [14] reported 3 cases from The Children's Hospital, Boston, where diagnosis was made pre-operatively from the appearance of this scattered calcification in the peritoneal cavity. Neuhauser affirms that no other condition in a newborn child, causes a similar radiological appearance.

Most of the children with meconium peritonitis are either born dead or die within a short time after birth. Those who survive, present themselves as cases of congenital intestinal obstruction with increasing distension. Hence one should strongly suspect this condition when a newborn child presents signs of intestinal obstruction, and flat films of the abdomen show scattered areas of calcification, with free fluid in the peritoneal cavity. Early intervention may save a certain number of lives if this condition is thought of.

Brunkow [3] describes a case operated on due to these suspicious areas of calcification. The child survived the operation.

Treatment

Organic obstruction, being the cause of meconium peritonitis in about 50 per cent of cases, the causative obstruction should be relieved by various standard procedures as recommended by Gross. When meconium ileus is the cause of peritonitis, the treatment merges into the treatment of the causative condition. A simple drainage of the peritoneal cavity is all that is required in those cases where no pathological cause of perforation is discovered. It is inadvisable and difficult to search out the site of perforation among the glued intestinal loops.

CASE REPORT

A female child, 2 days old, was admitted to the K.E.M. Hospital, Bombay, on 2-4-1957, with a complaint of not having passed meconium since birth, vomiting off and on, and distension of the abdomen.

The child was delivered at the Nowrosjee Wadia Maternity Hospital, Bombay. The mother had a normal full term delivery and the baby weighed 5½ lbs. at birth.

The child was dehydrated and listless. The abdomen was grossly distended, measuring about 13 inches in girth at the level of the umbilicus. The skin of the abdominal wall was thinned out and shiny. There were prominent dilated veins over the abdomen. There were no visible peristaltic movements.

On palpation, no lump could be detected. The spleen and liver were not enlarged. The abdomen was tympanitic all over and free fluid could not be demonstrated clinically. Ausculation revealed normal peristalsis all over the abdomen.

A rectal examination showed no anal atresia, the whole of the little finger could be passed in easily. There was no meconium on the examining finger.

The criculatory and respiratory systems were normal.

The temperature was 97 F., pulse was over 160 per minute and the respiration rate was 30 per minute.

During examination, the child vomited a small quantity of watery fluid which the parents had administered a short while before.

A diagnosis of ? Meconium Ileus was made clinically.

A flat film of the abdomen was taken with the child held upside down, because of the possibility of a high rectal or colonic atresia.

* From the Department of Surgery, K.E.M. Hospital, Parel, Bombay-12.

Fig. 1.

Anterior view: Plain X-ray abdomen — showing Right half of the peritoneal cavity occupied by fluid (Meconium) and intestines are pushed towards left side. Scattered calcification throughout the peritoneal cavity (touched).

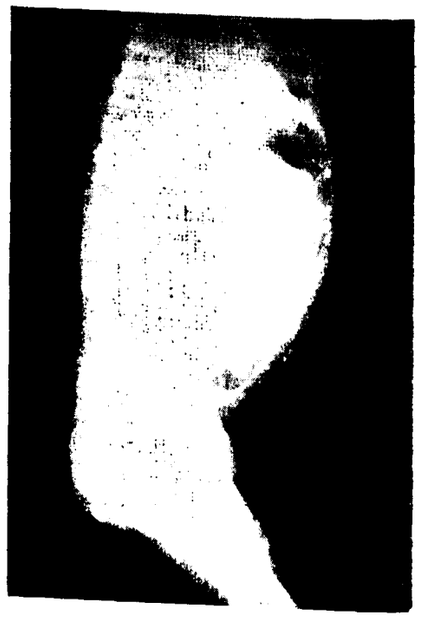


Fig. 2.

Lateral view of the same showing large collection of fluid.

Examination of the X-ray film showed scattered areas of calcification throughout the abdominal cavity and a large dense opacity on the right side of the abdomen which could not be explained (Figs. 1 & 2).

The child was treated conservatively as a case of meconium ileus with enemas and gastric lavage. The dehydration was combated by subcutaneous fluids with hyalase. As pancreatic enzymes were not available, they could not be administered. Antibiotics — penicillin and streptomycin — were administered to combat infection.

An immediate operation was considered inadvisable as the child was a very poor surgical risk. The next day the distension of the abdomen remained unaltered.

On the third day, the general condition of the child deteriorated; the distension of the abdomen was more marked; enemata had not produced any result all along. Hence, an operation was decided upon, as a last resort.

Operation

An exploratory laparotomy was performed nearly 48 hours after admission. Open ether anaesthesia was administered.

The abdomen was opened by a right paramedian rectus-splitting incision. On opening the abdomen, there was a gush of dark, thick, sticky, putty-like material, which immediately obscured the whole operation field. It was mopped out with considerable difficulty. The intestines were then seen pushed to the left side due to a large mass of this material occupying the right half of the peritoneal cavity (in retrospect, the dense opaque shadow in the X-ray film, was obviously meconium occupying the right half of the peritoneal cavity).

The coils of intestines were not distended. There were greenish-yellow flake-like bands on the surface of the intestines, and the latter were glued together at places. There was no evidence of intestinal atresia. No other pathological condition could be detected. As no perforation could be detected, it was presumed to have been sealed off among the adherent intestinal loops.

It was not considered advisable to separate the glued intestines. The abdomen was drained in the right flank and closed after spraying the peritoneal cavity with a solution of penicillin and streptomycin. During the operation, the child was given 75 c.c. of blood. Intravenous fluids were administered post-operatively. The child stood the operation well and came out of anaesthesia immediately after operation, but expired suddenly two hours after the operation.

Comments

(1) No particular cause for the perforation nor the perforation itself, could be found at the operation.

(2) Irregular calcification and free fluid in the abdominal cavity (localised to the right side in this case) on a flat film is suggested as an indication for immediate operation, as stressed by Neuhauser.

Summary

(1) A review of the pathological entity of meconium peritonitis.

(2) A case report of this condition.

REFERENCES

1. Abt, I. A.: Fetal peritonitis. Med. Clin. N. Amer. **15**: 611, 1931.
2. Boikan, W. S.: Meconium peritonitis from spontaneous perforation of ileum in utero. Arch. Path. **9**: 1164, 1930.
3. Brunkow, C. W.: Quoted by Tempest, M. N. in 17.
4. DeLee, J. B.: Quoted by Maguire, C. H. et al in 12.
5. Forshall Isabella, Hall, E. G. and Rickham, P. P.: Meconium peritonitis. Brit. J. Surg. **40**: 31, 1952.
6. Gover, E. M.: Quoted by Forshall et al in 5.
7. Gross, R. E.: Surgery of Infancy and Childhood. Philadelphia and London, W. B. Saunders Company, 1953, p. 177.
8. Landsteiner, K.: Quoted by Low et al in 11.
9. Lattes Raffaele.: Early pseudomyxoma peritonei in a case of fetal meconium peritonitis. Am. J. Obst. & Gynec. **46**: 149, 1943.
10. Litten.: Quoted by Low et al in 11.
11. Low, J. R., Cooper, G. and Cosby, L.: Meconium peritonitis. Surgery. **26**: 223, 1949.
12. Maguire, C. H. and Moore, W. R.: Meconium peritonitis. Surgery. **28**: 568, 1950.
13. Mall, F. P.: Quoted by Boikan in 2.
14. Neuhauser, E. B. D.: The Roentgen diagnosis of foetal meconium peritonitis. Am. J. Roentgenol. **51**: 421, 1944.
15. Rudnew, W.: Quoted by Low et al in 11.
16. Simpson, J. Y.: Peritonitis in the foetus in uterus. Edin. M. J. **15**: 390, 1838.
17. Tempest, M. N.: Meconium peritonitis. Brit. J. Surg. **40**: 28, 1952.
18. William, J. W.: Obstetrics, New York, D. Appleton & Co., 1926, p. 392.
19. Zillner, E.: Quoted by Low et al in 11.

Received for publication on 12-9-'57.

SCHAWANOMA OF SPINAL CORD

by K. S. BOSE, Calcutta.

INTRODUCTION

Spinal cord tumour cases present themselves with various manifestations, and diagnosis is difficult unless this condition is kept in view. Extra-medullary and intradural tumours are commonest and they present 3 clinical stages[5] (Learmonth. 1926) which are characteristic of them. First stage is that of root irritation — pain, paraesthesia of a particular segment depending on the root involved. Second stage is that of hemicompression causing signs and symptoms of Brown Sequard syndrome but this stage is transitory and hemicompression soon gives rise to total compression which is characterised by paralysis — motor sensory and trophic. Intradural tumours are rarer and they do not present these clinical stages. Their behaviour is somewhat erratic and progress is rapid. Diagnosis in the first stage is seldom possible except after careful observation for sufficient time and mistakes in diagnosis occur frequently in second and third stages with cases of root irritation and cord compression. They cause more root symptoms for a prolonged period and muscular rigidity is frequent.

Common tumours of intradural extramedullary type are meningiomas and neuro-fibroma and most of them are operable[2,6] (Rogers, 1935, Elsberg. 1942 and Bloom et al. 1955) and surgical extirpation gives satisfactory results[6] (Rogers, 1935). Rarer tumours are lipoma, dermoid[3] (Bose, 1957) and Schawanoma. The following case record of a schawanoma arising from a posterior nerve root, causing spasticity, intractable pain in chest and back is worth reporting for its rarity and successful result after operative removal.

CASE REPORT

M. N. Shome, aged 22 years, was admitted on 23-8-1955, with complaints of :

(1) Inability to walk and weakness of both legs — 10 months.

(2) Pain, chest and back — 2 years.

(3) Inability to flex neck and straighten trunk — 10 months.

(4) Difficulty of micturition — 10 months.

(5) Constipation — 8 months.

The onset was insidious, pain started about 2 years before more on right side of chest and back roughly corresponding to 4th & 5th intercostal space. It caused difficulty in inspiration. He had no cough or fever. In addition to pain, for the last 10 months he noticed, increasing weakness of both inferior extremities. He could not walk and was ultimately bed ridden. He had difficulty in micturition, specially in initiation of the act and constipation for the last 8 months.

On examination patient was looking his age and of average build and nutrition. He could not lie on his back, because he had a stiff and arched back and was lying on sides. The lower limbs were apastic and showed occasional spontaneous painful jerky movements. Atrophy of lower limb muscles with increased tone was present, and voluntary movements of both legs were lost. Rigidity of back and neck was present. Reflexes - knee and ankle increased on both sides. Babinski's sign was positive, ankle clonus was present on both sides, and abdominal reflexes were lost. Sensation — pain and touch was absent up to nipple line, a zone of hyperaesthesia above nipple line. Spinal movements could not be elicited. Spine of 4th dorsal was slightly tender. Gait could not be seen. No gross bladder distension was found. Superior extremity — nothing abnormal detected ; pupils normal, intelligence normal, general examination normal. Blood pressure 110/90 mm.

Investigation :

Blood picture — normal.
E.S.R. — 4 mm./hr.
W.R. & Kahn — negative.
Urine — normal.

C.S.F. :

Xanthochromia and low pressure was found.
Cell count — 3 per c.mm.
W.R. — negative.
Total protein — .72% (very high).
Lange colloidial reaction — 45555433200 (Paretic curve).

Routine skiagraphy of dorsal and lumbar spines was normal.

Lumbar myelographic report of 22-9-1955 — there was obstruction to the flow of contrast medium through spinal canal at the level of D4-D5. The upper border of contrast medium has a concave outline. There is evidence of abnormal increase in interpedicular distance of D4. which is 2.6 mm. while that of D3 and D5 is 2.4 mm. and D6 is 2.3 mm.

Cisternal puncture myelography showed obstruction at D2 level. Hence the localisation of tumour by ascending and descending type of myelography was done and it extended from D2 to D4.

Fig. 1.
Cisternal puncture myelography shows obstruction of dye at lower border D_2.

Fig. 2.
Lumbar puncture myelography shows obstruction at lower border of D_1 — upper border of dye is concave to signify tumour.

Operation notes :

On 17-10-1955 patient was put in lateral position — incision over tips of 2nd dorsal to 8th dorsal. Laminectomy was done from 2nd dorsal to 7D. Dural pulsation was absent. Dura opened with stay sutures — localisation was bit difficult due to arachnoiditis. Two needle test was done to define the tumour and also by palpation, slight resistance was felt over the tumour. On opening over a loculated arachoid area fluid spurted out and membranes collapsed when tumour was defined and dissected out with moist cotton pellets. It was found attached to one posterior nerve root and lifted from its bed on spinal cord which was compressed and hollowed out. Tumour removed without much difficulty but there was bleeding from its pedicle which was controlled by moist gauze pressure. Dura closed with 5.0 anacap silk. Muscles were sutured in two layers with chromic catgut. Skin sutured with interrupted nylon. Dressing applied with adhesive strapping and patient was nursed in lateral position. Post-operative period was uneventful. On 19-10-1955 sensation appeared up to middle of thigh and patient could pass urine himself. Patient subsequently maintained steady improvement and discharged on 27-11-1955 with return of motor and sensory powers. He could walk now for several miles a day normally and has normal bladder and bowel control.

Histopathological report :

Section shows a picture which resembles a Schawanoma.

DISCUSSION

Schawanoma is a nerve sheath tumour affecting peripheral nerves. According to

Boyd, schawanoma is a well encapsulated usually benign tumour and arises from nerve with peripheral type of myelination. Zone of transition between central and peripheral myelin patterns is most vulnerable, hence it occurs in accoustic nerve and posterior nerve root of a spinal nerve. It may turn out malignant. Anderson [1] thinks it to be a variant of Neurofibroma with dominance of schawanoma cells and little collagen formation. The tumour consists of elongated cells with regimentation and palisading of nucleii, minimum of reticular and collagen material which differs in staining properties from collagenous tissue of neuro-fibroma. Willis thinks that it arises from inner cell layer of nerve sheath, while outer one forms neurofibroma.

This tumour was completely intradural and extramedullary simulating intrinsic spinal cord tumour. Large tumours may protrude out in a dumb-bell shape and may cast a round shadow in chest skiagraphy.

SUMMARY

1. A rare case of schawanoma, completely intradural and extramedullary simulating intrinsic spinal cord tumour is presented.

2. The diagnostic criteria in different stages of spinal cord tumour are enumerated.

3. Different views regarding the pathogenesis of tumour are discussed, especially its difference with neurofibroma.

4. Complete localisation of tumour was possible before operation by lumbar and cisternal puncture myelography, though routine X-ray was negative.

5. Successful operative removal gave a very satisfactory clinical result as is usual with extramedullary tumours of spinal cord.

ACKNOWLEDGEMENT

My thanks are due to Dr. S. C. Bose, Principal-cum-Superintendent, Medical College & Hospitals, Calcutta for permission to publish the case record and to Professor Subodh Datta, Dr. K. C. Sarbadhikary and Dr. S. Mukerji, and Dr. N. N. De for help in compilation of the paper.

REFERENCES

1. Anderson, W. A. D.: Pathology. 3rd Edition. C. V. Mosby Co., St. Louis. 1957.
2. Bloom, H. G., Ellis, H. and Bennett, W. B.: The early diagnosis of spinal tumour. Lancet. **10**: 1955. 1935.
3. Bose, K. S.: Dermoid tumour of spinal cord. Jour. Ind. Med. Ass. **2**: 63, 1929.
4. Boyd.: Pathology of Surgeons. W. B. Saunders, Philadelphia, 1955.
5. Learmonth.: Brit. J. Surg. 14: 397, 1926-27.
6. Rogers, L.: The surgery of spinal tumours. Hunterian lecture — Royal College of Surgery. Lancet. **11**: 1187, 1935.
7. Willis, R. A.: Pathology of Tumours. 2nd Edition. Butterworth, London, 1953.

Received for publication on 10-9-'57.

ORTHOPAEDIC SECTION

TREATMENT OF MAL-UNITED COLLES'S FRACTURE

(A new method with a report on 40 cases)

by B. MUKOPADHAYA, Patna.

Malunion following Colles's Fracture is fairly common in our country. There are several reasons for this. Quite often, the patient fails to realize that he has sustained a fracture and does not consult any physician at the time of the injury and only when a persistent disability and deformity results, that he seeks medical attention. At other times the patient consults a bone-setter who fails to reduce the fracture. Sometimes, the diagnosis is missed even by a physician as many of the classical signs of a fracture are absent in this fracture, the fragments being usually impacted. In many cases the physician makes no attempt at reducing the fracture and the wrist is plastered with the fragments in displacement. In some cases reduction is attempted without anaesthesia and therefore, results in failure. In a small proportion, inspite of attempted reduction under anaesthesia, reposition of fragments is not achieved. At times malunion may occur despite the best available treatment. Most frequently this is occasioned by excessive comminution or compression of the fragments. Thus there are many causes leading to malunion in this fracture and its common occurrence.

Malunion in Colles's Fracture gives rise to a typical deformity and also disability. Most patients report for treatment because of the disability whereas a few are concerned about the deformity. The disability from a malunited Colles's Fracture consists of —

(1) Pain and tenderness on the ulnar side of the wrist specially over the lower end of the ulna ;

(2) Pain and limitation of movements of the wrist and inferior radio-ulnar joints, supination movement is specially limited ;

(3) Weakness of the grip, and pain at the wrist when attempting to grip any object firmly ;

(4) There may be stiffness of the fingers, trophic changes in the skin and an adhesive capsule, tenosynovitis of the tendon sheaths in front of the wrist, pain and stiffness of the shoulder and post-traumatic acute osteoporosis of the wrist and hand (Sudek's Syndrome).

The main problem of treatment in Malunited Colles's Fracture is that of functional restoration. The disability following this fracture varies considerably from patient to patient and a careful assessment of both the mental and physical aspects of the disability must be made before a programme of treatment can be planned. The degree of disability although roughly related to the extent of deformity, is not always proportional to it. There are cases in which a fairly severe degree of malunion is consistent with a reasonably good function. There are other cases in which marked disability is present although the malunion is only of moderate type. There is certainly a personal factor in the degree of disability present in a patient.

In planning the treatment of malunited Colles's Fracture, two factors are to be considered : —

(a) The disability that is directly attributable and follows primarily from the mal-position of the fragments.

(b) Associated disabilities which are precipitated by the fracture but are not caused directly by it. In this group, is to be included symptoms like finger stiffness, shoulder stiffness, Sudek's atrophy and similar symptoms. Certain patients

demonstrate a marked tendency to stiffen rapidly following this injury and it is not altogether correct to suggest that the stiffness is entirely due to lack of effort on the part of the patient to perform active exercises.

It is necessary to seggregate these two factors in the total disability in order to arrive at the correct line of treatment in a particular case.

The main line of treatment for the second group of disabilities in Colles's Fracture consist of intensive Physio-therapeutic measures. In some refractory cases, this has to be continued with assiduous care for a fairly long time. All forms of physio-therapeutic measures are of value, but active and progressive resistance exercises from the sheet-anchor of the programme of management. We have found that the use of cortisone group of drugs may be combined with physio-therapy with advantage during the initial phases of treatment. Treatment with these measures must be persisted until maximum restoration of function is achieved, and it is only when the disability is resistent to these measures that the question of preliminary operative intervention should be taken up.

In an occasional case there may be traumatic teno-synovitis of the flexor tendons in front of the wrist caused by friction against the sharp anterior margin of the lower fragment projecting into the carpal tunnel. This may require operative corection of the deformity for the relief of painful symptoms.

Where the disability is due to malposition of fragments, the question of operation has to be considered. Owing to the marked variation as to the amount of bony deformity and disability a distinction must be made between the border line case which will respond to physio-therapy with serviceable wrists and those in which surgery is required. Judgement is necessary in selecting cases for operation. It must be realised that even where the disability is due to the mal-position of fragments, considerable improvement in function may be obtained by vigorous physio-therapeutic measures. Physio-therapy, however, will not remove the deformity. It is also necessary to understand what is achieved by an operation because the operation will succeed provided it removes the causes of disability.

The contributory factors of disability in the first group are the following :—

(1) Shortening of the radius due to impaction, compression, comminution or displacement with overriding; with the passage of time the collapsed cancellous bone is absorbed and the discrepancy between the radius and ulna is increased. This shortening causes a distraction effect between the radius and ulna as the lengths of the two bones are no longer equal. This also upset the mechanics of the radio-ulnar movements.

(2) Dorsal angulation and radial deviation of the lower radial fragment. There may also be a supination twist of this fragment. This malposition causes a corresponding alteration in the axis of movements of the wrist joint. Upto 20° of posterior rotation of the lower fragment is compatible with reasonably good function; beyond this point, disability increases rapidly.

(3) Where there are intra-articular extensions of the fracture lines with comminution of fragments, an incongruous joint results. This predisposes to chronic traumatic artheosis which may increase with passage of time.

(4) Injury to the distal radio-ulnar joint or its ligamentous attachments. The radio-ulnar joint is a pivotal joint for pronation and supination movements of the forearm. Disability in this joint may be due to pain, limited motion, clicking sensation or instability. These symptoms are caused by traumatic artheosis of the radio-ulnar joint, sublimation of the joint caused by rupture or avulsion of its ligaments which have failed to heal properly or to stretch or sprain or tear of the triangular fibro-cartilage.

Any operative measure to be completely successful must remove these causes of disabilities. Even where painful osteo-arthritic symptoms are present at the wrist, operation may be indicated if a severe degree of deformity exists. Correction of the deformity places less strain on the joint during movements and allows the joint to function from the position of maximum advantage and thereby relieves symptoms to a great degree and also places the painless arc of movement in the most advantageous position.

There are various operative procedures for the treatment of malunited Colles's Fracture. These can be divided broadly into two groups :—

(1) Compensatory Procedures :—Operations designed to improve function without any attempt being made to restore the normal anatomy or mechanics of the wrist joint.

(2) Reconstructive Procedure :—Designed to restore the anatomy of the wrist as also its function.

In the former group comes operations like excision of the lower end of the ulna with or without removal of the styloid process (Darrac's Operation), partial resection of the ulna or Milch's sleeve resection, or a simple osteotomy of the radius for the correction of the backward angulation. These operative procedures are simple and can bring about improvement in function, but does not restore the appearance of the wrist. They are valuable in the milder type of cases.

The second group of operations of which Jackson Burrow's operation, Campbell's operation, Hugh Smith's operation and Cave's operation are examples, attempts at complete restoration of the anatomy of the lower end of the radius. The principle behind these operations is to restore the length of the radius by hinging an osteotomised lower end, (the osteotomy passing through the dorsal cortex at the site of the fracture) leaving the anterior cortex of the bone intact to act as the fulcrum of the hinge. By this process a gap pyramidal in shape, is produced on the dorsal aspect of the lower end of the radius, the base of the gap being dorsally and laterally. This gap is filled up by a trappzoid piece of cortical bone which is wider laterally than medially; this piece of bone being so inserted as to maintain the correction achieved at the time of the operation. (Fig. 1). The gap at the osteotomy site may be filled up by cancellous chips. Immobilisation following the operation is maintained till the gap in the dorsal part of the radius is filled up by new bone. The operations designed by different authors differ only in the matter of the source of the graft implanted into the osteotomised radius and also on the method of fixation applied to maintain the position achieved at the time of the operation.

Whereas in the first group of operations simplicity of technique is a great asset, in the second group, the technique is complicated, the execution of operation difficult and requires experience, the post-operative care prolonged and tedious and the ultimate results are relatively unsatisfactory in the most severe types of cases — the type of case which requires a reconstruction operation more than any other group of patients. Partial recurrence of the deformity inside the plaster cast during the period of immobilisation following the operation is not uncommon in this type of procedure. Nor is it always easy to cut out an exactly shaped piece of cortical bone which will rigidly maintain the correction of the deformity. There are one or two other criticisms of this type of operation. It does not remove one of the principal causes of disability following severe malunion, the cause being either a sub-luxation of the lower end of the ulna or tear or twist of the triangular fibro-cartilage. Changes in the

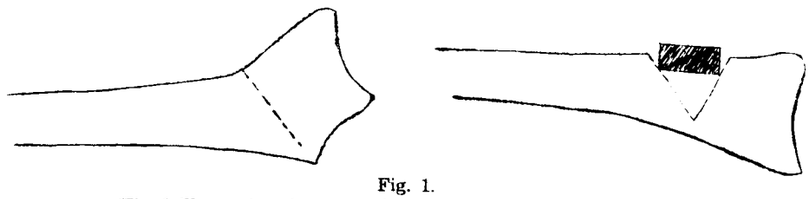


Fig. 1.
Fig. 1 illustrating the principle of Campbell's type of operation.

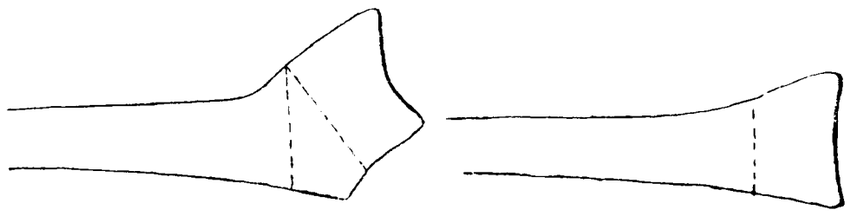


Fig. 2.
Fig. 2 illustrating the principle of the Author's operation.

Fig. 3.

Fig. 4.

Figs. 3 & 4. Pre-operative A.P. & Lateral X-rays of the wrist showing severely Malunited Colles's Fracture.

Fig. 5.

Fig. 6.

Figs. 5 & 6. Correction achieved by the combined operation.

fibrocartilage are a potent source of disability in this condition. The other factor in this type of operation is that the soft tissue structures which have become shortened and contracted as a result of collapse of the radius are placed under tension as a result of the attempt at the restoration of the length of the radius.

The technique that has been followed in this series of cases and is being described in this paper has been evolved for the treatment of malunited Colles's Fracture with a view to remove the criticisms of the 2nd group of operations while achieving the anatomical restoration brought by this type of procedure. It is claimed that this method of treatment removes all the local causes of disability and does not in any way interfere with the normal mechanics of the wrist and brings about a restoration of the anatomy of the wrist joint. The operation consists of making an incision on the medial side of the Ulna between the tendons of the flexor and extensor carpi ulnaris. A careful subperiestial exposure is made of the lower 2 to 3″ of the ulna. The lower 1½″ of the ulna is removed by careful sub-periestial dissection, the triangular fibro-cartilage being separated from its attachment to the ulna. Where the styloid process of the ulna is not fractured. this also is removed. Where the styloid process is fractured and tip attached to the triangular fibro-cartilage, the separated portion of the styloid is left behind with the fibro-cartilage. In children where-

Fig. 7.

Fig. 8.

Figs. 7 & 8. Pre-operative X-rays of wrist.

the lower epiphyseal growth plate of the ulna has not fused with the shaft, ulnar excision is limited to a segment of the bone about 1" in length proximal to the growth plate. The resection of the ulna should not include the whole length of origin of the pronator quadratus. If part of the attachment of this muscle is left intact, the ulna remains stable. After removing the ulnar segment, the lower end of the radius is approached from the medial side by separating the insertion of the pronator quadratus muscle from the dorsal margin of the radius. A sub-periestial exposure of the lower end of the radius is made through this exposure from the medial side bringing into view the site of the fracture. (Fig. 2). A Wedge Osteotomy is now performed of the lower end of the radius, the base of the wedge being directed

Fig. 9.

Fig. 10.

Figs. 9 & 10. Post-operative X-rays showing correction achieved.

anteriorly and includes the prominent portion on the anterior margin at the site of the fracture. Osteotomy falls short of the posterior cortex of the lower end of the radius. The osteotomy gap of the radius is now closed thereby correcting the posterior rotation of the lower fragment. The base of the wedge is so designed that when the gap is closed anteriorly the lower articular surface of the radius should point downwards the slightly forwards as in a normal radius. While closing the gap in the radius, an attempt is made to push the lower fragment medially thereby correcting the lateral displacement of the lower fragment. The closure of the wound is performed with scrupulous attention to detail. The rent in the attachment of the pronator quadratus through which the radius is exposed must be repaired carefully with interrupted stitches. The periosteum of the ulna to which is attached the ulnar collateral ligament, is carefully saved and thereby a substantial ligament is created, providing a firm attachment between the ulna and the carpus. At the end of the operation a plaster is applied extending from the knuckles to the region of the elbow, the wrist being placed in slight forward flexion but with no lateral tilt either medially or outwards. It is very important that medial tilt of the wrist in the plaster is avoided. If this happens, the lack of support to the medial side of the wrist caused by removal of the lower end of the ulna may give rise to a persistent ulnar deviation of the wrist and thus may cause post-operative disability. The limb is to be kept in plaster for a period of 4 weeks only. Longer post-operative immo-

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Figs. 11, 12, 13 & 14. Pre-operative A.P. & Lateral X-rays with clinical photographs of the wrist. The patient had severe limitation of wrist and radio-ulnar joint movements before operation.

bilisation is not necessary as the fragments are well impacted after the operative correction and there is very little risk of the fragments slipping out of position inside the plaster cast. Union is quite satisfactory during this short period of immobilisation. Active exercises of the fingers, elbow and shoulder must be performed with scrupulous care during the post-operative period.

The principle on which this operation is based consists of correction of the deformity, as well as restoration of the function of the limb. When the adjacent portion of the wedge osteotomy is brought into apposition and jammed, it makes the lower articular surface of the radius look downwards and forwards, the dorsel tilt and radial deviation of the lower fragment being simultaneously corrected by the osteotomy. Excision of the lower end of the ulna removes the abnormal prominence of this site and also relaxes the triangular fibrocartilage thereby removing one of the most important causes of disability at the wrist joint. The shortening of the radius produced by the wedge osteotomy is compensated by the removal of the lower end of the ulna so that no abnormal stress and strain is placed on the soft tissues. In point of fact the operation utilises a very basic and important principle of Orthopaedic operations for the treatment of deformities. Every deformity can be compared to a bow-string and a bow, the string

Fig. 15.

Fig. 16.

Figs. 15 & 16. X-ray appearances following operation.

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

Figs. 17, 18, 19, 20, 21 & 22. Clinical photographs to show the functional results achieved. (X-rays Figs. 15 & 16)

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

Figs. 23, 24, 25 & 26. Pre-operative X-rays and clinical photographs of the wrist.

Fig. 27.

Fig. 28.

Fig. 29.

Fig. 30.

Figs. 27, 28, 29 & 30 Post-operative X-ray photographs with clinical photographs to show the functional results achieved.

Fig. 31.

Fig. 32.

Fig. 33.

Figs. 31, 32 & 33. Clinical photographs to show the functional results achieved. (X-rays Figs. 27 & 28)

Fig. 34.

Fig. 35.

Figs. 34 & 35. Pre-operative X-ray photographs of a severely comminuted Colles's Fracture.

Fig. 36.

Fig. 37.

Figs. 36 & 37. Post-operative X-ray photographs showing improvement in the alignment of the wrist. This patient had considerable improvement in the function of the wrist.

being formed by the tightened soft tissues on the concave aspect of the deformity and the bow being formed by the deformed position of the skeletol elements. Correction of the deformity can be achieved either by straightening the bow and stretching the soft tissue so that the length conforms to the length of the straightened bow or by shortening the bone without stretching the soft tissues so that the final length corresponds to that of the tightened soft tissue. The principle of Campbell's operation is that of the former whereas the principle of the operation recorded here is that of the latter. The soft tissue relaxation achieved by this operation is conducive to early functional restoration.

Fig. 38. Fig. 39.

Figs. 38 & 39. Pre & Post-operative clinical photographs of the wrist of a case of severe malunion.

Results

This paper is based on a study of 134 cases of mal-united Colles's fracture seen between January 1953 and December 1956 and includes all degrees of malunion ranging from the very mild to most severe ones. Of these 134 cases, only 44 were submitted to operative treatment, the rest being discharged with serviceable wrists by physiotherapeutic treatment alone. Of these 44 cases, 5 were of comparatively mild deformity in which excision of the lower end of the ulna was performed with satisfactory result. 39 cases had the reconstructive-procedure as described in this paper. The age distribution of these 39 cases were as follows :—

10 to 15 years	—	3 cases
15 to 20 years	—	7 cases
20 to 30 years	—	6 cases
30 to 40 years	—	4 cases
40 to 50 years	—	9 cases
50 to 60 years	—	6 cases
60 to 70 years	—	3 cases
Over 70 years	—	1 case

Every case of this series has been carefully followed up. The resulte been assessed from point of view of —

(1) Correction of deformity,

(2) Restoration of function.

Only severe cases of malunited Colles's fracture with well-marked disability were taken up for this type of surgery.

Fig. 40.

Fig. 41.

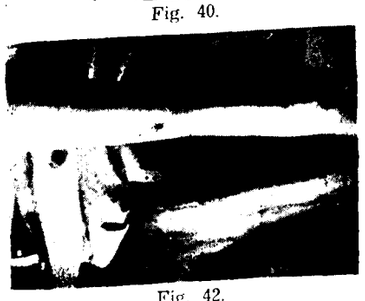


Fig. 42.

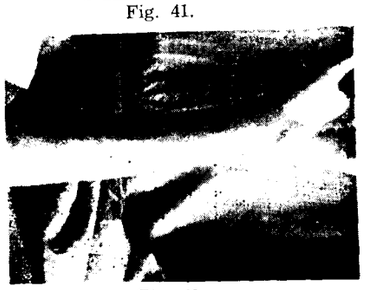


Fig. 43.

Figs. 40, 41, 42 & 43. Pre & Post-operative clinical photographs of the wrist.

Fig. 44.

Fig. 45.

Figs. 44, 45 & 46. Pre-operative X-rays and clinical photograph of a case of severe malunion.

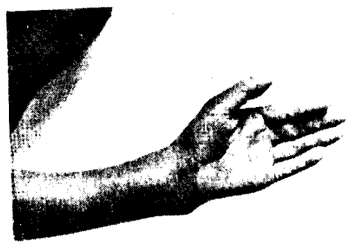


Fig. 46.

Correction of the deformity was achieved in every case. The absence of the ulnar head is noticeable but the cosmatic result is not at all displeasing.

The functional end result has been assessed on a points system as described by Gartland and Werby. This has provided a rigid yardstick for evaluating each case. On this basis 29 cases were judged as excellent in whom the ultimate loss of functions was not more than 10 as compared with the normal side. In 8 cases, the result was classified as fair. These patients had useful wrists but although their disability was reduced considerably from the original, moderate amount of loss of function remained. Of these 8 cases, 5 were instances of comminuted Colles's fracture in whom as a result of articular surface damage, excellent end result is almost unobtainable. However, in no case have we performed arthrodesis of the wrist as the residual symptoms have been within

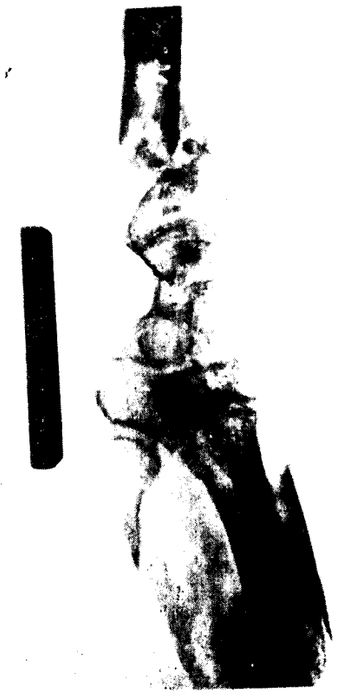


Fig. 47.

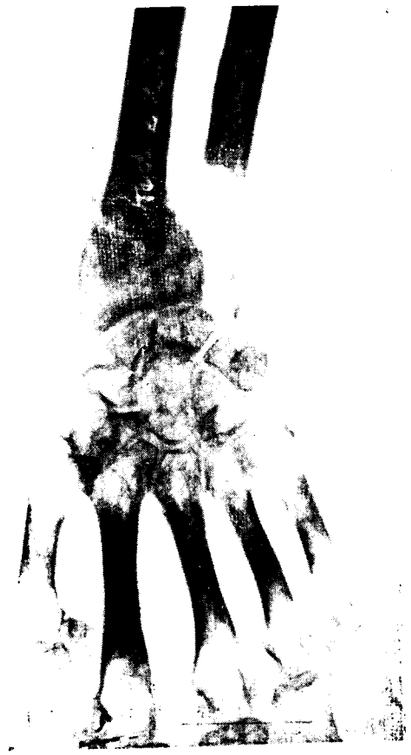


Fig. 48.

Figs. 47, 48 & 49. Post-operative X-rays and clinical photograph showing correction achieved.

Fig. 49.

bearable limits. Three patients developed some ulnar deviation of the wrist because of excessive medial tilt at the time of plaster following operation. These three patients have serviceable wrists but the results cannot be claimed as excellent. Two patients in whom the result was judged as poor were left with serious disability on account of persistent finger-stiffness. In one of these patients there was evidence of ischaemic contracture of the muscles of the forearm consequent on an excessively tight plaster applied after initial reduction. The other patient had marked finger stiffness with signs of osteoporosis which resisted physio-therapeutic measures. Operation was performed in

this case on the hope that correction of deformity may make it easier to get rid of finger stiffness. It is our present view that these two cases should not have been selected for surgical treatment. After resection of the ulna the strength of the grip is quite satisfactory although there may be a slight weakness as compared with the normal hand. However, this amount of weakness has not stood in the way of enabling most of our patients to return to their previous occupation. Thus it would appear that when the operation is properly performed in a carefully selected group of cases it gives extremely gratifying results.

Conclusion

(1) A perusal of 134 cases of malunited Colles's fracture proves that nearly two-third of patients can recover fairly good function of the wrist with physio-therapeutic treatment alone and does not require any operative interference.

(2) Even when age, occupation or psychoneurotic compensation factors do not preclude surgery, cases for operation must be selected with care and the proper procedure must be adopted to remove the source and degree of disability.

(3) Removal of deformity is almost always possible however severe the case may be. Restoration of adequate function is also possible even in the severest case provided irreparable changes have not taken place in the tissues of the wrist and fingers.

BIBLIOGRAPHY

1. Bacorn, R. W. and Hurtzke, J. F.: J. Bone and Joint Surg. **35A**: 643, 1953.
2. Bick, E. M.: Source Book of Orthopaedics.
3. Bohler, L.: Treatment of Fractures.
4. Bonnin, J. C.: Complete Outline of Fractures.
5. Burrows, H. J.: Proc. Roy Soc. Med. **30**: 565, 1936.
6. Campbell, W. C.: J.A.M.A. **109**: 1105, 1937.
7. Cave, E. F.: American Academy of Orthopaedic Surg. Instructional Course Lectures, Vol. XX, 1953.
8. Darrach, W.: Ann. Surg. **56**: 802, 1912.
9. Darrach, W.: J.A.M.A. **89**: 1683, 1927.
10. Gartland, J. J. and Werby.: J. Bone and Joint Surg. **33**: 895, 1951.
11. Inclan, A. B.: **65**, 1936. Cir. Ortop. Y. Traumatol. **4**:
12. Jones, R. W.: Fractures and Joint Injuries, Vol. 2.
13. Key, J. A. and Conwel, H. E.: Management of Fractures — Dislocations and Sprains.
14. Milch, H.: Amer. Journ. Surgery. **1**: 141, 1926.
15. Smith, H. American Academy of Orthopaedic Surgeons International Course Lectures, Vol. 6, 1949.
16. Speed-Smith: Campbell's Operative Orthopaedics.
17. Speed, J. S. and Knight, R. A.: J. Bone and Joint Surg. **27**: 361, 1945.

Received for publication on 6-1-'58.

ANATOMICAL AND PATHOLOGICAL ASPECTS OF THE INTERVERTEBRAL DISC

by W. J. VIRGIN, Ludhiana.

This paper deals with the Intervertebral Disc in man. It is based on investigations made on fresh post-mortem material and includes experimental and histological studies.

The Intervertebral Disc:

It consists of two cartilage plates hyaline in nature, joined at their periphery by a fibro-elastic annulus. The central portion contains a viscid hygroscopic gel. The disc is anchored to the vertebral body above and below by the attachment of the fibres of the annulus and by the attachment of the cartilage plate to the bony trabeculae of the vertebral body. In the early stages of development the fluid content, that is the nucleus, occupies most of the disc. The annulus is relatively thin. As age progresses the annular fibres encroach upon the central parts of the disc so that at the age of about 16 years the disc is largely an intermingling of concentric septa consisting of fibro-cartilaginous material interspaced by the gelatinous material which once made up the whole of the nucleus. This characteristic of the disc may be retained until very late in life. Very small areas of this structure may break down and form gelatinous mucoid material. This material usually occupies an area of not more than a centimetre in diameter. It tends to lie towards the posterior aspect of the disc, in relation to the posterior longitudinal ligament.

Its Mechanical Properties:

A good deal has been written recently on the effect of degenerative changes in the disc. In contrast to this, relatively little has been written on the physiological properties of the healthy disc and the former has tended to overshadow the latter. It has been shown that discs may be loaded to take a high degree of strain. They will then recover rapidly once the strain has been removed. Experimentally these loads have been made up to a limit of 1000 lbs. and more, without causing rupture of the disc or damage to the cartilage plates. It has been shown further that repetition of this loading under favourable circumstances is accompanied by an improvement in the mechanical function of the disc. This is true for single healthy intervertebral discs and it is also true for groups of discs tested in an intact portion of the spine. It is quite possible to maintain a spine in an erect position after removing all muscles, the whole of the posterior spinal column that is, spinal processes, laminae and pedicles. In other words, the system of vertebral bodies with their connecting intervertebral discs, is capable of maintaining the erect position of the body unaided. The muscles and the posterior system of joints add both flexibility and increased stability to the spine.

The effect of loading is to reduce the height of each disc, for example, a load of 500 lbs. will cause a loss in height of ·004

Fig. 1.
Intervertebral Disc, aged 5 months.

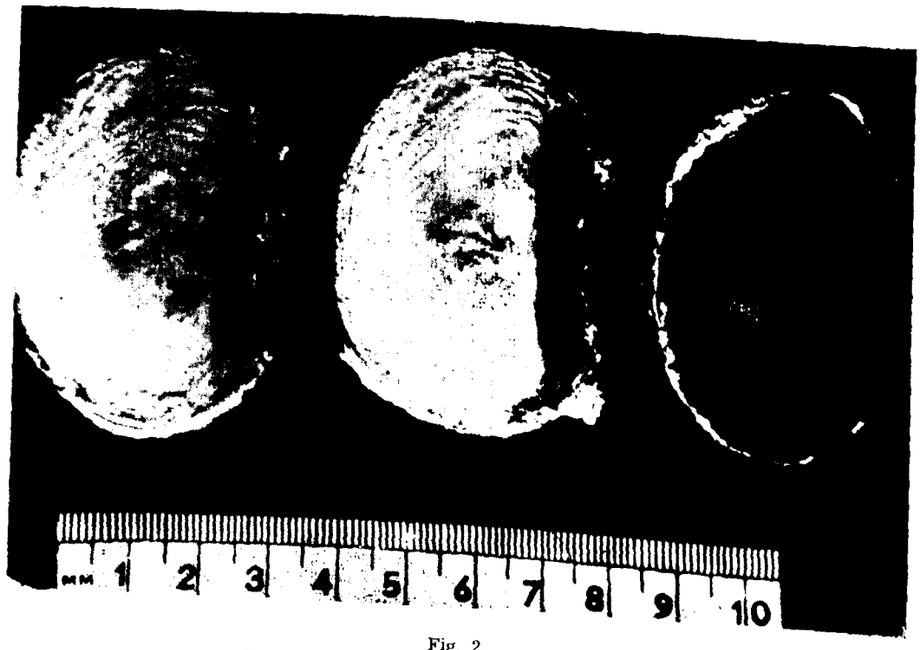


Fig. 2.
Serial sections of adult Intervertebral Disc.

inches. This loss of height is regained rapidly on removal of the load and is accompanied by the imbibition of fluid by the disc. It has been possible to demonstrate that the mechanical efficiency of discs from patients of up to 72 years of age is of a high order. There does not seem to be a marked loss of the property described, we may call it elasticity, even in advanced age, provided the patient is not suffering from a chronic wasting disease. That is, the anatomical pattern of the disc and its physiological property of elasticity, may both be maintained well on into the 70's. This may appear to be at variance with the conclusions in recent papers on degenerative changes in discs, but is easily demonstrable.

The Fluid Supply and Nutrition :

In view of the above findings the question of the nutrition of the disc arose and demanded investigation. During the experiments mentioned above, it appeared that the imbibition of fluid was the key to the continued efficiency of the intervertebral disc. When for any reason, a disc became incapable of imbibing fluid, it then lost its elasticity to a greater or lesser extent. It seemed that as a corollary there must be a very adequate mechanism for supplying the necessary fluid. This led to an experimental study of the vascular supply in the region of the disc, and in particular to the vertebral body.

The method adopted was to inject the aorta after tying it off above and below the portion of the spine under investigation, with an opaque material, such as barium, or India Ink. The former was used for X-ray investigations and the latter for visualization after decalcification and clearing of the specimen.

Fig. 3.
Injected specimen of vertebral body showing capillaries.

Fig. 4.
Injected specimen of vertebral body showing relation of capillaries to the cartilage plate.

Fig. 5.
Injected specimen of vertebral body showing relation of capillaries to the cartilage plate.

It was shown that there was very little blood supply to the annulus itself but that the blood supply to the vertebral bodies was very prolific. This can be seen from the accompanying photographs. In general, two main arteries enter the posterior aspect of each body, about mid-way between the two surfaces of the body. These break up into numerous arches which extend in the direction of the cartilage plates. At the level of the plates they run along parallel to them and send branches at right angles to the plates. Photographs of the vascular network immediately below the cartilage plates show that a very dense network of minute capillaries run along the walls of the trabeculae and along the bony plates supporting the cartilage plate. Vertical sections through this area show that these vessels enter small lacunar spaces. These lacunae extend into the substance of the plate. The small capillaries form little blood pools inside the lacunae. It will be appreciated from this description that the blood supply, and therefore, by inference, the fluid supply, to the deep surface of the cartilage plates is very adequate indeed. The actual mechanism whereby fluid is transferred through the cartilage substance is not clear but the principle of an adequate fluid supply is established by these experiments. An illustration of the effect of interference with this fluid supply is seen in the fact that in early tuberculosis of vertebral bodies, thinning of the intervertebral discs is a very early manifestation of this process. The tuberculous endarteritis rapidly diminishes the blood supply to the affected vertebrae and this is manifested by a thinning of the intervertebral disc as it becomes dehydrated.

Attempts were made to follow diffusible substances through the plate from this capillary bed, but so far these experiments have not been successful.

Fig. 6.
Injected specimen of vertebral body showing the capillary bed underlying the cartilage plate.

Pathological Changes :

Pathological changes have been described at great length by A. A. Beadle 1931, and Harris and McNab, 1954, and others. We may concern ourselves with the effect of these changes on the function of the discs rather than with their details. They may be divided roughly into changes with age, degenerative changes, and traumatic effects.

The changes associated with ageing consist principally of a loss of the fluid content of the nucleus, and its replacement by fibro-cartilaginous material which appears capable of exercising most or all of the function of the fluid nucleus. My present view is that the so-called aged disc is physiologically a mechanically more efficient structure than the disc containing the fluid nucleus. This view is contrary to that expressed by most writers. My reason for this view is that the aged disc has been shown to be capable of enduring stresses and recovering from them with greater efficiency than the young disc with its fluid nucleus.

The other evidences of degeneration are valid. degenerative changes. They consist in general of loss of disc substance, the production of osteophytes, tears in the cartilage plates, loss of disc substance into the vertebral bodies, etc. These may be described as primary changes in the disc. They are accompanied by secondary changes in the vertebral bodies, the apophyseal joints, the ligamenta flava, the size and shape of intervertebral foramina, and in the relationship between adjacent vertebral bodies (spondylolisthesis or Retrospondylolisthesis). Secondary arthritis of the apophyseal joint may cause adhesions

between its capsule and the immediately adjacent nerve root. Subluxations of this joint may cause sufficient narrowing of the intervertebral foramina to cause nerve root pressure. The annulus may become so weakened that it bulges into the spinal canal causing pressure on the posterior longitudinal ligament and one or more nerve roots at that level.

The significance of these changes is this: that singly or collectively they interfere with the physiological function of the spinal column, and produce in it a condition of instability. Under these circumstances movements between the vertebrae become exaggerated and to a more or less degree uncontrolled. This results in a new stress on the ligamentous structures of the spine, on the one hand, and permits, on the other hand, actual trauma to the nerve roots as they leave the spine. The former effect causes low back pain, related to normal work and the latter causes low back pain plus sciatic radiation, and is responsible for loss of muscle power in the segments affected. Pain and disability is also increased by the presence of secondary arthritis in the apophyseal joint.

Herniation of the disc is usually unilateral but is stated to be bilateral in 7% of the cases. A central protrusion of the nucleus may be so small as to be almost unnoticed or produce only back pain, on the other hand it may be large enough to cause a sudden paraplegia. This is always the danger in manipulative treatment of disc lesions.

The ruptured disc is caused by the protrusion of a sequestrated nucleus through the annulus.

A pocketed or partially sequestrated disc may occur. In this case there is no instability of the joint as the rest of the disc is normal. Root pressure occurs.

A bulging disc is one in which the annulus has become weakened or thinned out so that it bulges into the spinal canal sufficiently to cause nerve root pressure. This is usually associated with subluxation of the adjacent apophyseal joint.

Common Causes of Lesions of the Disc:

(a) *Trauma* — The trauma here is normally a back strain associated with unusual work. It is almost always produced with the spine in flexion. This, of course, implies, that the anterior column is taking all of the strain. These lesions usually occur in relatively young people and are associated with acute lumbago and sciatica. A second example is the rupture of the disc associated with a fracture dislocation of the spine. A third variety of this lesion is that associated with an avascular necrosis of a vertebral body. In this case the disc is thinned somewhat but may remain functionally efficient, although the body may become a mere 0·5 cm. in height and remain so permanently.

(b) *Congenital Malformations of Vertebrae* — These frequently occur in the lumbo-sacral area and affect the fifth lumbar or the first sacral vertebra or both of them. Gross malformations are often associated with weakness of the intervertebral disc at this level. Congenital wedged vertebrae are also associated with a weak or deformed disc. Early degeneration of the disc is the condition usually associated with these deformities.

(c) *Infections of the Disc* — These may be pyogenic or tuberculous. They affect the vertebral body primarily but cause a secondary dehydration of the disc and produce thinning and loss of elasticity. Tuberculous infection is very common and is often manifested by a thinning of the disc

(e) *Chronic Wasting Diseases* — Such as Chronic Nephritis, Chronic Anaemias, chronic tuberculous infection (other than Pott's Disease) produce widespread and marked degenerative changes in the intervertebral discs.

This brief review of the anatomy, physiology, and pathology of the Intervertebral Disc is presented simply as a precursor to the discussion of the treatment of the common intervertebral disc lesions. It is given in outline only as the details of the recent investigations done under the above heading are very extensive.

REFERENCES

1. Beadle, O. A.: The Intervertebral Discs, London: Medical Research Council. Special Report, Series No. 161, 1931.
2. Harris, R. I. and Macnab, Ian.: Jour. Bone & Joint Surg. May, 1954.
3. Macnab, Ian.: Royal College of Physicians and Surgeons of Canada, Report of Annual Meeting and Proceedings, October 1952.
4. Virgin, W. J.: Jour. Bone & Joint Surg. Vol. 33B: No. 4, November 1951.

Received for publication on 6-1-'58.

INTRAMEDULLARY NAILING IN FRACTURES OF SHAFT OF FEMUR *

by M. D. DESAI, Ahmedabad.

There is no doubt that intramedullary nailing has come to stay in the treatment of fractures of shaft of femur.

Those of you, who have seen unsatisfactory — and many a time bad — results with the orthodox methods like use of Thomas-splint, immobilisation in plaster or skeletal traction will testify with me that use of Kuntscher's nail is really a great advance in the treatment of fractures. Many surgeons, perhaps all, are reluctant to use metal in the treatment of fractures and were afraid of using wire, screws or plates. The use of a long solid rod, occupying the whole of the medullary cavity of a long bone, therefore, caused almost a shock to begin with, but good results observed amongst soldiers in occupied areas in the 2nd World War could not be denied. The use of Kuntscher's Nail soon became popular all over the world and today there are many modifications, both of the nail and the original technique, practised throughout the world.

Even in our country, the use of intramedullary nail is quite wide-spread and it is the aim of this paper to share our experience and to discuss various problems involved in the use of Intramedullary Nailing.

To make this paper useful to practising Surgeons, both the Orthopaedic and the General, I have discussed in detail operative technique and complications which are commonly met with. Details of history of nailing and its evolution have been purposely omitted and for the same reason I have resisted temptation of surveying world literature on the subject. I may be excused for that.

The paper is based on 64 cases of Intramedullary Nailing carried out for fractures of shaft of femur, since December 1952 in different units at the V. S. Hospital, Ahmedabad, a post-graduate teaching institution. The first case of this series was operated upon in 1952 and the last in October 1957. All were by the open method. Out of these 64 cases, 51 have been followed up and results assessed.

Table I

Total cases of Intramedullary Nailing	83	
For Fractures of Femur	64	
For Other Fractures	19	
With Clover-leaf nails	57	(For
With other types	7	Femur)

Table II
Intramedullary Nailing for Fractures of Femur

1952	—	1
1953	—	6
1954	—	17
1955	—	16
1956	—	13
1957 October	—	11
Total		64

Table II shows that nailing has become an established measure at this Hospital and more and more cases are being taken up every year, for this procedure.

* Paper read at the Orthopaedic Section Meeting of the Association of Surgeons of India held at Nagpur, Dec. 1957.

Fig. 1-A.

Fig. 1-B.

Fig. 1-D.

Fig. 1-C.

Fig. 1-E.

Fig. 1-A. Transverse fracture of left femur at its middle third in a male aged 65. (B) the same fracture with an interamedullary nail, 10 weeks after. (C) 14 weeks after, when the nail was removed. (D) (E) the same patient in sitting and squatting postures.

Fig. 2-A.

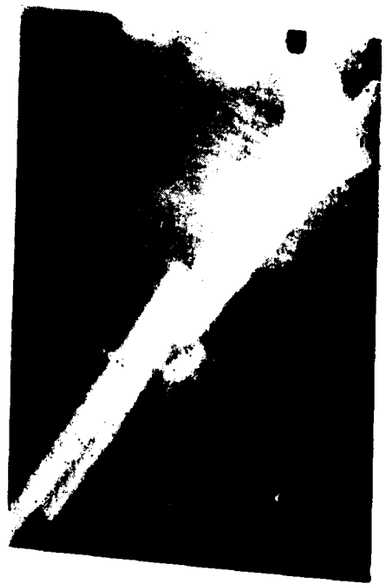


Fig. 2-B.

Fig. 2-A. Fracture of femur at the middle third, with a loose butterfly fragment, two months after the injury.

Fig. 2-B. After intramedullary fixation.

Fig. 3-A.

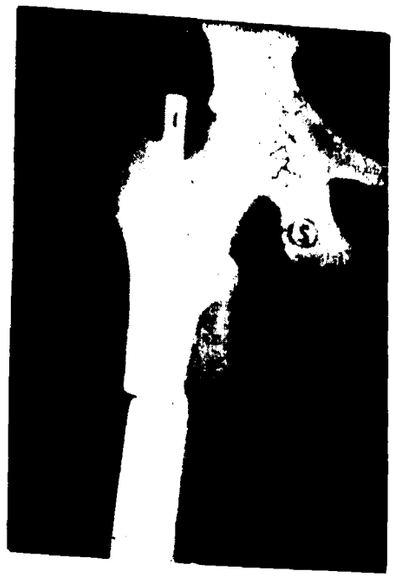


Fig. 3-B.

Fig. 3-A. Dislocation of hip, with transverse fracture of the femur, at its upper third.

Fig. 3-B. After reduction, with the help of an intramedullary nail.

Selection of cases :

Age and sex are no bar to this treatment. Table III and IV show this distribution, in this series :

Table III

Males	—	49
Females	—	15
Total	—	64

Table IV

Intramedullar Nailing — Age distribution

0 — 9	—	6
10 — 19	—	17
20 — 29	—	9
30 — 39	—	10
40 — 49	—	8
50 — 59	—	6
60 & above	—	8
Total	—	64

(a) Even though, there are 6 cases of children in this series, I am not in favour of nailing in children. I dislike use of nail in children, not because it produces any special complication, peculiar to the age, (like growth disturbances) but because an operative procedure is unnecessary in children. Sound union always takes place in young age and overriding with slight shortening even if present gets corrected in course of time. However, I must mention a case of a child aged eleven in whom Intramedullary Nailing was carried out for fracture of femur. Soon after the operation, he developed very severe anaemia. It could not be attributed to any other cause.

We, now a days, do not select young children, for nailing.

(b) Elderly people, especially after 60, on the whole are poor surgical risks. One likes to avoid such cases but I am of the opinion that there are more risks involved in other lines of treatment than the nailing. Apart from death, mal-union, non-union, stiffness of knee and hip, persisting pain and oedema are quite often noticed in old people treated with traction or plaster. Possibility or early mobilisation and ambulation by the use of nail, therefore, go a long way, in the management of fractures in old age. (Figs. 1-A, B, C, D & E).

(c) *Site and type of fractures :*

(i) Fractures at the middle 1/3 of the thigh indicate Intramedullary Nailing. It is typical of this site to cause transverse or short oblique fractures. There may be a third butter-fly fragment added to it.

Intramedullary Nailing is not only indicated here, it becomes a necessity. The dangers of over-riding and angulation are so great with conservative measures, that it is only a nail or a graft or a plate that can control it. (Fig. 2).

Dissatisfied with traction methods, I had tried grafting for transverse fractures in the past. I consider technique of bone-grafting easier than Intramedullary Nailing. Results were not bad either. But the great disadvantage of the method was prolonged immobilisation in plaster. Many a time, it resulted in stiffness of knee, partial but permanent. In many hospitals grafting and plating have been long abandoned in favour of Intramedullary Nailing.

(ii) Fractures at the upper third of femur are many a time oblique or spiral and comminuted. These fractures rarely do not unite. If rotational deformity is corrected, and if upper fragment is not too much flexed or abducted ultimate results are satisfactory. Intramedullary Nailing in such long oblique or spiral fractures is a difficult procedure. Only surgeons experienced in nailing should undertake them. An additional procedure of screwing or

Fig. 4.

An oblique fracture at the upper end of the femur, treated by intramedullary nail, with Supplementary wire loop.

wiring may be necessary, to keep the fragments in proper apposition. (Fig. 4).

(iii) Fractures at the lower third are still more difficult to deal with. The technic of nailing, for this site, may not be more difficult but the results are poor. It is very difficult to immobilise efficiently lower fragment because of its shortness and wide medullary cavity.

I have noticed, one more drawback, of nailing at this site; marked limitation of movements at the knee joint. The results of traction method are equally unsatisfactory and, therefore, the surgeon should select each case on its own merits. I consider that grafting has its place in fractures of shaft of femur, near knee joint.

(d) *Open Fractures*:

Literature is full of encouraging results of Intramedullary Nailing in open fractures but our experience is very depressing. It is true we do not get many fresh cases of compound fractures to treat but five cases which were treated at our institution after converting them into "closed fractures" by primary excision, all became more or less septic and gave poor results, in spite of intensive use of antibiotics.

(e) *Multiple fractures on the same side*:

When more than one bone are broken at the same time, Intramedullary Nailing becomes the treatment of choice. We had one case of fracture of Tibia and femur at the same time in a very heavy man. The end results were quite satisfactory. In another case of fracture of upper third of femur, there was anterior dislocation of hip joint, at the same time. The reduction of the dislocation with a very short upper fragment would have been extremely difficult but for a strong Intramedullary Nailing in the shaft. (Fig. 3).

(f) *Pathological fractures*:

We had two cases of pathological fractures in our series (1) of osteomalacia and (2) of bone cyst. The danger of passing nail through the soft cortex is well illustrated in our case. The end results in both cases were good.

Operation

(a) *Pre-operative measures*:

(i) We never rush for the operation, even in fresh cases. Shock and other body reactions following the original injury which are usually very severe are allowed to settle before operation is undertaken.

(ii) In the meantime, the fracture limb is immobilised with skin traction.

(iii) Skin preparation is started and heart, kidneys and Nutrition are assessed just like other major operations.

(iv) Antibiotics are started prior to operation and continued.

(v) Blood is grouped and matched as transfusion is required in many cases.

(vi) It is customary at our institute to place a skin mark (usually with a sterile needle) at the level of the lower end of the upper fragment in the X-ray room on the previous evening of the operation. This is found necessary to avoid extension of skin incision later on in cases with marked displacement.

(vii) Nails, especially their length and diameter are checked up, the previous evening.

To some of you, this precaution may seem superfluous but again and again I have found that for the want of nails of proper size from a limited stock, operation had to be abandoned at the last moment. Thus, apart from creating a very bad impression, subjects the patient to hardships and risks of an open operation.

We tried to select the diameter of Nail by X-Raying nail strapped to the side of the thigh, as advocated by Bohler, in our early cases, but we soon found that it was rarely helpful and often misleading. We do not spend on X-ray film, now, for this purpose.

Anaesthesia:

This is left to the discretion of the anaesthetist. However, spinal anaesthesia is avoided as a rule as we do not like a patient remaining conscious on the table when forceful procedures are going on.

Relaxants are given as a routine, to facilitate reduction of fracture. In cases where there is marked overriding this procedure is a great help and avoids a lot of unnecessary pulling, bending or twisting.

Special Instruments:

Except nails and long guide-pins and an extractor, we do not use any special instruments. Reamers are not used because we could not procure them.

Lowman's clamp is not considered a necessity. A hack-saw is perhaps necessary only for those Surgeons who are impatient by nature and who do not want to heed to experiences of others.

Description of Nails used by us, in our series will give you some idea of sizes required.

Length	Diameter m.m.				No. of cases
	8	8.25	8.5	9	
32	2	1	3	–	6
34	5	1	4	1	11
36	6	2	3	2	13
38	3	3	4	3	13
40	2	4	3	1	10
42	1	1	1	1	4
Others	–	–	–	–	7
					64 Total

Operative Technique:

The patient lies on his back, near the edge of an ordinary operation-table. A special orthopaedic table is not necessary. Great care is necessary in drapping the extremity as towels are likely to be displaced while manipulating the limb during reduction. Use of stockinet is, therefore, preferable. Use of tourniquette is neither possible nor necessary.

In most of our cases, we have used anterolateral exposure of Henry for fractures of lower two-thirds of shaft. But recently, we have started using posterolateral approach. The latter approach avoids splitting of vastus-intermedialis—a step absolutely necessary with Henry's approach. Function of Quadriceps is bound to be disturbed when Vastus-intermedialis is split in fractures of shaft at the lower one-third, resulting in partial loss of movements of knee joint. For fractures at the upper end, direct lateral incision is sufficient.

After exposing and liberating the ends and both the fragments, we routinely

reduce the fracture first. This gives idea of manipulation necessary to reduce fractures with irregular ends and their ultimate position with full correction. A butter-fly fragment when present is likely to be overlooked otherwise.

After this, the end of the proximal fragment is brought out of the incision and a guide-pin is passed upwards till the resistence is felt in trochanter. This gives information of actual length of upper fragment and its direction.

The narrowest portion of the medullary cavity, known as isthmus is usually at the junction of the upper with the middle-third or near the centre of the shaft. Any nail that passes through this isthmus is safe for use. To determine, this safe diameter, a nail that can snuggly pass upwards and downwards through this narrowest portion, is tried and selected for the final use. Trial is taken with a nail, by passing it upwards in the proximal fragment and downwards in the distal. Gentle tapping is necessary to negotiate isthmus. This step will be unnecessary if reamers are to be used. But in the absence of reamers, this preliminary determination of diameter of nail has never put us into an awkward position of removal of a jammed nail.

Having thus determined the length and diameter of nail, guide-pin that fits in the selected nail is again passed through the proximal fragment, till it appears under the skin, above the trochanter. It is necessary to adduct the limb flexed at knee and rotate the patient on the table. If sufficient adduction is not carried out, the tip of the pin will pass under the gluteii muscles and appear on surface at a very high level from trochanter. A small incision is made on the tip of the guide-pin allowing it to emerge about 2-3 inches. The selected clover-leaf nail is passed over the emerging length of the guide-pin with its eye pointing medially and tapped down, till it enters the upper part of the shaft. The guide-pin is now removed from the proximal fragment from below and is passed down from above, through the nail, till it just appears at the lower end of proximal fragment. Nail is tapped down, over the pin, till it also reaches fracture site. Fracture is again reduced and pin is carefully negotiated through the lower fragment. The limb is made straight and kept in a neutral position. Rotational displacement is to be strictly avoided. Having verified again that :

(a) the pin is in the medullary cavity of the distal fragment,

(b) that the reduction of fracture is proper, and

(c) that the limb is in a straight line, nail is tapped down till it reaches the upper border of patella and remains about $\frac{1}{2}$ to $\frac{3}{4}$ above the trochanter. This last step gives difficulty, if nail-tip disappears under bulky muscles. The extra length of nail under gluteii causes pain and may necessitate early removal.

In the end complete haemostasis is secured, wound is cleaned of blood clots, penicillin powder is put in the depth of the wound, muscles replaced, deep fascia sutured with continuous Chromic catgut or silk sutures and skin closed with interrupted linen sutures.

Post-Operative Treatment :

(1) Antibiotics are continued for about 4 days.

(2) Limb is kept in a neutral position in bed with a soft pillow under the knee.

(We use for the first 4 days a canvas shoe with a horizontal wooden splint nailed to it for this purpose, as advocated by Watson-Jones in cases of Smith-Peterson Nailing.)

(3) Active quadriceps movements are encouraged as soon as the local reaction is passed off. This took 3 to 5 days in our cases.

(4) Sutures are removed on the 9th day and active movements of knee and hip are started. As soon as the patient learns these movements and quadriceps drill, he is discharged from the Hospital, usually within 2 weeks of the operation.

(5) He is instructed to carry on all possible movements in the bed but is forbidden to walk.

(6) After about 8 to 10 weeks depending upon the age and type of fracture, he reports again, when union is checked by X-ray examination and if callus formation that usually forms on the concave side is satisfactory, he is taught to walk with crutches, putting increasing weight on the fractured side.

Early discharge of the patient from the hospital has certain definite disadvantages. If physio-therapy is carried out under trained supervision, not only early ambulation may be carried out but perhaps stiffness of knee which is noticed in not a few cases might be avoided. Heavy demand on beds is the cause of early discharge.

Complications :

(1) I hope, from the description of the operative steps, I have not created an impression that the Intramedullary Nailing with Kuntscher's clover-leaf nail is a very simple procedure and that it requires only a nail and a guide-pin, to practise it. It is true that the procedure is a very simple and looks extremely easy in experienced hands but one has to see an unexperienced, struggling with a nail, to believe how unsafe and difficult this measure could be and with what disastrous results. I distinctly remember a case in my Hospital in which a young enthusiastic beginner started hammering a tight nail and went on using greater and greater force with the hope of passing through the barrier of isthmus with the result that the nail got so irretrievably impacted in the proximal fragment that even after struggling for full one hour, it could not be removed and the patient though survived had to get his limb amputated due to vascular complications. Hammering has no place whatsoever in Intramedullary Nailing; only gentle taps are allowed. If this rule is strictly followed and details given above are minutely studied, I do not think, any serious complications can ever arise in nailing procedure.

To get good results, a nail snuggly-fitting both isthmus and metaphysis is essential. However, I have found again and again that provided it is fitting well at isthmus and provided it is of sufficient length, distal metaphyseal fixation is not absolutely necessary. If active muscular exercises are developed at an early stage, there is no danger of rotational deformity or non-union.

(2) Apart from impaction of nail, there is another dreadful complication of nailing, viz. infection. As a matter of fact, one is afraid of infection in any open operation on bone but in Nailing particularly the danger is greater because the whole of medullary cavity is likely to be involved. Strict aseptic measures and meticulous care in handling tissues are, therefore, imperative as in other major orthopaedic operations. Unfortunately, there is growing tendency among surgeons to compromise with strict aseptic measures and to compensate with greater use of antibioties, both locally and parenterally. This attitude requires to be checked in time.

In these series, apart from open fractures mentioned before, there did develop infection of mild degree in six more cases but as strict measures have been made a rule, not a single case has developed sepsis in my own series.

	Total No.	*Infected.*	
Open Fractures	5	5	
Closed Fractures	59	6	3 Skin infection 3 Jammed nail bone infection

Presence of infection invariably delays and healing affects end results. The following table speaks for itself, emphasising this point :

Results	*Cases without infection*	*Infected cases*
Excellent	24	–
Good	7	1
Fair	4	3
Poor	5	7
Total	40	11

13 cases have not been assessed for lack of follow-up results and cases done in later part of this year. Excellent in this series is defined as one with sound union within 4 months, without shortening, without wasting and with free knee movements.

(3) (i) If at the time of operation, a nail of proper size is not available, a narrower one should be substituted and the limb plastered. This is better than simple plastering as there is no possibility of angulation or over-riding taking placing at the site of fracture.

I remember a case in which presence of a spike so nicely fixed the fragments that I was tempted to apply only plaster. Eight weeks after when a check X-ray was taken, marked angulation had taken place under plaster that had become loose.

(ii) In another case of fracture at the lower one-third even a narrower nail could not be negotiated on account of curvature of shaft. The guide-pin was kept in position and limb plastered. After about 4 weeks, the guide was pulled out from above. The result was good. (The pin should be of non-reacting steel).

(4) In one case, "Callus cap" was formed over the upper end, under gluteii muscles. This required removal, along with the nail.

(5) Migration of nail upwards took place in 4 cases in course of time. This may be the result of loose fitting or loosening of grip due to early ambulation.

Migration always causes pain in hip and if union has taken place, nail should be removed.

(6) In our series, there is no case of fracture or bending of nail, probably because we do not allow early ambulation. Kuntscher's clover-leaf nails are sufficiently strong to withstand any powerful muscular action in bed.

(7) There has been one sudden death in our series by pulmonary embolism. The patient was a poor surgical risk and should have been avoided.

(8) *Stiffness in knee* :

(a) In cases followed by physiotherapeutic measures, no disability was left except in fractures of the lower one-third of the shaft. Whenever infection occurred stiffness was marked.

(b) In elderly persons, who had osteo-arthritic joints, stiffness, pain and slight swelling remained for a long time.

Summary and Conclusions

(1) 51 cases of fractures of shaft of femur treated by open Intramedullary Nailing and follow-up have been presented and discussed.

(2) Intramedullary Nailing even by the open method is a major procedure and all possible care should be taken in selecting the case, in preparing him for operation and in immediate post-operative period, to combat shock and haemorrhage.

(3) Open nailing may not be a complicated surgical technic but at every step one is likely to meet with difficulties. The operator should face them with patience and presence of mind. Dreadful complications like impaction and infection can be avoided if minute details of technic are constantly borne in mind.

(4) Every surgeon who is called upon to treat fractures should know the technic of Intramedullary Nailing and keep ready nails and other instruments required for it.

(5) My purpose of reading this paper will be well served if I have been able to stimulate some of you to take up and master Intramedullary Nailing, a procedure of choice in transverse-fractures of shaft of femur.

Received for publication on 17 1 '58.

L. A. RAVI VARMA, M.B.C.M., D.O.M.S. (Lond.)

(Oct. 1885 — Feb. 1958)

Born in October 1885, Dr. Ravi Varma spent the earlier years of his career in Travancore. Later he joined the Madras Medical College to prosecute Medical Education and took his M.B.C.M. in 1911. Subsequently he took the D.O.M.S. (London) in 1921. He was a reputed Eye Surgeon in the Re-organised Eye Department of the Ophthalmic Hospital at Trivandrum. After retirement he continued to practise as a Consultant. One of his special hobbies was Sanskrit Literature and he had written many authoritative Papers. His writings were greatly respected both in India and in Europe.

During the organisation of the 'Hall of Fame' at Chicago by the International College of Surgeons he rendered meritorious services for which he was offered an Honorary membership of the College.

He was a Foundation member of the Association of Surgeons of India and had contributed Papers on Ancient Surgery in India to the Indian Journal of Surgery.

CONTRIBUTORS—February, 1958

1. Dr. Santokh Singh Anand, M.B., F.R.C.S., F.A.C.S., F.C.C.P., Professor of Surgery, &
   Dr. Waryam Singh, M.S., Asst. Professor of Surgery,
   Medical College, Amritsar.

2. Dr. H. Roy, M.B.B.S., Demonstrator-cum-Curator, Dept. of Pathology,
   Dr. A. C. Guha, M.B.B.S., D.B. (Manch.), Professor of Pathology, &
   Dr. S. M. Ghosh, M.B., F.R.C.S., Professor of Surgery,
   National Medical College, Calcutta.

3. Dr. U. Mohan Rau, M.S., F.R.C.S. (Eng.), Hony. Surgeon, Govt. General Hospital, Madras-3 (Surgical Clinic, 207, Poonamallee High Road, Madras-7).

4. Dr. K. K. Chaturvedi, M.B.B.S., M.A.T.S., F.C.C.P., F.I.C.S., Medical Superintendent, Mahadevi Birla Tuberculosis Sanatorium, Ranchi, Bihar.

5. Dr. D. J. Reddy, M.D., Principal & Professor of Pathology,
   Dr. K. Gopalakrishna Gupta, M.B.B.S., Tutor in Pathology, &
   Dr. V. Kameswara Rao, M.D., Tutor in Pathology,
   Guntur Medical College, Guntur.

6. Dr. B. N. Balakrishna Rao, B.Sc., M.B.B.S., F.A.Sc., F.I.C.S., F.R.C.S. (Eng.), Professor of Surgery, G. R. Medical College, Gwalior, &
   Dr. P. N. Ghei, M.B.B.S., Formerly Demonstrator in Surgery, now Resident Surgical Officer, J. A. Hospital, Gwalior (India).

7. Dr. Y. V. Sachdeva, M.S., Professor of Clinical Surgery, &
   Dr. J. R. Talwar, Research Assistant, Dept. of Clinical Surgery,
   Medical College, Amritsar.

8. Dr. B. L. Gupta, M.S. (Bom.), Surgical Registrar, K.E.M. Hospital, Bombay-12.

9. Dr. K. S. Bose, M.S., Hony. Surgeon (Orthopaedics), Medical College Hospitals, Calcutta (39, Pudda Pukar Road, Calcutta-20).

10. Dr. B. Mukopadhaya, M.B.B.S., M.Ch.(Orth.), F.R.C.S., P. W. Medical College, Patna.

11. Dr. W. J. Virgin, M.D., M.Ch.orth., F.R.C.S., Christian Medical College, Ludhiana.

12. Dr. M. D. Desai, M.S., F.R.C.S., M.Ch.Orth., Professor of Surgery & Superintendent, Sheth Vadilal Sarabhai General Hospital & Sheth Chinai Maternity Hospital, Ahmedabad.

INDEX TO ADVERTISERS

Printed by Mr. G. Raghavan at The Huxley Press, 114, Armenian St., G.T., Madras, and Published by Dr. A. VENUGOPAL, Secretary, Association of Surgeons, 164, Poonamallee High Road, Madras 10. March 1958.

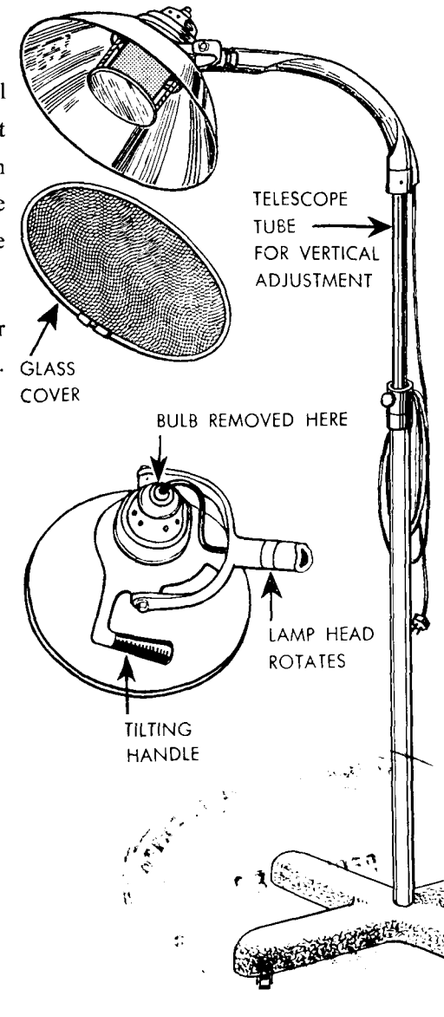
The Indian Journal of Surgery

Vol. XX APRIL 1958 No. 2

PORTABLE SHADOWLESS LAMP

It is a mobile stand model Lamp with a reflector of about 12″ diameter. It gives uniform and shadow-free light. The illuminating field is also wide enough.

This is the most popular Lamp for any kind of operation.



*

INEXPENSIVE

yet

EXTREMELY STURDY

*

SATISFACTORY

LIGHTING UNIT

Manufactured by :

H. MUKERJI & BANERJEE SURGICAL PRIVATE LTD.

39/1, COLLEGE ST., (Regd. Office) **CALCUTTA - 12**

and at

ASUTOSH BLDG., (Cal. University) **CALCUTTA - 12**

THE INDIAN JOURNAL OF SURGERY

APRIL, 1958

BIMONTHLY
Annual Subscription Rs. 24

new . . .

chemically conditioned!

ACHROMYCIN* V

Tetracycline Buffered with Sodium metaphosphate

ACHROMYCIN V combines sodium metaphosphate with the outstanding broad-spectrum antibiotic ACHROMYCIN Tetracycline. With chemical structure intact but tetracycline action intensified, ACHROMYCIN V provides *greater antibiotic absorption / faster broad-spectrum action* for quick control of infections commonly seen in medical practice. Indications for ACHROMYCIN V include all infections specified for ACHROMYCIN (proved in over 50 diseases).

Available : Bottles of 16.

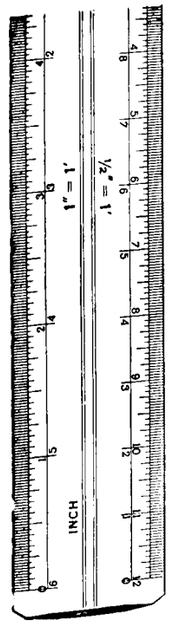
Each Capsule (pink) contains :
Tetracycline equivalent to tetracycline HCl . . . . . 250 mg.
Sodium Metaphosphate . . . . . 380 mg.

Dosage : 6-7 mg. per lb. of body weight per day for children and adults.

LEDERLE LABORATORIES (INDIA) PRIVATE LIMITED, P.O.B. 1994, BOMBAY 1

Lederle

*Regd. Trade Mark



by any measure it's

BARD-PARKER RIB-BACK SURGICAL BLADES

and by any measure it is just as true today as when our Company was founded . . . in the purchase of B-P RIB-BACK SURGICAL BLADES you are provided with the most dependable cutting edges that modern scientific methods and *the art of accuracy* can produce . . . their performance in use is the answer to the question of economy!

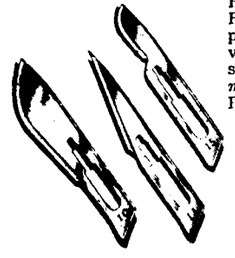
Sole Distributors :

BOMBAY SURGICAL CO.

New Charni Road : : BOMBAY 4

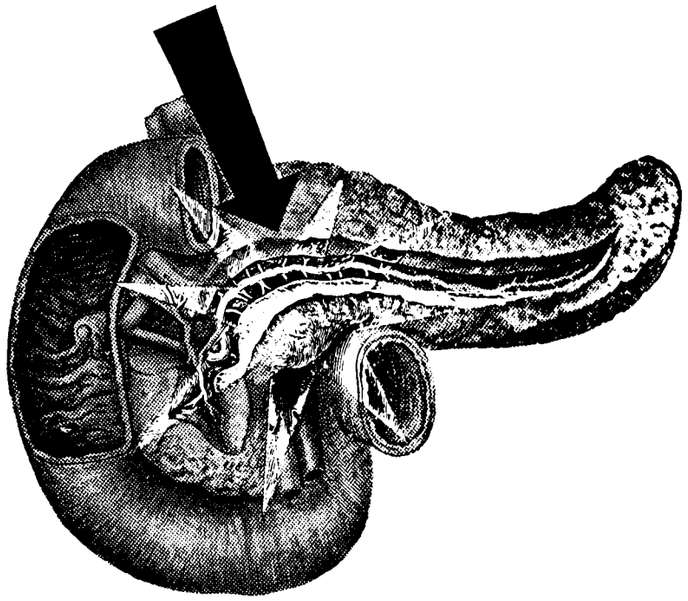
CUTTING EDGES • ENDURING • UNIFORMLY SHARP • QUALITY AND DEPENDABILITY •

It's Sharp



RIB-BACKS packaged in the *new* RACK-PACK eliminates unwrapping, handling or racking of individual blades. A real *time* and *labor* saver for the O.R. personnel. *In a matter of seconds* from RACK-PACK to sterilizer.

Its action is physiological



TOLBUTAMIDE DUMEX

Stimulates natural production of insulins

ADMINISTERED orally, TOLBUTAMIDE Dumex affords a physiological action in the treatment of diabetes — stimulating the natural production of insulins within the body.

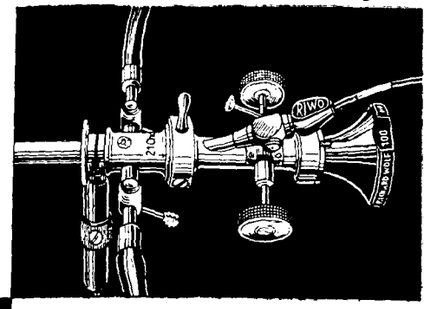
TOLBUTAMIDE Dumex is free from antimicrobial activity, and has proved well tolerated even during prolonged administration — its freedom from chemo-therapeutic side effects makes it the safest anti-diabetic agent available today.

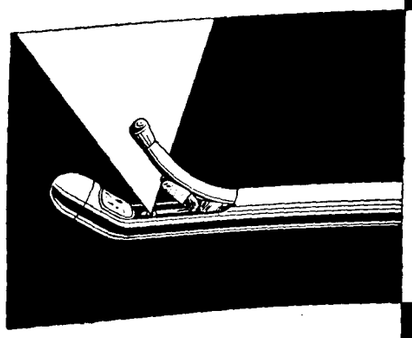
TOLBUTAMIDE Dumex is available in bottles of 20 and 100 tablets, each tablet containing:

Para-Tolylsulfonyl-Butylcarbamide . . . 500 mg.

Latest Technical Progress and therefore Highest Class Performance
You will find in WOLF'S (Germany) ENDOSCOPES being the result of more than 50 years experience

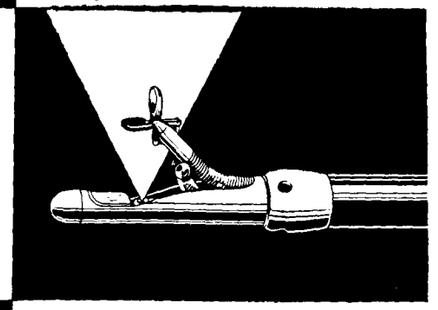
ORIGINAL WOLF

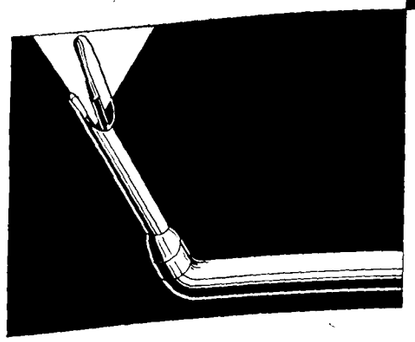




Cystoscopes
Cystolith-
Instruments
Resectoscopes
Urethroscopes

Laparoscopes
Gastroscopes
Rectoscopes
Telescopes for Bronchoscopy
Thoracoscopes
Douglasscope
Choledochoscopes
Photo-Endoscopes





RICHARD WOLF GMBH
KNITTLINGEN/WURTT.

For Details and literature please contact :

Mr. THOMAS SUCK P. O. B. 1414 BOMBAY 1

Urologists, who visit the International Exhibition at Brussels, may call at the stall of M/s. Siemens Reiniger A. G. where the full range of Endoscopes can be inspected.

The Indian Journal of Surgery

VOL. XX No. 2

CONTENTS — APRIL 1958

ORTHOPAEDIC SECTION

NOTICE TO CONTRIBUTORS

The Indian Journal of Surgery publishes original articles in all branches of surgery and allied subjects. *Papers for publication* and all editorial communications should be addressed to the Editorial Secretary, Indian Journal of Surgery, 164, Poonamallee High Road, Madras 10. Papers sent to the journal are sent to a panel of referees and are accepted for publication on their recommendation. The accepted papers are published on the understanding that they have not been, and will not be published in whole or in part in any other journal.

Orthopaedic Section : Articles intended for publication in the Orthopaedic Section of the Journal may kindly be sent to the Sectional Editor, Dr. N. S. Narasimhan, F.R.C.S., 221, Thambu Chetty St., Madras 1.

Thoracic Surgery Section : Articles pertaining to Thoracic Surgery may be sent to the Sectional Editor, Dr. P. K. Sen, M.S., F.A.C.S., K.E.M. Hospital, Bombay.

Style : Manuscripts must be typewritten on one side on quarto or foolscap sheets, double space and with a margin of not less than two inches. They should bear the name and full address of the author to whom the proofs are to be sent. The paper should conclude with a brief summary stating the conclusions described in the paper.

Tables and Illustrations : Tables should be numbered in Roman numerals and set out on sheets separate from the text. The illustrations should be kept separate from the text and should be numbered consecutively in Arabic numerals. Each figure should be referred to in the text and the descriptive legends should be typewritten on a separate sheet of paper. Nothing should be written or typed on the back of the illustrations. Photographs and photo-micrographs should be printed on glossy paper and generally should not be larger than 6.5 x 6.5 cms. If transmitted through the post they should not be folded and should be protected by corrugated cardboard paper.

For every article 12 blocks shall be printed free of cost. Cost of preparing extra blocks will have to be borne by the author.

Illustrations will not be accepted unless they reach a certain standard of excellence technically, present an attractive appearance and add significantly to the value of the presentation.

References : These should be arranged alphabetically by authors. For citation of a book, give in order author's name, initials, complete title, place of publication, name of publishers, year and page. For an article author's name, initials, full title of paper exactly as it appears, name of journal (abbreviated as in the Quarterly Cumulative Index Medicus), volume number (in heavy type Arabic numerals), inclusive page numbers and year. The following example illustrates the desired punctuation and arrangement.

> Christopher, F.: Minor Surgery. 5th Edition, Philadelphia and London : W.B. Saunders Company, 1945, p. 348.

Citations in the text should give the author's name followed by the number listed in the reference.

Proofs : Contributors will receive one proof in galley by air mail, if necessary, which should be immediately corrected and returned by air mail to the Editor. Only minor alterations will be accepted in the original manuscript at the time of the correction of proofs.

Reprints : 25 reprints of an article will be sent to the author or divided among the authors. Additional reprints can be supplied at cost price if application is made when the proofs are returned.

All communications regarding membership of the Association, subscription to the Journal, and advertisements may be addressed to the Hony. Secretary, Association of Surgeons of India, 164, Poonamallee High Road, Madras 10.

THE
INDIAN JOURNAL OF SURGERY

Vol. XX APRIL 1958 No. 2

EFFECT OF SURGERY ON SERUM ELECTROPHORETIC PATTERN

BY

P. N. SATSANGI, BAL KRISHNA AND TARA CHANDRA LUCKNOW*

Introduction

Recent reviews of Engel (1953), Selye and Horava (1953), and Cuthbertson[4] (1956), show that the characteristic features of the metabolic reaction to physical injury are, the negative balances of nitrogen, sulphur, phosphorus and potassium, and, in the early stages, impaired carbohydrate utilisation, fatty liver, tendency to ketosis, sodium chloride and water retention, particularly in more severe cases, and, usually, an increase in the blood and urine corticoids. The tissue changes include hypertrophy of the adrenals with diminution of ascorbic acid and cholestrol contents, a hyperplasia of the lymphoid tissues, involution of the thymus, leucocytosis with lymphopenia and eosinopenia.

Cuthbertson[5] found by chemical precipitation methods a well marked rise in the globulin moiety of the blood plasma, a rise in the fibrinogen content in most cases and slight lowering of the albumin fraction. Ligeti et al (1953) from their studies of the serum electrophoretic patterns found a decrease in the albumin and an increase in alpha 1 and alpha 2 globulins in one-third of their cases during the first 24 hours, and in 80% of all cases within 4 days after operation. They did not find any variation in the total protein contents. Birch and Jepson[2] (1956) working on similar lines found a rise in alpha 1 globulin and gamma globulin which was maximal on the 2nd post operative day, a fall in the beta globulin maximal on the 3rd and 4th days, a rise in alpha 2 globulin maintained from the 2nd to 6th day, and a rise in plasma fibrinogen maintained at a maximal level from the 3rd to the 8th day after operation. Lovenson et al (1955) studied the changes in the amino-acid contents of the plasma proteins and found that, (*a*) five amino acids, namely glycine, histidine, threonine, proline and glutamic acid remained normal, (*b*) six amino acids, namely, leucine, isoleucine, lysine, valine, tyrosine and alanine rose moderately during the first week and then fell, (*c*) three amino acids, namely, phenylalanine, aspartic acid and methionine also rose during the first week but to a greater degree, and (*d*) taurine showed no change.

The present study was undertaken to note the changes in the serum protein patterns in patients undergoing operation in relation to their pre-operative general condition, and post operative convalescence and wound healing.

Methods and Materials

Controls and patients : The study includes five controls and eighteen patients. The patients have been divided into three groups (A), (B) and (C) according to the pre-operative general condition of the patients.

"A" consisted of patients of normal or almost normal in health, their nutrition was good and they gave no history of weight loss or weakness. Their systolic blood pressure was 110 mm. of mercury or above and Haemoglobin content 90% (Sahli's *Units*) or above. It included the following five cases :—

Hernias (2), Epispadias (3), Contracture lip (4), Contracture forearm (1).

"B." The nutritional state of the patients in this group was average. The patients were not keeping well, their systolic blood pressure ranged between 90–110 mm. of mercury. The haemoglobin was between 80 to 90% (Sahli's Units). It included eight cases :

Carcinoma oesophagus (1), Tubercular adenitis axilla (1), Acute appendicitis (1),

* From the Department of Surgery, King George Medical College, Lucknow.

Carcinoma transverse colon (1). Volvulus sigmoid colon (1). Carcinoma cheek (1). Loculated Ascitis (1). and Pulmonary tuberculosis (1).

" C ". The general condition of the patients in this group was poor. They were debilitated and in the majority, emaciated. The systolic blood pressure was below 90 mm. of mercury. The following patients were included in this group :—

Pyloric stenosis following duodenal ulcer (1). following acid burn (1). Fungating carcinoma penis (1). Primary carcinoma liver (1). and carcinoma iliocaecal region (1).

Experimental Techniques

Collection of Sera : 2 ml. monoxalated blood was drawn from the patients before operation and on the eighth post-operative day. Sera were separated and in some cases were stored for 4–5 days in a refrigerator. The eighth post-operative day was chosen, as by that time, wound healed by primary intention and sutures were removed in most cases.

Two types of studies were done on these sera, (*a*) total serum protein studies and (*b*) the serum electro-phoretic studies. The total serum proteins were estimated by micro-kjeldahl method. The colour was developed by Nessler's reagent and the readings were noted on a B & L colorimeter at 430 mu.

Serum Electrophoresis : Whatman No. 3 M.M. filter paper was used for spotting the serum in a fine streak 5 cms. from one end of the strip : each strip was 30 cms. long and 3 cms. wide. The strips were previously soaked in the veronal buffer of pH 8.6 and 0.1 to 0.01 ml. of serum was used. The electrophoresis was run for 16 hours at 110 volts, and 2 ma. current per strip.

After the run the filter paper strips were taken out from in between the glass plates, the dipping ends of the strips were cut off and the strips were dried on a clean glass plate under the infra red lamp. The dried strips were stained in 0.01% bromophenol blue solution (Bromophenol blue 100 mgm. glacial acetic acid 50 ml. mercuric chloride 50 gms. distilled water 1 litre) for 16 hours. The strips were then rinsed in three changes of 2% acetic acid, twice for 5 mts. and lastly for 10 mts. Finally the strips were rinsed in 10% acetic acid containing 2% sodium acetate. The strips were blotted and dried.

The dried strips were scanned directly on the photovolt densitometer using a filter of 590 mu. Readings for every mm. were obtained. Graphs were plotted with distances as abscissae and readings of densitometer as ordinates. Vertical line dips in the graph were drawn to the base line and they demarcated the various fractions of the serum proteins. Area under each curve was calculated by counting the number of squares. The total area was taken as 100 and the different fractions were then expressed as percentages of the total proteins.

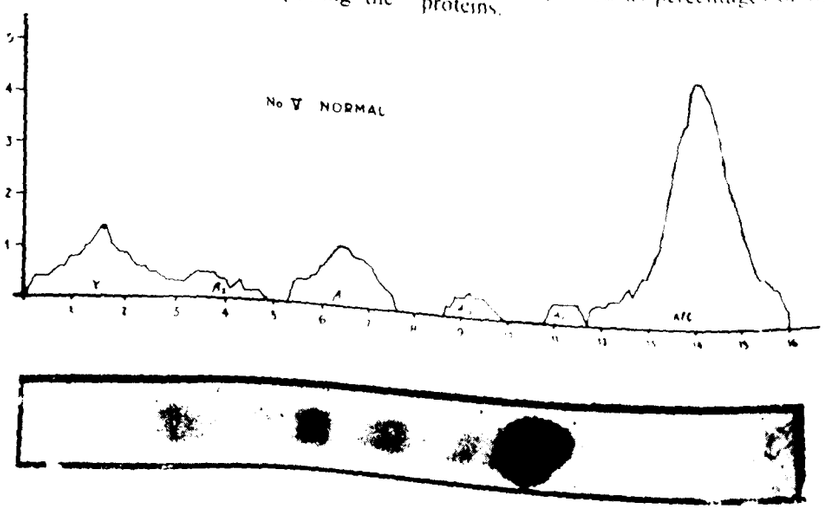


Fig. 1
Typical serum Electrophoretic pattern in normal group. G.K.G.

TABLE I—*Serum Protein Fraction in Normal Individuals*

Serial number	Name	Age in years	Total serum protein in gms. %	Albumin %	Globulin				
					Alpha 1 %	Alpha 2 %	Total alpha %	Beta %	Gamma %
1	D.K.A.	24	6.57	50.2	5.81	7.2	13.01	13.67	22.3
2	V.K.R.	27	8.49	49.8	3.34	12.45	15.79	10.55	23.84
3	R.K.N.	24	7.8	47.02	3.14	8.92	12.06	13.96	26.94
4	P.N.S.	27	7.25	40.76	5.8	11.5	17.3	16.8	25.0
5	G.K.G.	26	7.62	63.6	2.1	2.87	4.97	13.5	18.95
	Mean Average :		5.02		4.02	8.6	12.62	13.4	23.5
	Mean Error : ±		7.5	±	± 3.5	± 3.5		2.6	± 2.6

Total serum protein represented in gms. per 100 ml.
Fractional proteins represented in gms. percentage.

Results

Studies of Total Serum Protein : The results of the total serum protein estimations are given in the tables along with the results of the electrophoretic analysis. They show that the pre-operative serum protein levels in most cases are within the reported normal limits of 6-8 gms. per 100 ml. inspite of variations in the general nutritional status of the patients. Except for one patient, S.S., a case of carcinoma ileo-caecal region, in which the pre-operative serum protein level was 2.5 gm., % the values even in group 'C' ranged between 6.8 gms. %. The serum protein levels show a fall post-operatively in all but three cases.

Electrophoretic Analysis

Controls : The findings obtained in the five controls are listed in Table No. 1. The albumin fraction in our cases showed a mean error of 7.5 a rather high figure and the gamma globulin fraction showed a higher percentage than that reported by other workers. The values for the rest of the fractions are comparable to the values reported by others.

General nutritional state and the albumin fraction : The pre and post-operative findings of total serum proteins, electrophoretic serum fractionation, the post-operative general condition and the wound healing are listed in Tables Nos. II, III and IV. From a look at these tables, it is apparent that the serum albumin fraction reflects the general nutritional state of the patient. Thus in group 'A' where the general condition was good, the serum albumin fraction was above 40%, in group 'B' where the general nutritional state was judged to be average the albumin percentage was between 30-40% and in the third group where the albumin fractions were below 30%, the patients were emaciated and in a poor nutritional state.

Changes in groups A and B : (Tables II and III). In one case the post-operative blood could not be obtained. In the remaining twelve cases, healing by primary intention and smooth convalescence occurred in eight of the cases. A comparison of the pre and post-operative patterns shows that surgery induces a definite change in the serum protein fractions characterised by :—

(*a*) fall in the albumin fraction which occurred in six out of eight cases.

(*b*) rise in the alpha globulin which occurred in four cases.

(*c*) rise in beta globulin which occurred in all cases.

(*d*) rise in gamma globulin which occurred in five cases.

Fig. No. 2 (*a*) and (*b*) represents the pre and post-operative electrophoretic patterns in case No. 4 group A. S.P., a child aged 5 years, who had a contracture of the left hand following an accidental burn. The scar tissue was excised and the hand buried in the abdomen. The child had smooth convalescence, the graft took up nicely and later the pedicle was detached. The post-operative electrophoretic curve shows a fall in the albumin, a rise in the alpha 1, alpha 2, and beta globulin fractions. There is a slight fall in the gamma globulin fractions.

Fig. No. 3 (*a*) and (*b*) represents the electrophoretic patterns in case No. 3 group B., N.L., aged 28 years was a case of pulmonary tuberculosis in which first stage thoracoplasty was done and the first three ribs were removed. The patient had no post-operative complications. The wound healed by primary intention. The post-operative electrophoretic curve shows a fall in the albumin, a rise in alpha 1, a fall in alpha 2 and a rise in beta and gamma globulins.

Changes in group C (Table No. II) : A comparison of the pre and post-operative patterns shows that post-operatively (*a*) there is a rise in the albumin fraction and (*b*) there is a fall in the gamma globulin fraction.

Fig. 4 (*a*) and (*b*) depicts the pre and post-operative serum patterns in case No. 2, group C, R.L., aged 30 years, who was a case of pyloric stenosis following duodenal ulcer, where partial gastrectomy was done. The patient had smooth convalescence and proper healing of the wound. The figures show that the albumin has increased from 28.4% to 31.3%. There is only a slight increase in the beta and slight fall in the gamma globulins.

Post-operative general condition and wound healing : The cases which had a smooth convalescence with proper wound healing, showed an increase in the beta globulin. The only exception was that of U.A.K. (group A, No. 2) in which though an increase in the beta globulin from 5% to 16.9% was observed, the wound gave way twice. Secondary suturing was done once but still the wound healed by secondary intention. In this case stilboestrol was being administered in the beginning and the healing started only when it was discontinued.

TABLE II—GROUP A—*Post-operative changes in serum protein fraction*

S. No.	Name	Disease and operation.	Total protein		Albumin%		Globulin Alpha Globulin Alpha 1		Alpha 2		Total Alpha		Beta		Gamma		Remarks—(Post-operative general condition and wound healing)
			Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	
1	M.Z.	... Incisional Hernia repair.	7.63	6.2	45.3	41.1	2.8	1.3	8.7	5.7	11.5	7	6.5	11.3	36.7	40.5	Slight serous discharge from the wound which gradually healed well.
2	U.A.K.	... Epispadius : Plastic repair.	8.87	8.87	61.8	36.9	8.0	8.3	4.7	13.6	12.7	21.9	5.9	14.9	20.0	26.1	Put on stilboestrol ; wound gave up twice secondary suturing unsuccessful. Stilboestrol withdrawn, healing by secondary intention.
3	G.P.R.	... Contracture lip : Excision scar and transfer of pedicle to lip.	7.97	5.85	46.4	32.4	...	6.6	14.7	15.1	21.4	22.9	12.9	16.3	23.9	23.1	Graft taken up hand release two weeks late and repa completed.
4	S.P.	... Contracture forearm : Excision scar and embedding hand in the abdomen.	6.91	5.52	41.4	37.6	6.7	7.8	5.8	...	7.1	...	14.7	...	20.5	...	General condition satisfactory. Wou healed by primary intentic Post-operativ blood not obtained.
5	D.K.	... Left oblique Inguinal hernia : Herniorrhaphy.	7.63	...	57.5	...	1.3	...									

TABLE III—GROUP B—*Post-operative changes in serum protein fractions*

S.No.	Name	Disease and operation	Total protein		Albumin%		Globulin Alpha						Beta		Gamma		Remarks—(Post operative general condition and wound healing)
							Alpha 1		Alpha 2		Total						
			Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	
1	S.A.	... Tubercular adenitis axilla with cold abscesses : curettage of the abscess.	6.57	8.9	4.2	44.5	...	4.6	5	7.2	10.7	11.8	15.9	15	30.6	25.3	Upper part of the incision healed by secondary intention, scar became keloidal
2	R.S.	... Carcinoma Oesophagus : Exploratory Thoracotomy.	7.69	6.76	36.9	14.3	...	1.7	...	10.8	25.0	12.0	13.9	8.3	23.4	6.5	Did not tolerate anæsthesia. Wound healed well. general condition deteriorated.
3	C.K.	... Carcinoma cheek lifting of tube pedicle.	7.46	6.47	37.2	34.4	4.	6.1	14.9	13.1	18.1	20.0	15.6	14.6	28.3	31.	Infection in the donor area, one month later hemi-mandibulectomy and reconstruction cheek done.
4	N.L.	.. Pulmonary tuberculosis : I stage thoracoplasty.	7.97	4.28	36.6	35.9	4.6	5.6	14.9	11.3	19.5	16.9	16.5	18.4	27.3	28.8	Wound healed well ; second stage done after 3 weeks.
5	A.J.	... Loculated Ascites Laparotomy.	6.08	3.57	33.4	29.9	6	5.9	18.2	17.8	24.2	13.5	12.4	12.9	29.9	43.7	General condition satisfactory ; wound healed well.
6	Bby.	... Carcinoma transverse colon ; Colostomy.	7.25	4.46	34.4	23.1	4.2	9.4	11.3	17.9	15.5	27.5	10.3	11.4	39.4	38.2	Patient progressed well ; second stage Resection and Anastomosis done later.
7	R.D.S.	... Acute Appendicitis ; Appendicotomy.	6.39	7.81	35.7	5.7	3.5	15.0	15.5	20.7	19	10.3	11.8	33.9	33.6	...	General condition satisfactory ; wound healed well.
8	Jeeln.	... Volvulus sigmoid colon ; Reduction.	7.1	5.15	32.4	35.7	4	5.1	14	16.5	18	21.6	12.8	15.7	36.7	26.9	Had recurrence but improved on conservative treatment. Wound healed well.

TABLE IV —GROUP C.—*Post-operative changes in serum protein fraction*

S.No.	Name	Disease and operation	Total proteins		Albumin%		Globulins						Beta		Gamma		Remarks—(Post-operative healing and convalescence)
							Alpha 1		Alpha 2		Total						
			Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	
1	S.C.	... Carcinoma Ileo-caecal region : Ileotransverse colostomy.	2.5	...	32.1	...	4.6	...	9.9	...	14.5	...	38	...	15.2	...	Expired on IV post-operative day.
2	R.L.	... Pyloric stenosis following duodenal ulcer partial gastrectomy.	8.5	7.8	25.4	31.3	7.2	8.3	22.3	14.6	29.5	22.4	8.2	8.7	36.9	36.7	General condition satisfactory ; wound healed by primary intention.
3	J.B.S.	... Fungating Carcinoma Penis ; Radical amputation.	6.94	5.36	21.3	29.0	6.7	8.1	13.8	16.8	20.5	24.4	9.3	8.2	48.2	37.8	Marked sloughing of the margins. General condition deteriorated. Expired on 26th day. Post-mortem showed pelvic abscess.
4	J.B.	... Pyloric stenosis following acid burn : gastro-jejunostomy.	7.25	5.36	30.8	32.7	5.5	9	12.2	13.4	17.7	22.4	11.8	12.4	40	32.4	Patient improved markedly. Incision healed by primary intention. Keloid developed in the scar.
5	N.M.	... Carcinoma Liver Laparatomy.	7.3	...	20.6	...	9	...	14	...	23	...	12.9	...	43.3	...	Post-operative blood not obtained. Patient developed burst abdomen and expired in the third week.

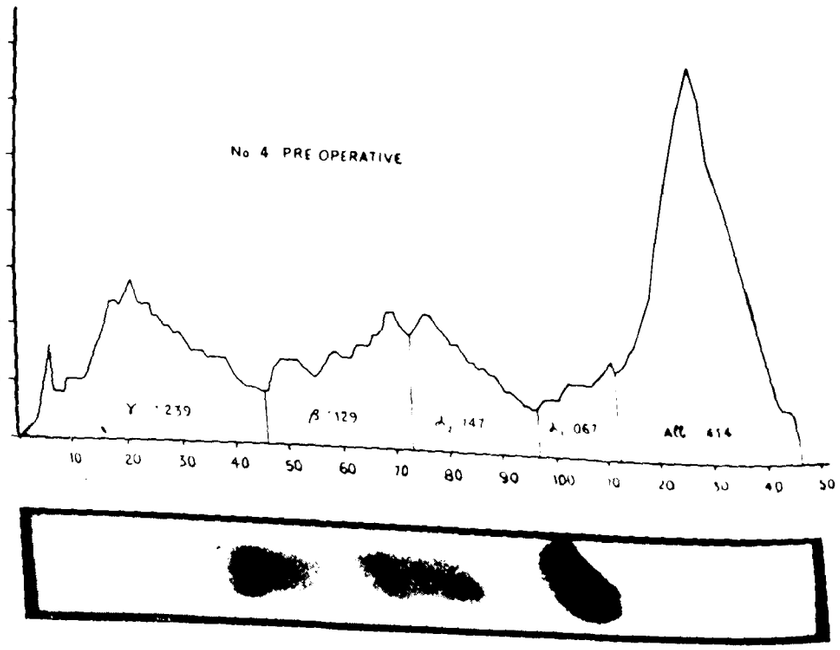


Fig. 2 (a)

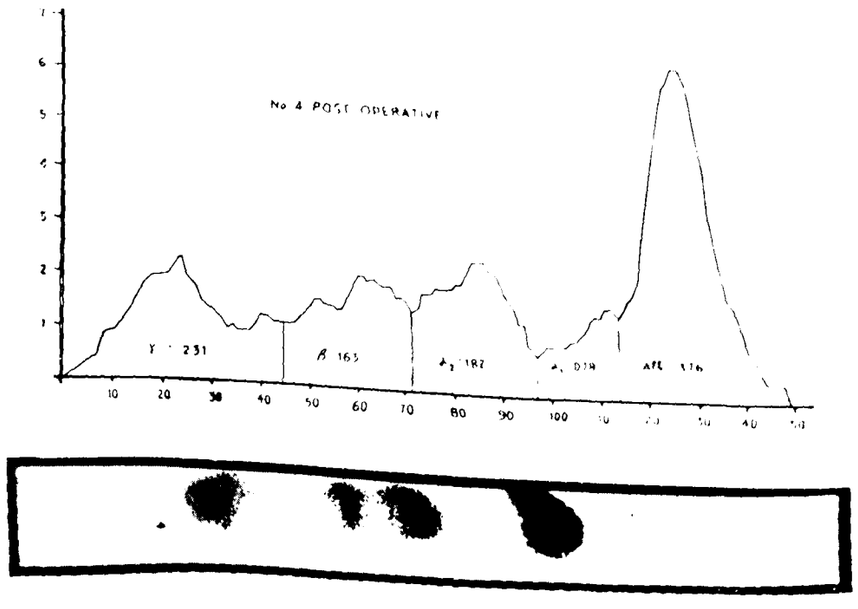


Fig. 2 (b)

Fig. 2 (a) & 2 (b) Pre- and Post-operative serum electrophoretic pattern in Group A. S.P. Post-operatively there is fall in Albumin, a rise in alpha 1 and alpha 2 and beta globulins and slight fall in gamma globulin.

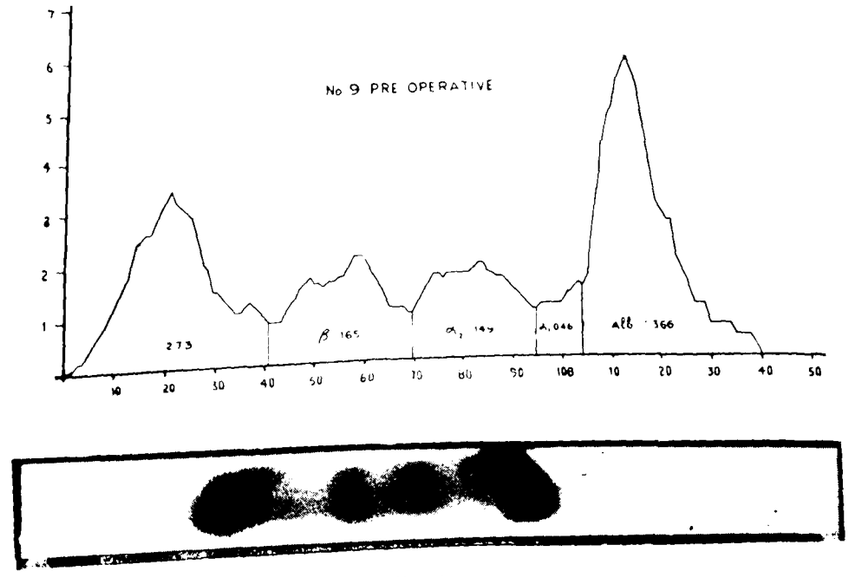


Fig. 3 (a)

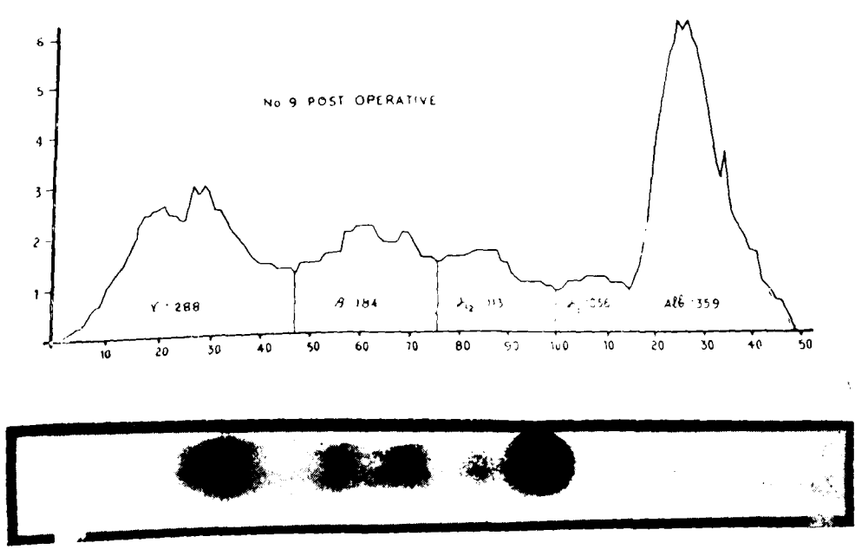


Fig. 3 (b)

Figs. 3 (a) & 3 (b) Pre- and Post-operative serum electorphoretic pattern in Group B. N. L. Post-operatively there is fall in Albumin, a rise in alpha 1, a fall in alpha 2, and a rise in beta and gamma globulins.

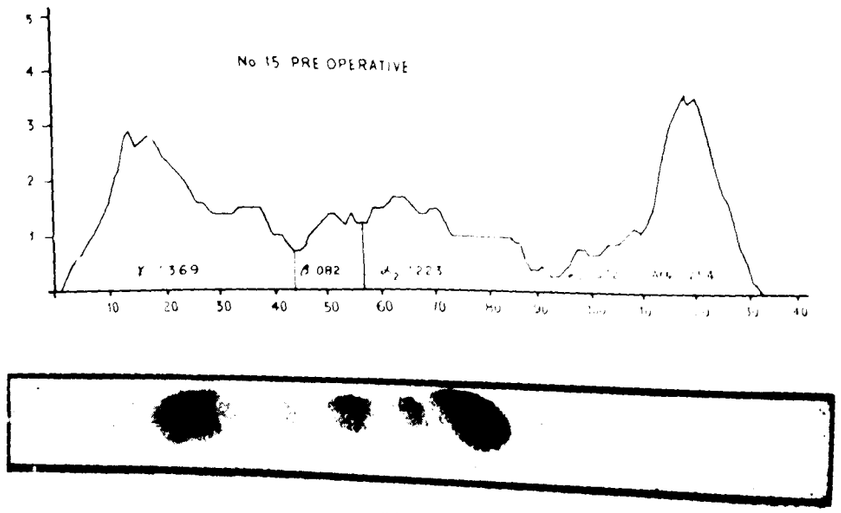


Fig. 4 (a)

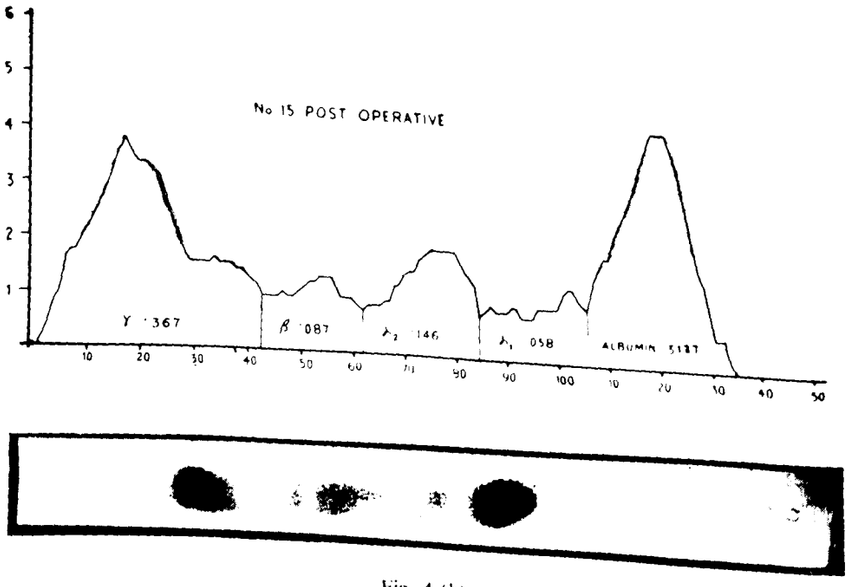


Fig. 4 (b)

Fig. 4 (a) & 4 (b) Pre- and Post-operative serum electrophoretic pattern in Group C. R. I. Post-operatively there is rise in albumin, fall in alpha, a rise in beta and slight fall again in gamma globulins.

A fall in the beta globulin fraction was associated either with deterioration of the general condition of the patient or infection of the wound. The only exception being of S.P.R. in which a fall in the beta globulin from 14.9% to 13.2% was observed. Yet the healing took place by primary intention and the pedicle took up nicely.

Discussion

Basis of classification : Different laboratory methods have been used to evaluate the protein status of the patients and they include (1) nitrogen balance studies, (2) plasma protein determinations, (3) tissue biopsy and determination of the tissue proteins, (4) response of the total circulating proteins to saline infusions, (5) water content of the serum, (6) nitrogen tolerance tests. But none of them taken singly is perfect. Ravdin (1946), Keys et al (1946), and Localis et al (1948) have clearly demonstrated that normal serum protein levels may occur in association with decreased tissue protein contents, and presence of dehydration, anaemia and infections introduce the complicating factors. An appraisal of the clinical status of the patient is a more reliable method. Works of Weech (1937), Zeldis et al (1945) suggest that estimation of the total circulating albumin is a better index than any of those described above.

An analysis of the results obtained in the present study confirms the view that the total serum protein content is not a reliable test of the protein status of the patient. The albumin fraction, obtained electrophoretically, however, agrees very closely to the protein status of the patient as judged clinically. Thus in group (A) the albumin level was above 40%, in group (B) above 30% and in group (C) below 30%. [Figs. 5–9 (*a*) and (*b*)].

Changes in electrophoretic patterns : [Figs. 5–9 (*a*) and (*b*)] Reference has already been made to the works of Cuthbertson (1942), Ligeti et al (1953), Berch and Jepson (1956).

Comparison of total and fractional Serum Proteins in Groups A & B and Group C.

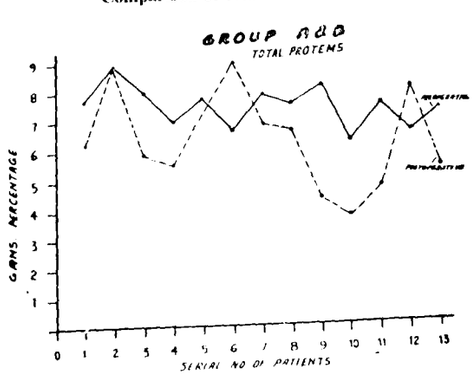


Fig. 5 (a)

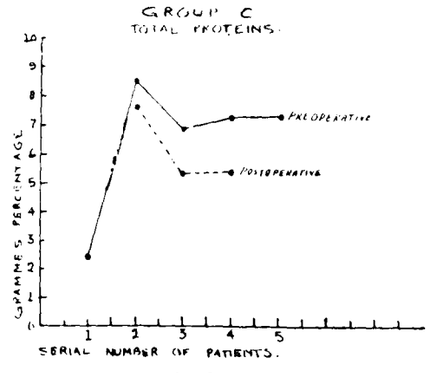


Fig. 5 (b)

Figs. 5 (a) & 5 (b) *Total serum proteins.* Post-operatively a fall occurs in a great majority in all groups.

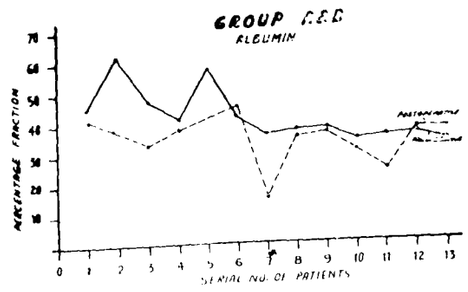


Fig. 6 (a)

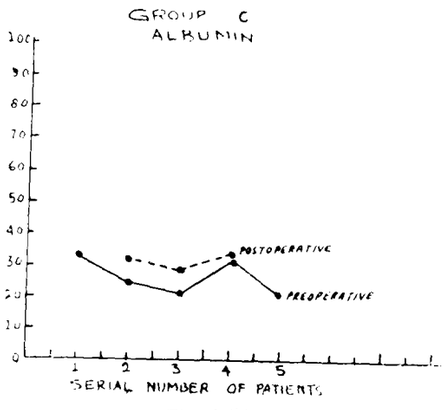


Fig. 6 (b)

Figs. 6 (a) & 6 (b) *Serum Albumin.* Post-operatively a fall occurs in most of cases of Groups A & B, while a rise occurs in Group C.

Comparison of total and fractional Serum Proteins in Groups A & B and Group C.

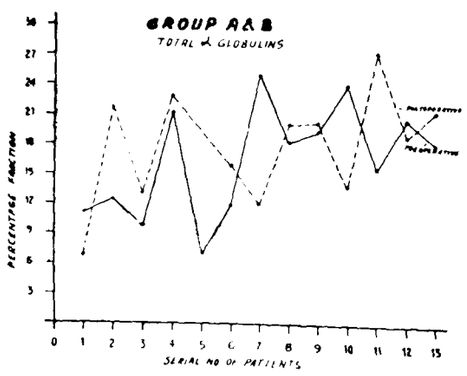


Fig. 7 (a)

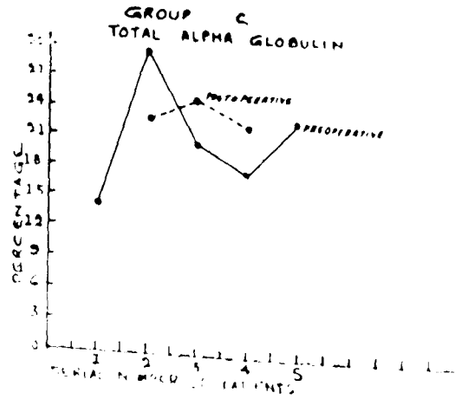


Fig. 7 (b)

Figs. 7 (a) & 7 (b) *Serum alpha globulin.* Post-operatively a rise occurs in a great majority in all the groups.

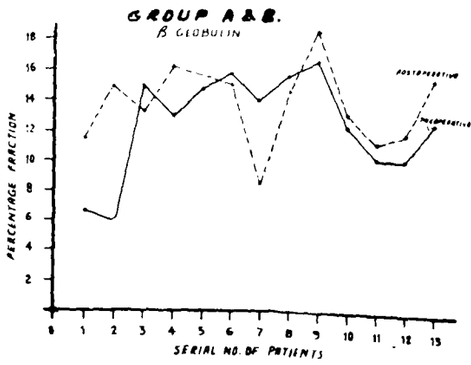


Fig. 8 (a)

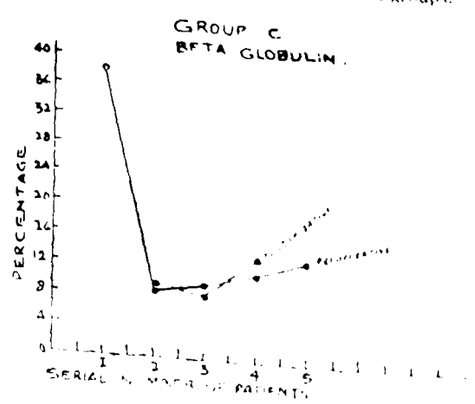


Fig. 8 (b)

Figs. 8 (a) & 8 (b) *Serum beta globulin.* A rise occurs post-operatively in all cases showing good wound healing and smooth convalescence irrespective of the group.

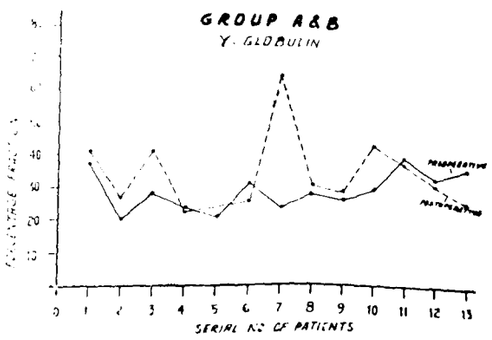


Fig. 9 (a)

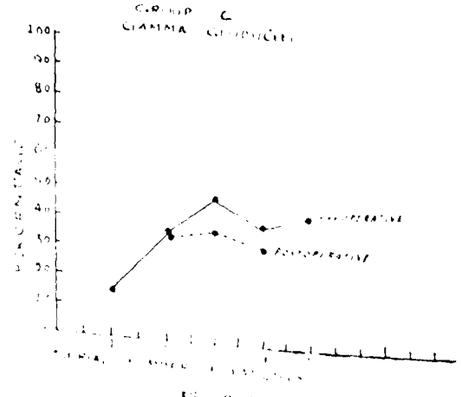


Fig. 9 (b)

Figs. 9 (a) & 9 (b) *Serum gamma globulin.* Post-operatively a rise occurs in a majority in Groups A & B while a fall occurs in Group C.

Our results show a fall in the albumin and a rise in the beta globulin fraction in well nourished individuals. Alpha globulin had shown a rise only in 50% of our cases. But when the pre-operative nutritional state of the patient is poor the fall in the albumin level does not take place. Instead of that, there is a rise in the albumin level and correspondingly there is a fall in the gamma globulin fraction. This reversal of the response in patients with poor nutritional state is in agreement with the findings of Wilkinson[11] et al (1950) that negative nitrogen balance may not occur in patients with little nitrogen reserve.

Ligeti, et al[8] were unable to observe the reversal of the phenomenon in their cases as the pre-operative level of albumin was between 68–47.8%. In the present series, however, the albumin level in group C is below 30%. It may, therefore, be inferred that in our group of patients the critical state of poor nitrogen reserve approaches when the albumin level is in the vicinity of 30%.

With smooth convalescence and proper wound healing the beta globulin fraction increases in the post-operative phase, but in case of infection and/or deterioration of the general condition of the patient, the beta globulin fraction decreases. This increase may partly be accounted for by an increase in the beta lipoproteins and the related anti-bodies.

Peters[9] (1946–47) advanced katabolic and anti-anabolic theories to explain the phenomenon; but Werner[12] (1946–47) rejected both these theories and suggests that there is no alternation in katabolism and anabolism except that they act at a higher rate of exchange and the equilibrium is attained at a higher level.

Ligeti, et al (1953) pointed towards the liver enzymes responsible for protein synthesis which may be decreased in the post-operative phase. Burnett and Cohen[3] (1955) have shown a decrease in the serum cholinesterase in the post-operative phase. Protein depletion experiments, by the Wisconsin group of workers (1950) have shown a decrease in the activity of the liver enzymes. But it is difficult to explain the reversal of the negative nitrogen response, when the nutritional state of the patient is poor, on this hypothesis.

Hormonal factors have also been incriminated. It is true that the operative injury acts as a stress, and also that the adrenocorticotrophic hormone of the pituitary and 11-oxycorticoid produce a negative nitrogen balance. But the experimental evidence that cortisone retards wound healing and that the adrenocortical steroids suppress the responsivity of the connective tissue to the substances issued by the injured tissues, do not reconcile the negative nitrogen balance with the natural tendency of the wound healing in the post-operative phase.

The true mechanism of the changes in the serum electrophoretic pattern following surgery is still unknown.

Summary

1. Total serum proteins and the electrophoretic analysis were done in five controls and eighteen patients.

2. The patients were divided in three groups according to their general health, and this classification corresponded to their serum albumin levels. An albumin level below 30% indicated a poor general health.

3. The patients who were normal or average normal in health and had smooth convalescence and good wound healing, showed post-operative serum electrophoretic pattern characterised by —

(i) Fall in albumin.

(ii) Increase in alpha, beta and gamma globulins.

4. The patients who were poor in general health, even when wound healing was good and convalescence smooth showed—

(i) Increase in albumin.

(ii) Increase in beta globulin.

(iii) Varying changes in alpha and decrease in gamma globulin.

5. A rise in beta globulin occurred in all cases showing good wound healing and smooth convalescence while it showed a fall when the wound healing was not proper or the convalescence not smooth.

6. A post-operative fall in the total serum proteins was observed in most cases.

7. Hypotheses explaining the mechanism of this phenomenon have been discussed.

Acknowledgement

We express our gratitude to Dr. B. Mukerji, Director, Central Drug Research Institute for allowing us to work in his Institute, and to Prof. S. C. Misra, F.R.C.S., and Dr. B. N. Sharma, M.S., F.R.C.S. for allowing us to to take up their cases. Thanks are due to Mr. B. N. Banerji for his technical help and to Mr. S. Banerji for the photographs.

BIBLIOGRAPHY

1. Baker, B. L. and Abrams, G. D.: The Physiology of connective tissue. Rev. Phy. M: 61 78, 1955.

2. Birch, D. A. and Jepson, R. P.: Micro-electrophoretic studies of plasma proteins in post-operative patients. British J. Surgery **43**: 467-473, 1956.

3. Burnett, W. and Cohen, Y.: Liver functions after surgery. British J. Anaesth. **27**: 66 72,1955

4. Campbell, R. M., Sharp, G., Boye, A. W. and Cuthbertson, D. P.: Cortisone and Metabolic response to injury. British J. Expt. Path. **35**: 566-575, 1954.

5. Cuthbertson, D. P.: Post Shock Metabolic Response. Lancet **1**: 433 436 1942.

6. Huges, W. L.: The proteins of Blood Plasma and Lymph. The Proteins, Vol. II, Part B. Ist Edn. New York, Academic Press Inc., Publishers: 706, 1954.

7. Osgood, C. K. and Favour, C. B.: The effect of adrenocortico-trophic Hormone on Inflammation due to Tuberculine Hypersensitivity and Turpentine and on circulating Antibody Level. J. Expt. Med. **94**: 415 430 1951

8. Tigeti, C. H. Irvin, K. and Sprinkle, F. P.: Investigation of serum protein patterns in patients undergoing operation. Proc. Soc. Exper. Biol. & Med. **34**: 707 710, 1953.

9. Peters, J. P.: Nitrogen Metabolism in Acute and chronic diseases. Ann. New York Acad. Sc. **47**: 327 342, 1946 47.

10. Spain, D. M. and Molomut, N.: Failure of Somatotrophic Hormone (S.T.H.) to counter act Cortisone action on wounds in Mice. Proc. Soc. Exper. Biol. & Med. **8**: 326, 1953

11. Swingle, W. W. and Kleinberg, W.: The pituitary and Adrenals. Am. Rev. Phy. **17**: 367 392, 1955.

12. Werner, S. C.: Discussion on Peter's paper. Amm. New York. Acad. Sc. **347**: 343 344, 1946 47.

13. Wieme, R. S.: La migration de l'hemoglobin additionne au serum humain lors de l'electrophorese sur papier. Experientia **9**: 380 381, 1953.

14. Wilkenson, A. W., Billing, H. H. Nagy, C. and Stewart, C. P.: Nitrogen metabolism after surgical operations. Lancet **1**: 533 35, 1950

Received for publication on 23-7-57

SURGERY IN STERILITY IN MEN*

BY

G. M. PHADKE, BOMBAY

Fertility is a joint responsibility and in a successful union, man is as responsible as the woman. It was only after the discovery by Huhner, of the absence of spermatozoa in a post-coital test, that a suspicion of some defect in man was raised, in a barren marriage. But he was not subjected to any investigation or treatment, due to his ego as well as the false notion that potency was a sign of fertility.

The husband's role in fertility is concerned with the production of a certain number of healthy spermatozoa, to carry them along the tubes from the testis to the urethra and deposit them in the region of the cervix. Thus any defect in (1) Sperm-production in the testis, or in (2) Sperm-transmission along the channels, or in (3) Sperm-deposition during coitus, is likely to result in sterility.

In the attempt to find out where the defect lies, clinical examination may reveal gross abnormalities in the external genitals or in the prostate. Evident clinical manifestations of hormonal deficiencies do not concern us here, as such patients do not seek advice for sterility. As a matter of fact, males attending a sterility clinic, are apparently healthy and active. They need further investigations in order to find out the defect.

1. *Defect in Sperm-production :* The Testis is the only organ in the body which produces spermatozoa. Gross defects in the gonad, such as small size, soft or flabby consistency can be recognized, but its minor abnormalities can not be diagnosed clinically. Although only one supermatozoon is needed to impregnate an ovum, a very large number, over 20 millions per c.c. of semen, is necessary for a successful union. In my opinion, a specimen of semen, having the following minimal characteristics, is a good one for impregnation.

Quantity	:	2 c.c.
No. of Sperms	:	20 millions per c.c.
Motility	:	50 per cent.
Abnormality	:	25 per cent.
pH	:	7.8.

* (*Paper read at the 18th meeting of the Association of Surgeons of India, at Indore, in December*, 1956.)

It is very essential to note that deficiency in one of these constituents is likely to be compensated by good quality in another. For example, a specimen with less than 20 millions of sperms per c.c. (Oligozoospermia) but with motility of more than 80 per cent or over, will produce pregnancy. An extreme degree of defective specimen is one, in which the number of sperms is nil (Azoospermia). Such a condition means that either the gonads are incapable of producing spermatozoa or if they are produced at all, some obstruction in the channels from the testis is present. It is not possible to state, which is which, in a given case, unless some gross abnormalities exist. In the absence of these, the only investigation to guide us is testicular biopsy.

Testicular Biopsy : This is a minor procedure, carried out under local anæsthesia. The cord is infiltrated with 5 to 10 c.c. of 1 per cent novocaine. The testis is grasped in the fingers of the left hand and the skin over its anterior aspect is stretched. This is infiltrated with the anæsthetic. A transverse incision $\frac{3}{4}$ of an inch long is made in the skin and is deepened, until the tunuca vaginalis is opened. The cut edges are either retracted with a self-retaining eye-lid retractors, or held apart with fine Allis's forceps. This exposes about one square cm. of the surface of the pearl-white tunica albugenea. An incision of half a c.m. is made through this, when the grayish looking and granular tubules of the testis will pout out into the wound. In case they do not, the incision is enlarged slightly and the testis is gently squeezed. The tubules may be coaxed out by gently pressing the surface of the gonad, by the sides of the incision through the tunica albugenea, with a blunt pointed instrument. The tubules, on no account, must be teased out with a needle or pulled out with a pair of forceps, as this will disrupt the delicate cellular pattern lining them. After enough material is seen in the wound, a portion about 3 by 3 m.m. of it is cut away with a fine pair of scissors and is gently rolled over the handle of a scalpel, to be transferred into Boin's fluid for fixation. Later on paraffin blocks are made, sections are taken and stained for miscroscopical study.

At times there is brisk hæmorrhage from the cut edges of the tunica albugenea. This will stop if pressure is applied for a few minutes. If not, the edges are approximated with a fine thread of linen or silk, on a delicate atraumatic curved needle. This always succeeds. I do not recommend, closing the wound in the tunica albugenea, as a rule. The substance of the testis does not pout out and I have seen this wound to have healed with a fine scar, at the time of the anastomosis operation carried out, in some, after a lapse of couple of months.

The wound is closed in the usual way. The scrotum is supported with a 'T' bandage and the patient is sent home, with instructions to take rest for the next couple of days. The stitches are removed after 48 hours, when he can resume his normal activities.

Post-operatively there is slight pain in the testis, which may radiate to the loin in an occassional case. A tablet of aspirin is all that is necessary on the first day. We never had to use stronger medication. In a series of over 400 testicular biopsies, I have had superficial haematoma only in three cases without any serious consequence. In none of our series, have we seen testicular atrophy nor any other complications. The patients are more nervous before the operation, but all of them agree that the pain and discomfort were far less than expected. The operation is truly a minor one. This procedure gives such a valuable information about the structure of the testis, that I always recommend it in a case of azoospermia.

Table I shows the various microscopical pictures met with in a series of 191 cases of azoospermia.

TABLE I

Normal Spermatogenesis	...	108
Germinal cell aplasia	...	26
Peritubular fibrosis	...	24
Spermatogenic arrest	...	22
Disorganization and sloughing of cells in the lumen of tubules.		11
Total	...	191

Normal spermatogenesis in the testis with azoospermia suggests obstruction in the channels from the testis to the urethra. Germinal cell aplasia is probably a congenital condition, in which the spermatogonia are absent and the tubules contain only the Sertoli cells. No treatment is available for this. Peritubular fibrosis is the result of toxins on the testis, as seen after an attack of small-pox, typhoid, mumps or any other infection. This condition is irreversible. Spermatogenic arrest and disorganization are probably due to hormonal imbalance and as such, cannot be improved by surgery. In oligozoospermia, the testis may show a normal or hypospermatogenesis after a biopsy. Such a condition may be due to interference with the nutrition of the gonad, as seen in varicocele. Correction of the latter is a logical conclusion. We have carried out a high ligation of the vein in the inguinal canal in five cases. In one the number of spermatozoa went up to 35 millions from 2 millions per c.c. of the semen. It remained at that level with improvement in motility and his wife became pregnant. There was a slight increase in the count of the second case, but the other three do not show any change for the better. The number of cases is too small for any definite conclusion. We intend to follow this line of action in some more cases.

Theoretically, a hydrocele may interfere with the blood supply of the testis or may destroy it by pressure. We are investigating such cases at present. But the general impression is that a patient with an idiopathic hydrocele, even bilateral, is not necessarily sterile. A large hydrocele, however, may interfere with the act of coitus.

Thus a defect in sperm production cannot be corrected by surgery, except in an occasional case of varicocele.

2. *Defect in Sperm transmission.* A normal spermatogenesis after a testicular biopsy with absence of sperms in the semen, suggests an obstruction somewhere in the passage. This may be in the rete testis, epididymis, vas, seminal vesicles or the prostate. The site of obstruction is found as follows.

The presence of pus cells in the semen after massage of the prostate, points to a lesion in that gland. The absence of fructose in semen is diagnostic of some defect in the seminal vesicles, as this is the only structure in the body, which secretes this carbo hydrate. An obstructive lesion in the scrotal portion of the vas or epididymis may be guessed, when, some nodule or an irregularity is evident on

clinical examination. At times the vas is absent congenitally, usually on both but, occasionally on one side. I have seen 12 cases, in whom it was absent on both sides and 4, where it was absent on one. In my experience such abnormal findings are rare. Even if they were present, final evidence of obstuction is confirmed at the time of an exploratory operation.

Lesions of the prostate, seminal vesicles, abdominal portion of the vas, and rete-testis, are not amenable to surgical correction so far. Thus we are left with the extra-abdominal portion of the vas and the epididymis. Fortunately obstructive lesions are present in these structures in the majority, and more so in the globus minor. This is indeed lucky, as surgical correction is possible by side-to-side anastomosis of the globus major above with the vas below.

No reliable information is obtained by epididymal puncture for presence of spermatozoa or by needling of the vas for patency, through the skin. Such blind procedures injure the structures and produce more harm than good. Similarly dilatation of the openings of the ejaculatory ducts through an urethroscope, is a bloody and clumsy operation. These investigations are mentioned only to be condemned. Having satisfied ourselves that an obstruction is present, an exploratory operation is advised.

Technique of the operation : All patients were operated upon under spinal anaesthesia lasting for about two hours. General or local may be employed if the surgeon prefers.

A scrotal incision, three inches long from the external abdominal ring downwards, is made. After the cremesteric fascia is cut open in the line of the skin incision, the cord is taken out. The vas along with its blood vessels is separated from other structures of the cord. It is isolated right up from the external abdominal ring to the globus minor, so that it can be easily approximated to the epididymis without tension. Great care is taken to handle the vas gently with fingers. Normal colour of the vas is pearl-white, but if it is chalky white, it is definitely abnormal, and suggests an obstruction in the intra-abdominal portion of it. The white colour is due to droplets of fat from dead and degenerated spermatozoa, accumulating above the seat of obstruction.

After this the testis is pushed up through the wound and the tunica vaginalis is opened near the epididymis to expose this structure. A careful search is made to find out any abnormality. In a genuine case of obstruction, the upper part of the epididymis will be swollen, is firmer in consistency and its dilated and tortuous tubules are easily visible through the tunica albugenea. There may be a nodule in the region of the globus minor or it may be shrunken, with the epididymis ending blindly above it. No time is wasted in trying to find out the cause of block, as it will be impossible to restore the continuity of the tiny tubules in this region. Our aim is to by-pass this by carrying out a side-to-side anastomosis between the epididymis above with the vas below.

At a suitable site in the upper part of the epididymis, a longitudinal incision 1/3rd of an inch long is made and is deepened. As soon as the tubules are cut open, some juice white or light brown in colour begins to flow out. This is collected on a glass slide, a cover slip is put on and is handed over to the anaesthetist for microscopical examination in the theatre, for the presence or absence or spermatozoa, incidentally noting their motility. If none are seen, the incision is deepened to cut open deeper tubules, and fluid is re-examined. Absence of sperms in the epididymis, suggests a block in the vasa-efferentia or in rete-testis. In such a case, no further exploration of the vas is done and the wound is closed. But the presence of sperms in the epididymis, demands investigation of the vas, for its patency, so that an anastomosis may be carried out.

A suitable portion of the vas which can be easily approximated with the epididymis, is grasped gently between the thumb and the index finger of the left hand. A transverse incision is made with a small knife through the exposed surface of the vas, just enough to cut open the anterior half of the tube to expose the tiny lumen. When this wound is opened out, the lumen is easily recognized as a small dot. (Fig. I-1 and 2). A fine hypodermic needle, size B.D. 26, is gently introduced into the lumen, and some sterile saline is injected down the vas towards the abdomen. If the lumen is patent, the material will flow in easily, but in the presence of a block, not even a drop can go in. If more force is used the fluid will regurtitate and at times the vas gets distended. Under such circumstances, no further operation is possible, and the wound is closed. In our experience this method of finding out the patency of the vas is very reliable. We do not like the idea of injecting

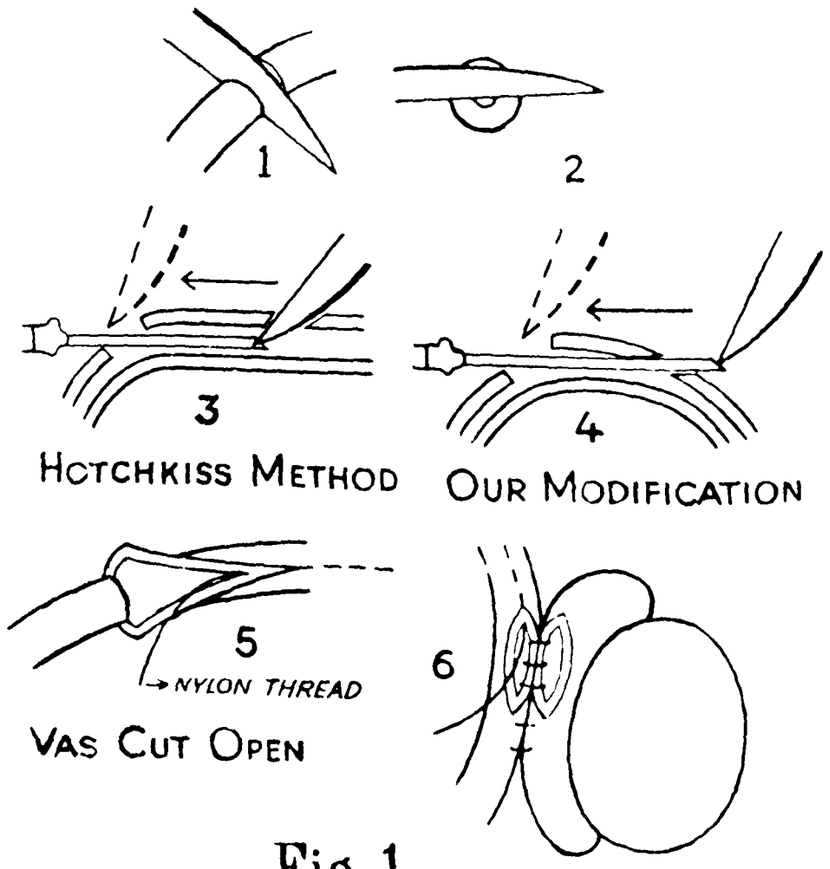


Fig. 1

some coloured material like methylene blue down the lumen and recovering it through an indwelling catheter in the bladder. The lumen of the vas is so tiny, that we do not wish to irritate it with any chemical for fear of closure later on.

Having ascertained the potency of the vas, it is to be opened longitudinally. After steadying it as before, Hotchkiss introduces the needle to a desired length down the lumen, about 1/3rd of an inch. An assistant thrusts the point of a knife through the wall of the vas and engages it into the bevel of the needle, a blind procedure indeed. (Fig. 1,-3). Once engaged the blade of the knife is pushed downwards along with the needle, towards the cut in the vas. (Fig. 1-3). We did not find it easy to engage the point of the knife, blindly. So we modified the method by pushing the needle through the wall at the desired length. It was an easy matter to engage the sharp instrument into the bevel of the exposed needle, to cut open the vas. (Fig. 1-4). This method prevents injury to the posterior portion of the tiny opening after the sides of the longitudinal incision are opened out, the portion of the vas looks like a funnel. (Fig. 1-5).

A fine nylon thread is introduced down the lumen for a short distance and is kept in position during the subsequent anastomosis, to prevent encroachment on the lumen by the stitches. The opened out portion of the vas is approximated to the longitudinal cut in the epididymis for a side-to-side union. Two stitches of linen are passed through the adjoining structures below the proposed anastomosis. (Fig. 1-6). These stitches not only hold the structures together but prevent tension on the

sutures at union. The sides of the openings in the vas and the epididymis are joined in two layers, a posterior and an anterior, with the help of interrupted stitches of 5/0 arterial silk on a fine straight needle. An atraumatic needle, straight or curved, will be better. Posterior edges are joined first. Usually three stitches in each layer are enough. The knots of the sutures are kept outside the opening. The nylon thread is removed before the last anterior stitch is tied. The tunica vaginalis is closed over the anastomotic site, and the parts are replaced into the scrotum. The wound is closed in different layers in the usual way.

A very important procedure throughout the operation is to prevent drying of the exposed parts. This is prevented by spraying sterile saline over the operation area by an assistant at intervals, as suggested by Bayle.

A similar procedure is carried out on the other side at the same sitting. It would be convenient for the surgeon to change the side. The scrotum is held against the perineum with sticking plaster or a 'T' bandage.

Bayle advises very fine 5/0 tantalum wire as a suturing material. We have used this in some, however, black silk 5/0 is very easy to handle and has given us satisfactory results.

Post-operative care is like that after any operation on the scrotum. The patient is kept in the hospital for a week. Strict rest in bed is very essential to prevent tension on the scrotum during the early period of repair. Antibiotics are used as measure of safety. No hormones or vitamins are given post-operatively. The patient is asked to report every two to three months to have the semen examined. Earliest time in our series, when the spermatozoa appeared in the semen, after the operation, was five weeks and the longest was eighteen months. Once they begin to be seen, their number gradually increases in the majority.

TABLE II

RESULTS

Number of cases explored ...	105
Epididymo-vasostomy done ...	85
Spermatozoa present in semen, after operation.	54
Resulting pregnancies in these 54 cases.	24

These 85 cases were reviewed by me before the second World Congress on Fertility and Sterility, at Naples (Italy) last year. There has been an increase in the number of patients who showed spermatozoa in the semen, as well as in the number of pregnancies since then. This is to be expected and as time goes on a few more successes will be seen.

The disparity between the number of cases with positive semen and the number of pregnancies, is due to the fact that many couples did not attend the clinic after the operation on men, to get defects in the other partner corrected. The sperm-density in those resulting in pregnancies varied from 5 to 130 millions per c.c.

One significant fact in those with positive semen after the operation, is the diminution or absence of motility of the spermatozoa in the ejaculates, even though they were very active, when recovered from the epididymis at the time of the operation. Apparently a factor, either in the seminal vesicles or in the prostate, is responsible. We have not been able to account for this. This explains the continuation of sterility in a few.

In three cases the semen became azoospermic again after being positive for 6 to 8 months. No apparent cause could be detected. It is possible that the lumen got blocked again. If no spermatozoa are seen in the semen, during a period of 18 months, after the operation, we consider it a failure and advise re-exploration. As a matter of fact patients are not willing for a second operation. We have done this in one case, a few months ago. The vas and epididymis had separated completely. Re-establishment of anastomosis was done after ascertaining that the epididymis did show spermatozoa and the vas was patent. Tantalum wire was used. Semen became positive after three months.

Another form of obstruction is after vasectomy carried out as a contraceptive measure. We have restored the lumen by a side-to-side anastomosis of the cut ends of the vas, in 5 cases. Three of them showed sperms in the semen and two of them have impregnated their wives. It is interesting to note that in one case the operation of vasectomy was done ten years previously. Testicular biopsy showed normal spermatogenesis before exploration. This incidentally disproves the theory that the seminiferous tubules get degenerated and, atrophy in due course to allow more room for

hyperplasia of the Leydig cells. Our findings of normal spermatogenesis in cases with congenitally absent vas, as well as those of obstructive azoospermia, disprove the above theory put forward by Steinach.

3. *Defect in Sperm-deposition :* Inability of the man to carry out normal intercourse results in faulty deposition of spermatozoa. In a very large majority of cases, impotence is psychic in origin. Treatment of this is not surgical, unless it is due to new growth or injury of the spinal cord. Physical examination will reveal the presence of hypo-spadias, epispadias, large hydrocele or thickened skin of the genitals due to filariasis. Such conditions will interfere with normal sexual act and prevent penetration. Treatment of these is surgical on appropriate lines.

Summary

(1) Man is equally responsible in a barren marriage.

(2) His role is concerned in production, transmission and deposition of healthy spermatozoa near the cervix.

(3) Defect in any one of these three phases will make the individual sterile.

(4) Diagnostic procedures are mentioned to find out where the abnormality exists.

(5) Surgical procedures to correct the defects in each phase are mentioned.

(6) Surgery is of doubtful value in defect of sperm-production, but is of definite value in that of sperm-transmission and in that of sperm-deposition.

(7) Details of the operative technique of epididymo-vasostomy with our results are given. This is the most commonly used surgical procedure in obstructive azoospermia.

REFERENCES

Bayle, H.: Press Med. **58**: 276, 1950.

Bayle, H.: Proc. Soc. Study Fertil. **4**: 30, 1952.

Bayle, H.: Personal communication.

Hotchkiss, R. S.: "Fertility in men." Henman, London, 1945.

Hotchkiss R. S.: Reflections upon Fertility in men. Jl. of Urology, **59**: 149-153, 1948.

Hotchkiss, R. S.: Personal communication.

Received for publication on 13-8-57.

INTRACARDIAC SURGERY UNDER HYPOTHERMIA

An Experimental Study

BY

PRITAM DAS, LUCKNOW

Operations under hypothermia, particularly those on the heart are now becoming increasingly common in many clinics abroad. The main underlying principle is, that under hypothermic conditions the body metabolism gets lowered and the oxygen requirements are reduced to such low levels that the sensitive tissues like the cerebral cells can be deprived of their blood supply for ten to fifteen minutes so that the circulation can be brought to a standstill without prejudice to the recovery of these cells. The reduced metabolism is completely reversible and no oxygen debt is incurred by the tissues during cessation of circulation (Bigelow et al, 1950).

The present study was undertaken on dogs to get familiar with the technique of intracardiac operations under hypothermia and to assess its safety. The technique employed for anaesthesia and operation was kept similar to the one likely to be used during operations on human beings. Observations regarding pulse, respiration, blood-pressure, temperature and cardiac behaviour were made during the operations. In a somewhat similar study Swan et al (1953) found significant changes in the serum potassium, the blood pH and the blood Co_2 content, and they correlated some of the changes in their values with the occurrence of ventricular fibrillation. An estimation of these values was also done in this study.

Simultaneously another study on operations with azygos flow was being carried out at normal temperature, a reference to it is occasionally made in this paper for comparison of conditions under hypothermia with those at normal temperature.

Technique of Anaesthesia and Hypothermia :

The dogs were cooled by immersing them in ice cold water. The dogs (weighing from 8 to 15 kg.) were first shaved on their back, chest and abdomen. They were then induced with ether. Induction was usually quick and the dogs were under anaesthesia in less than five minutes. An endotracheal cuff tube was next passed and connected to an Oxford Vaporisor through which pure oxygen was delivered. The femoral vein was then exposed below the inguinal ligament, and a polythene tube 14 c.m. long was passed up the vein into the inferior vena cava. This was used for intravenous saline drip and for administration of sodium pentothal. Soon after canulation one to two c.c. of $2\frac{1}{2}\%$ solution of pentothal was given. The pluse, rectal temperature, and respiration were recorded and blood samples were collected. Two c.c. of pentothal were administered again and the dog was dipped in ice cold water (4 c) in a tub. When the body temperature fell to 32 c. the endotracheal tube was connected with a pump respirator, giving a respiratory rate of 46 min., and a volume of 200 c.c. of oxygen per stroke. The volume delivered per stroke of the pump was reduced to 150 c.c. in smaller dogs. The animal was kept in cold water till the temperature fell to the required level, which varied between 29° and 25 c. The cuff on the endotracheal tube was kept deflated and the expired air escaped out partly by the side of the endotracheal tube and partly via the tube through the Y-arrangement into the outlet of the pump respirator (Fig. 1). Carbondioxide absorbing arrangement was not used.

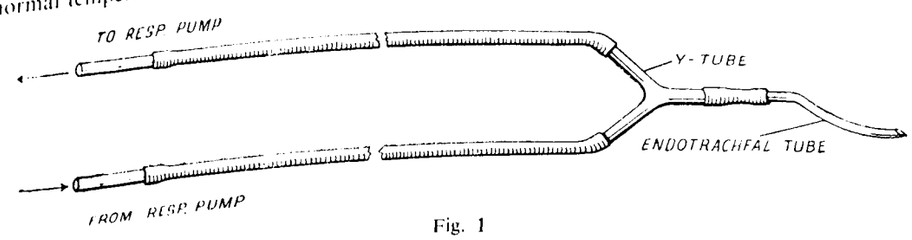


Fig. 1

Showing the Y—arrangemen for connecting the endotracheal tube with the respirator pump.

The animal was then taken out of cold water and its body surface was dried with a towel. The temperature of the animal fell further after removal from the tub and, thereafter it remained more or less steady showing only a slight rise during the latter part of the operation. During the operation it was observed occasionally that the lung expansion became poor inspite of the pump respirator. The respiratory excursion could be improved to any desired level by inflating the cuff around the endotracheal tube. In this study the pump respirator was not stopped during cessation of circulation as practised by Swan et al (1953). Before closing the chest the lungs were made to expand fully by inflating the cuff around the endotracheal tube, and were kept so throughout the period of closure and for some time afterwards. Aspiration of the chest was performed by means of a catheter passed into the pleural cavity for ten minutes after closure. The chest having been closed the animal was immersed in warm water (45 c.) As the animal warmed up to about 28 c. to 32 c. spontaneous respiration returned and so the pump respirator was disconnected. The animal was removed from the warm bath when its body temperature returned to 36 c

On an average it was not found necessary to give any more anaesthetic drugs except the initial dose. But occasionally when there was shivering during cooling or diaphragmatic spasm during the operation, a further dose of 1 to 2 c.c. of sodium pentothal was given. In all 6 to 8 c.c. of pentothal were necessary. No other drugs such as pre-medication drugs, procaine or drugs having effect on myocardium were given. However about 300 c.c. of normal saline solution was administered by slow drip throughout the procedure, partly to keep the intravenous canula open, and partly to replace the loss of water and blood during operation. Moreover, the administration of saline simulated conditions that are likely to be present clinically.

Technique of operation

The chest was opened through the right fourth intercostal space. The bleeding from the skin incision was more than is usually observed from an incision at normal temperature. The heart was found to be smaller than it would be at normal temperature. It was slow and steady with no irregularities. The pericardium was found covering the heart loosely. The two vena cavae appeared less tense and smaller in calibre

The upper lobe of the right lung was retracted downwards and the superior vena cava exposed. The pleura first on its lateral side and then on its medial side was incised, the phrenic nerve was separated from its surface and a rubber tape was loosely passed twice around it. The same was done to the vena azygos a little proximal to its junction with the superior vena cava. The phrenic nerve was then separated from the surface of the inferior vena cava and a rubber tape was passed around it also.

Two stay sutures were now passed in the pericardium, a little anterior to the site of entrance of inferior vena cava and the pericardium was incised vertically between them. The incision was carried vertically upwards where the superior vena cava enters the pericardium and another couple of stay sutures were applied there on either side of the incision. Two transverse incisions were then made towards the midline from either end of this vertical pericardial incision, thus raising a rectangular flap of the pericardium towards the sternum.

Circulation through the heart was then stopped by tightening the tapes around the three veins (Fig. 2). First the tapes around the superior vena cava and the vena azygos were tightened. This resulted in a minimal reduction in the size of the heart and slight if any, lowering of the pulse rate. Forty five seconds later the tape around the inferior vena cava was also tightened. This caused slowing of the heart rate, and the chambers of the right atrium and ventricle collapsed. The heart became much smaller in size, and it could be seen that during diastole the heart wall dented considerably inwards, instead of distending outwards. However the heart beat remained regular.

Two stay sutures were then applied on the anterior aspect of the right atrium and it was incised between them (Fig. 2). The atrium was incised for about an inch and a half and its cavity laid wide open. A blood vessel was found running on the anterior surface of the lower part of the atrium and had to be cut across in making the incision. In most cases the atrium was found almost empty except for a negligible amount of blood flowing in from the coronary sinus. The inside of the chamber was inspected and the various landmarks

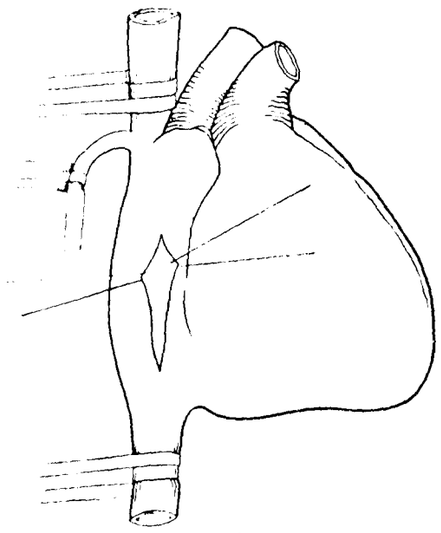


Fig. 2.

Showing rubber tapes passed twice around the Superior vena cava, the Azygos vein and the inferior vena cava. The atrium has been incised widely and stay sutures are seen keeping the wound margin apart.

noted. The tricuspid valve was visualised and its working observed. The tricuspid ring opened out during diastole while during systole the ring became smaller and the bases of the leaflets could be seen bulging towards the atrium. The atrium was then explored with the index finger. The passage of the finger through the tricuspid orifice caused irregularity of the cardiac rhythm and invariably resulted in slowing of the heart which took some time to recover, or which, in some cases, was the starting point for some more serious cardiac irregularity. Therefore the introduction of the finger into the tricuspid ring was avoided in later cases.

The atrium was kept open for about eight minutes after which stitching was started at the lower end of the incision. A continuous running suture of 4/0 or 5/0 arterial silk was quickly applied in most of the area except the upper part which was kept widely open (Fig. 3). while the superior vena cava was released ten minutes forty-five seconds after its occlusion (ten minutes after occlusion of inferior vena cava). The blood from the superior vena cava filled the atrium expelling the air out through the upper part of the atrial incision which was kept open for this purpose. Some blood was also allowed to be expelled out to make sure that no air remains inside the atrium. This method was adopted in place of rapidly filling the atrium with saline because it was found that the saline disappeared into the ventricle as soon as it was poured into the atrium and also because a clamp had to be applied to close the artial incision. The clamp is likely to crush, however slightly, the atrial wall. The remaining part of the atrial incision was then closed and the inferior vena cava was released. Another layer of continuous everting sutures was then applied over the previous running suture to ensure safety against leakage of blood from suture line of the atrium.

The release of the vena cavae quickened the heart rate, the atrium appeared bluish in colour for a few seconds but returned to normal colour soon after. No irregularities of the heart were usually observed.

The pericardium was loosely stitched by interrupted sutures leaving sufficient space between the stitches. The pleural cavity was

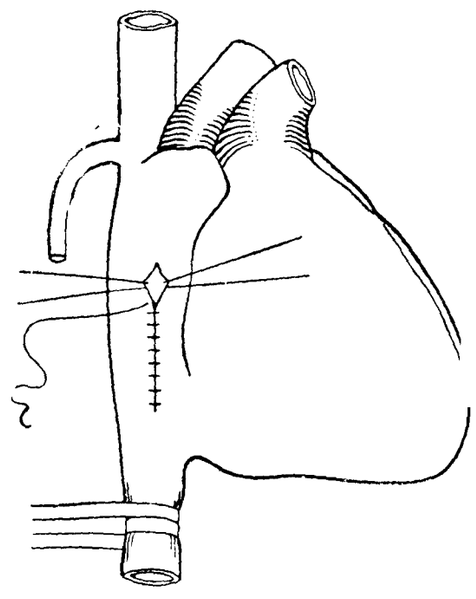


Fig. 3

Showing the technique of avoiding air embolism. The atrial wound has been stitched except for the upper most part which is held widely open. The superior vena cava is shown to be released. The blood from superior vena cava fills the atrium and expels the air out of the atrium.

cleared of any blood. The retracted lung was allowed to expand fully and the chest was closed by first passing one or two pericostal sutures of thick linen thread (size 20), and then a continuous suture of fine linen (size 70) was applied through the incised intercostal muscles. Penicillin powder was left inside the chest cavity and the muscles were stitched in separate layers by continuous linen sutures. The platysma and skin were then stitched.

Post-operative : After about two hours of rewarming, the dogs could be seen struggling to get up, and stood up without help. Usually they remained dull for thirty-six to forty-eight hours after the operation, and then gradually brightened up. They were given milk from the next day after the operation and after a few days were put on a meat and chappaty diet. Procaine Penicillin 200,000 units and half a gramme of streptomycin were given by intramuscular injection once daily for four days, and thereafter half this dose was given for the next three days.

Mortality and Survival

Nineteen dogs were operated on as described above and in them the duration of cessation of circulation was from ten to twelve minutes only. Of these, two dogs died on the table, and the rest survived the operation. Of those who survived, one died a few hours later, some time in the night. The remaining sixteen animals survived for a longer period. Thus three of the animals could be taken to have died as a result of the operation. The first of these (Dog 32) died, in all probability, due to blockage of endotracheal tube and thus to lack of adequate oxygenation. During the operation he developed ventricular fibrillation soon after occlusion of the vena cavae and application of stay sutures on the atrium. The vena cavae were immediately released and the heart was defibrillated and normal rhythm was restored by cardiac massage. Ten minutes later occlusion was tried again and intracardiac manipulations were carried out. Ventricular fibrillation developed a second time soon after the circulation had been restored and the second layer of sutures was being applied to the atrial incision. The normal rhythm was restored a second time but the heart beat became gradually feebler and the heart stopped. It was realised very late that respiratory excursions were almost nil. On checking up the tubes it was found that the endotracheal tube was blocked with mucus. The second dog (Dog 44) died during the operation due to cardiac standstill a little before the release of inferior vena cava. The heart had slowed down to 20 mm. during cessation of circulation and on release of superior vena cava it stopped in diastole. Cardiac massage was carried out after release of the inferior vena cava. This led to ventricular fibrillation. It was then defibrillated and a slow feeble beat was restored but it gradually became worse. The third dog died some hours after the operation. This occurred in the case in which blood pressure recordings were made on a moving drum. The experiment not prolonged till late in the evening, the blood pressure had fallen below zero during occlusion so that some concentrated citrate solution went into the aorta. The expansion of the lung also could not be achieved fully after the operation, nor could the chest be evacuated completely of its blood and air because of breakdown in suction machine. Post-mortem examination of the animal showed a fair amount of blood in the chest, atelectatic condition of the right lung and a line of construction on the heart. This will be discussed later in connection with the pericardial suturing. In this way a number of factors like inflow of citrate solution into circulation, the atelectasis of lung and faulty stitching of pericardium led to his death. Thus of the two deaths on the table one was avoidable, and the dog who died some hours later could also have survived.

The remaining sixteen dogs did very well from all points of view. During the post-operative period the animals operated on under hypothermia appeared to have lost more weight than those operated on at normal temperature, and they took a few days longer to pick up normal appearance. Otherwise they showed no detectable sign of nervous or physical disorder. They were usually quite active and smart by the third day of operation. Of the 16 survivors, one (Dog 33) died on the fifth day, another (Dog 35) on the seventeenth day and a third (Dog 34) on the 22nd day after the operation. They looked dull and sank gradually over a few days before death. On post-mortem examination the right pleural cavity was found to contain a fair amount of seropurulent fluid, so that they died due to infection and no other reason could be ascribed for their death. Dog 26 was sacrificed seventeen days after the operation and Dog 30 four weeks after due to lack of space. The remaining eleven dogs are still alive at the time of reporting three to six weeks after the operation.

The condition of the heart on post-mortem examination showed the pericardium to be adherent to the heart in the region of the stitch line. The adhesions were thin, whitish in colour and could be separated easily. Before getting fully separated the adhesions stretched like plastic material. On the outer surface the atrial suture line was covered with whitish fibrinous material, the stitches being visible through it. On the endocardial surface the stitches were not visible and the area was covered with smooth shining endocardium. Occasionally a small patch of purplish colour was seen on the endocardium adjacent to the suture line. The heart wound had healed firmly in all cases.

Physiological Data

Temperature : The temperature was measured by inserting a chemical thermometer about six inches into the rectum, and care was taken that the water from the bath did not enter the rectum. The smaller dogs displayed a fall in temperature only a little after being dipped in cold water, while the larger ones took about five minutes. The rate of fall of temperature varied from 1 C in 1.88 minutes to 1 C in 4.6 minutes. The time taken for cooling varied from 17 minutes which was the shortest time taken by a small dog, to sixty minutes which was the maximum taken to produce a fall of 13 C in the temperature of a large sized animal. The time taken for cooling, and the rate of cooling, appeared to vary with the size of the dog, the amount of ice used, the initial temperature of the dog and the external atmospheric temperature. Smaller dogs took lesser time than the larger ones. Majority of dogs were cooled to 26 C before they were taken out of the cold water, two were cooled to 29 C and three to 28 C. The body temperature fell further after they had been taken out of the tub. This fall varied rather widely from 1 C in four dogs to 7 C in three dogs, the majority showing a fall of 2 to 3 C. The time taken for this lowering of temperature also varied widely. Usually the fall started within two to three minutes after the animal was removed from the tub and the maximum fall reached at varying intervals of five to fifteen minutes. One dog continued to show a very slow gradual fall of temperature for half an hour. The fall in temperature was maintained for quite some time and usually lasted for the duration of the operation, and it was unusual for the body temperature at the end of the operation to be higher than what it was before it.

The body temperature during rewarming also rose gradually and the rate of rewarming varied from 1 C in 2.6 minutes to 1 C in 7 minutes. The time taken to bring the body temperature to 36 C varied from 13 minutes to 75 minutes. Figs. 4 and 5 give graphic account of the changes occurring in body temperature during the entire procedure.

Pulse : (Figs. 4, and 6). The pulse showed quick and marked fall. The fall was almost precipitous. It fell immediately after dipping the animal in cold water and was observed even before a fall in rectal temperature was recorded. Some showed a more gradual

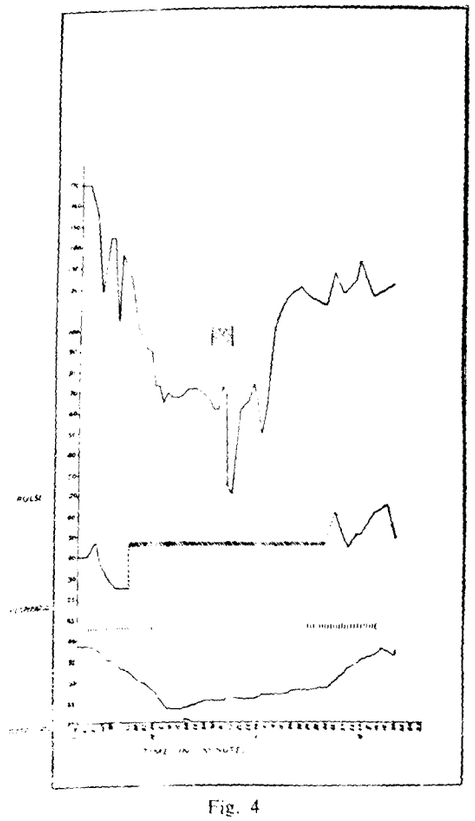


Fig. 4

Showing the pulse, respiration, and temperature charts of an average case. The cross hatched area in the pulse chart indicates the period of occlusion. The cross hatched shading in the respiration chart shows the period when the respiratory pump was connected to the endotracheal tube. The vertically shaded area over the temperature chart indicates the period of cooling on the left hand side and period of rewarming on the right side.

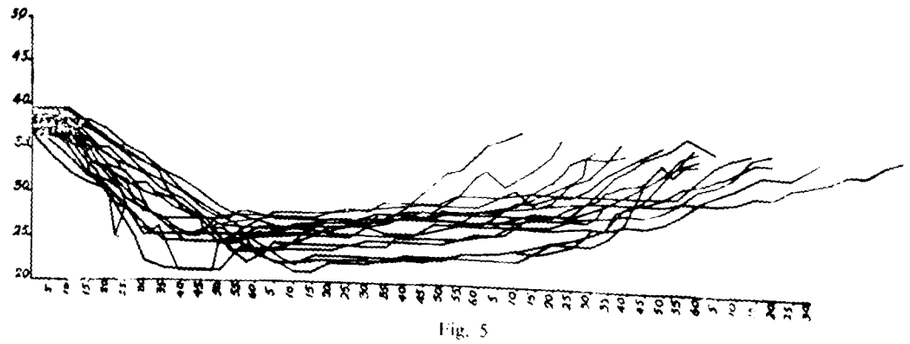


Fig. 5

Showing the temperature chart of 17 dogs drawn in one composite diagram. The general pattern of different animals is about the same. The abscissa is time in minutes and the ordinate temperature in degrees centigrades.

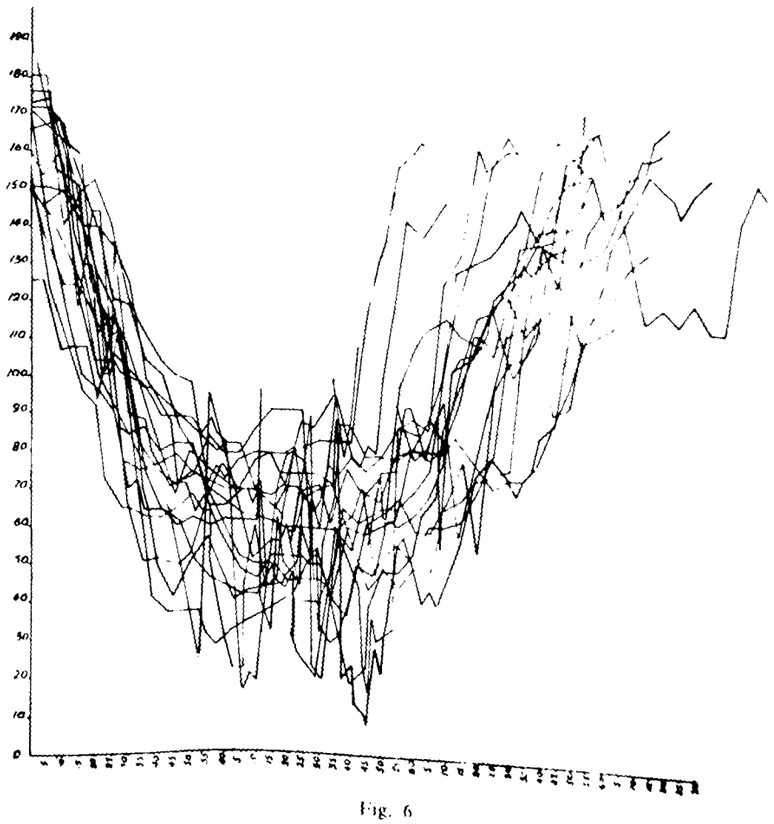


Fig. 6

Showing composite pulse chart of 16 dogs during the entire procedure. Abscissa is time in minutes and the ordinate indicates the pulse rate per minute.

fall. It is generally accepted that the slowing of pulse is due to direct action of cold on sinoauricular node. Another phenomenon noted was a temporary stabilisation or even an upward trend in the pulse rate for two to three minutes after a sharp fall. This stabilisation is in all probability due to adrenaline release as a part of hormonal response to cold. The adrenaline having an effect of increasing the pulse rate acted in a manner contradictory to the effect of cold. The fall in pulse rate continued till the animal was removed from cold water. In the beginning the fall of pulse was rather rapid, *viz.* an average of 16 in the first five minutes, although two dogs showed no fall of pulse in this period. In the next five minutes the fall was even more marked, an average of 23 in five minutes. Subsequently the fall became less marked being 11.6 and 12.5 in the next two instalments of five minutes each. The total fall of pulse during cooling ranged from 60 to 134, the average being 86.7. The average rate of fall per minute was 2.85. The fall was more rapid till the body temperature reached 30 C, thereafter it was more gradual. Comparing the fall of pulse with the fall in temperature, the pulse on an average fell by 7.7 for every degree of fall in temperature.

During the rewarming period the pulse rose equally rapidly. The total rise varied in different dogs from 20 to 112 and in about 30 to 45 minutes it reached the pre-cooling level. The average increase of pulse per minute was 1.93 and average rise per degree rise of temperature was 8.26.

During the operation, from skin incision to its closure the pulse fell in five dogs by 10 to 48, while in twelve other cases it rose by 4 to 42.

The pulse rate during occlusion of circulation and the period shortly afterwards will be discussed later.

Respiration : (Figs. 4 and 7). Respiration was recorded frequently. The pump respirator was connected to the endotracheal tube when the temperature fell to 32 C. This procedure was adopted because the repiratory rate had fallen by about one-third of the original by that time. The actual fall in respiratory rate during this period varied from 4 to 30 and one animal showed a rise of respiratory rate instead of its lowering.

On rewarming spontaneous respiration returned at 28 to 32 C. The rate of spontaneous respiration now was usually much higher than in the pre-cooling period. It was shallow and varied from 40 to 80 per minute. The respiratory rate usually increased on further rewarming and shot up to much higher levels than normal (Fig. 7). This continued for some time after the temperature had been restored to normal. This marked increase in respiratory rate could indicate Co_2 retention during hypothermia. It will be seen later that Co_2 content of blood, a minute after release of circulation was not much, therefore it can be presumed that the rise in respiratory rate was not in response to acidosis. During rewarming it was observed that if warm water was poured directly on the body of the animal,

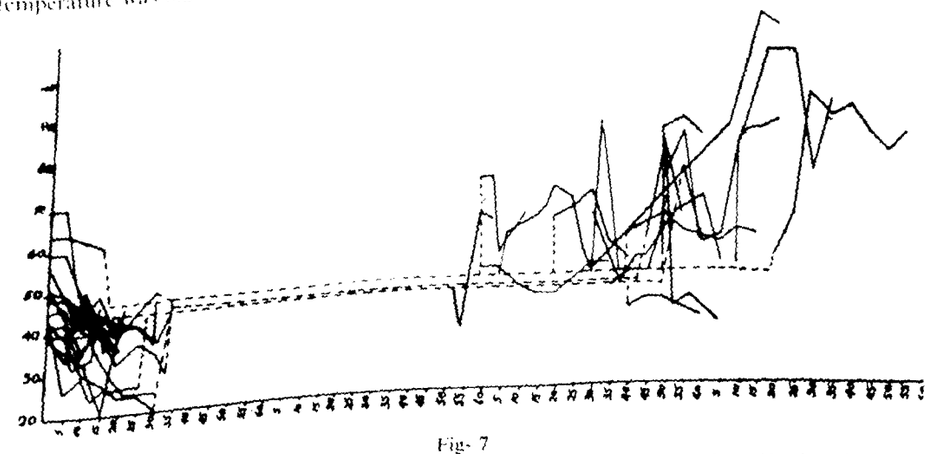


Fig. 7

Showing composite respiratory rate chart of 16 dogs. The dotted line represents the artificial respiration.

the respiration quickened immediately. The same could be observed by adding hot water to the bath. This indicates that the rapid rate of respiration observed during and after rewarming is due to the stimulus provided by the heat, the phenomenon being explainable in the same way as the panting of dogs in hot weather.

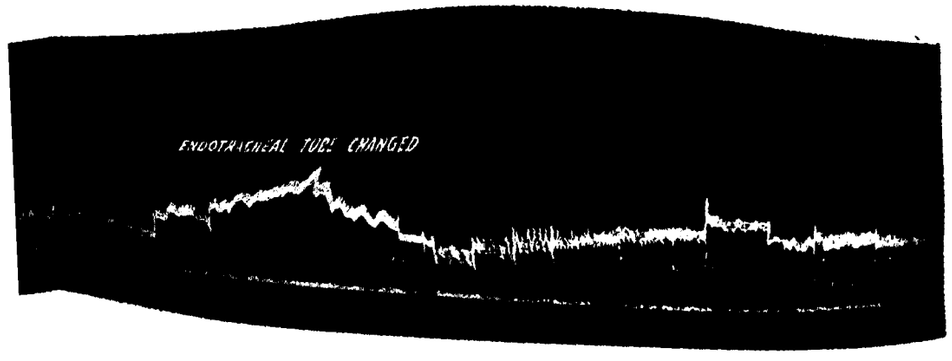
Blood pressure : Blood pressure was recorded in two cases. For this purpose the femoral artery was canulated and connected to a mercury manometer and the tracings were recorded on a moving drum. It will be seen in Fig. 8, that the blood pressure fell very gradually during cooling and appeared to be well sustained. The total fall of blood pressure during cooling was from 110 m.m. to 65 m.m. of mercury. This sustained maintenence of blood pressure is, in all probability, due to vasoconstriction and hormonal responses excited by cold.

When the superior vena cava alone was occluded, there was only a slight fall of blood pressure, but the occlusion of inferior vena cava caused a precipitous fall till it fell below the base line. At that time the citrate solution could be seen moving through the canula into the artery indicating a negative pressure in the aorta. Incision of the atrium made no difference to the blood pressure level. At the end of occlusion period, when the superior vena cava was released, there was a slight rise, while the release of inferior vena cava caused a marked rise of blood pressure, and to a level even higher than the pre-cooling level. The curve then showed a slight gradual decline.

During the rewarming period, the rise in blood pressure was again very gradual. The examination of the curve shows another interesting phenomenon of the effect of Co_2 retention on the blood pressure. At the place indicated on the chart the endotracheal tube was found to be blocked, it was cleaned and replaced. During this period there was no respiration, and the blood pressure showed quite a marked rise.

Biochemical changes

The biochemical determinations made in these experiments were serum potassium, Co_2 content of blood and the blood pH. The potassium was tested by sodium cobalt nitrate method and colorimetry was done on Lumetron photoelectric colorimeter (Model 400-A, Photovolt Corporation, New York). The various steps followed in the process were according to the booklet provided with the colorimeter. The Co_2 estimations were done on Haldane's Blood Gas analysis apparatus by Volumetric method. The Co_2 was evolved by tartaric acid. The pH of the blood was tested by Cambridge Bench pH-meter.



Showing the blood pressure tracing taken in one of the experiments. On the left hand side the various temperature at which the blood pressure was taken during cooling are marked. At SVC and IVC the veins were being cleaned and tapes passed around them. At SVC the superior vena cava and at IVC the inferior vena cava were occluded. Furthur on the right the same letters indicate the release of these vessels. The temperature markings at the extreme right hand side of the chart indicate the temperatures at which B. P. was recorded during rewarming.

Thereafter it became apparent as to why the conditions of the experiments

Serum Potassium : Serum potassium was estimated in 15 cases. In eight of them, only two determinations each were made, one before cooling and the other at the end of the cooling period. In the other seven cases serum potassium was estimated in four samples of blood from each dog. (1) the control sample was taken after the dog had been anesthetised and the femoral vein had been canulated, (2) the second sample was taken after the chest had been opened, one minute before the occlusion of circulation. This sample was collected from the inferior vena cava directly by piercing it with a hypodermic needle above the diaphragm, (3) the third sample was collected in the same way nine minutes after occlusion of circulation, that is, one minute before the vena cavae were released, (4) the fourth sample was collected two minutes after the release of circulation. This was also collected from the inferior vena cava above the diaphragm. This procedure of collecting the blood from the inferior vena cava above the diaphragm was adopted because the canula in the femoral vein occasionally got blocked, and since a number of samples had to be taken for different determinations, difficulty was encountered in obtaining sufficient amount of blood via the femoral canula.

Tables I and II show the results of these estimations. It will be observed that the serum potassium gets consistently lowered during cooling under the conditions of the experiment. The average fall in the serum potassium was 6.32 mg. per 100 c.c. Most of the dogs showed a slight rise of serum potassium two minutes after release of circulation as compared to the pre-occlusion level.

TABLE I

Showing Serum Potassium levels in Mgs./100 c.c. as observed during the operations. Dogs cooled, Hyperventilated and saline drip given

S. No.	Dog number	Control normal temperature 37-39° C.	After cooling, one minute before occlusion temperature 22-26° C.	Nine minutes after occlusion of circulation temperature 25-27°C.	Two minutes after release of circulation temperature 25-27°C.	Ventricular fibrillation
1					...	No
2	26	32	24	...	...	No
3	30	14.2	10.5	...	...	No
4	31	24.1	18.6	...	...	Yes
5	32	24.1	18.6	...	...	Yes
6	33	24.3	21.0	...	...	No
7	34	31.8	23.5	...	...	No
8	42	29.81	21.9	...	...	Yes
9	44	24.45	18.45	...	13.82	No
10	46	18.0	14.4	14.8	...	No
11	48	15.9	13.5	13.62	33.45	Yes
12	51	37.175	18.00	18.77	36.0	No.
	56	35.4	30.15	30.22		

TABLE II

Showing Serum Potassium levels in Mgs./100 c.c. as observed during three operations with dogs cooled, hyperventilated but no saline drip was given

S. No.	Dog number	Control normal temperature 37–39°c.	After cooling one minute before occlusion temperature 22–26°C.	Nine minutes after occlusion of circulation temperature 25–27°C.	Two minutes after release of circulation temperature 25–27°C.	Ventricular fibrillation
1	57	38.10	29.40	26.55	30.00	No
2	58	18.15	15.10	16.65	26.03	No
3	59	17.7	17.875	16.50	17.10	No

The relation of serum potassium to the occurrence of ventricular fibrillation has been discussed by Swan et al (1953). In this study there appears to be no positive relationship between the two. Firstly the lowering of serum potassium occurs in all cases while ventricular fibrillation does not always occur. In this series fibrillation occurred in dogs whose lowest serum potassium were 18.6, 21.00, 18.45 and 18.0 mg. percent. On the other hand fibrillation did not occur in dogs in whom the serum potassium had fallen to even lower levels such as 10.5, 13.5 or 14.4 mg. percent.

Carbon Di-oxide content of blood : This was estimated in eight cases, five were such in which drip of saline had been given continuously and in the other three it was not given. Samples of blood were collected at the same time as for serum potassium. The blood was collected in oxalated tubes under liquid paraffin.

Table III gives the values obtained in the five dogs in whom saline drip was given. It will be observed that the level of Co_2 in blood at normal temperature is lower than the standard normal figures. The reason appeared to be that the experiments were conducted in hot summer months when the dogs were panting and their respiratory rate ranged between fifty and sixty per minute. Another anomaly apparent in the table is that the Co_2 content of blood after nine minutes of occlusion of the vena cavae is lower than in the blood collected before the occlusion. During the period of occlusion the blood flow is at a standstill and there is no reason why the Co_2 should get reduced in blood during this period. The explanation of this anomaly remained obscure till an accident happened in one of the experiments. It had been the routine to keep the intravenous saline running throughout the period of experiment at a slow rate of 20 to 30 drops per minute unless of course the canula got partially or completely blocked. In Dog No. 56 by oversight the saline drip had been running in a stream during the period of occlusion. After nine minutes of occlusion when the blood was withdrawn from the inferior vena cava above the diaphragm, it was a great surprise to find that the sample withdrawn was almost a clear colourless fluid. This appeared unbelievable, so another sample was withdrawn after inserting the needle afresh and after confirming that the needle was in the inferior vena cava and not outside it. A similar fluid was obtained, and a third attempt resulted in the same saline-like material being withdrawn. In all about four cc. of the fluid were removed. In searching for a cause, it was found that the saline was running into the vein in full stream. In all probability the saline had been accumulating in the inferior vena cava during the period of occlusion. However it is still a matter of great surprise as to how the saline completely replaced the blood in the inferior vena cava.

Thereafter it became apparent as to why the Co_2 content of blood taken 9 minutes after occlusion was lower than before occlusion. It was because the blood in inferior vena cava got diluted with saline during the period. Therefore to get a correct picture no saline drip was given in the next three experiments. The results obtained are given in Table IV. It will be observed here that : (i) there is a slight increase of blood Co_2 during cooling. The increase is very small but it was so under the conditions of the experiments. In all probability it may be due to the fact that the rate of the pump respirator was lower than the initial respiratory rate. (ii) The Co_2 content increased slightly during occlusion. During this period there is no flow of blood so that the Co_2 remains locked up in the tissues. It may be that some blood finds its way from the tissues into the inferior vena cava or may be that some lymph laden with metabolites has been added to the blood during this period. (iii) The Co_2

TABLE III

Showing Blood Co_2 Content. Ml 100 c.c. (N.T.P.) as observed during operations. Dogs cooled, hyperventilated and saline drip given

S. No.	Dog number	Control temperature 37–39 C.	One minute before occlusion of circulation temperature 22–25 C.	Nine minutes after occlusion of circulation	Two minutes after release
1	46	43.9	45.7	47.5	54.5
2	48	35.17	50.12	44.84	52.2
3	50	38.7	47.48	32.53	48.3
4	51	41.5	51.88	44.84	49.9
5	52	39.54	38.7	43.03	46.6

TABLE IV

Showing Blood Co_2 Content in Ml/100 c.c. Dogs cooled, hyperventilated, no saline drip was given

S. No.	Dog number	Control	One minute before occlusion of circulation	Nine minutes after occlusion	Sixty seconds after release
1	57	41.32	43.96	48.37	51.88
2	58	40.6	40.6	44.12	47.64
3	59	43.3	48.62	49.5	53.00

content of blood collected one minute after release of circulation is always higher than at other times. It should be so and indicates that tissues have been respiring during the period of cessation of circulation and the Co_2 has been accumulating in their vicinity. After the restoration of circulation this accumulated Co_2 is washed from the tissues into the blood stream. It is to be noted that the increase is not much and is lower than the normal outer limit.

The relationship of blood carbondioxide to ventricular fibrillation has been impossible to determine in this study, however one of the dogs had persistent ventricular fibrillation and in him the endotracheal tube was found blocked with mucus.

One very interesting and important observation was made in one of the experiments regarding the effect of Co_2 in producing ballooning of the heart. By ballooning is meant overdistension of the atrium and the ventricle to such an extent as to impair contraction of the cardiac muscle. Ballooning had been noticed by Andreasen and Watson (1951 52) and Cohen and Lillehei (1954) during their studies on Azygos factor in dogs at normal temperature. It was also observed in another of our studies that was being simultaneously conducted on azygos flow : there ballooning was found to be the main cause of cardiac standstill after the release of vena cavae. It was not observed during operations under hypothermia till it was met with in Dog 55. In this case after occlusion of veins and atrial exploration had been successfully carried out, the superior vena cava was released and forty-five seconds later the inferior vena cava was also released. The release was followed by ballooning, the atrium was markedly distended and intensely blue and so was the right ventricle. The heart beat became slow and feeble. The inferior vena cava was occluded again and the heart was assisted by manual compression to expel the extra blood out of it. This helped a little but not much. The intensity of blue discoloration of the atrium in this case gave the idea that if respiratory excursion could be improved that might lead to improvement of the condition. The endotracheal tube cuff was inflated which led to full expansion of the lungs. To our great surprise the ballooning and cyanosis of the heart disappeared under our vision in a few moments. This was in contrast to the prolonged struggle that had to be put to reduce ballooning in other experiments. This case provides a reasonable explanation for the occurrence of ballooning which had so far been supposed to be due to overdistension. No doubt distension would play a part but this case demonstrates that the Co_2 content of blood has much to do with the occurrence of this phenomenon.

Blood pH : For the determination of pH, heparinised samples of blood were collected as for Co_2 under liquid paraffin. Blood pH was determined in seven cases. It will be observed from Tables V and VI, that the pH was slightly towards the alkaline side after cooling and hyperventillation. Similarly there was a tendency toward, acidity after release of occlusion. This is to be expected. Marked changes in blood pH were not observed in this study.

TABLE V

Showing Blood pH as observed during operations. Dogs cooled, hyperventilated and saline given

S. No.	Dog number	Control	One minute before occlusion	Nine minutes after occlusion	Two minutes after release of circulation
1	48	7.43	7.32	7.4	6.96
2	48	7.61	7.07	6.9	6.8
3	50	7.06	7.1	7.06	—
4	51	7.09	7.16	6.83	6.96
5	53	6.9	6.8	6.8	6.7

TABLE VI

Showing Blood pH as observed during operations. Dogs cooled, hyperventilated and no saline given

S. No.	Dog number	Control	One minute before occlusion.	Nine minutes after occulation.	Two minutes after release of circulation
1	58	6.7	6.94	7.12	7.03
2	59	6.91	6.99	6.93	6.88

Behaviour of the Heart

A striking feature observed on exposing the heart was its small size. There was considerable diminution in the size as could be judged from the looseness of the pericardium which was wrinkled and could be picked up easily. The contour of the heart changed after occlusion of the vena cavae. As soon as the occlusion of the superior vena cava was done the atrium became slightly smaller. The occlusion of inferior vena cava, however, produced a marked collapse of the atrium and ventricle which became much smaller. With diastole when these chambers should normally distend, their walls got dented inwards to a considerable extent. The auricle sometimes got inverted outside in, indicating a markedly negative pressure. The incision of the atrium did not make any difference to the inward collapse of the right ventricle and this definitely proves that when the atrium is opened, air does not go into the ventricle. If the air had gone in there should have been no denting of the ventricle. What prevents the air from entering the ventricle ? The subject has not been studied and whatever has been opined here will be a matter of conjecture. It may be that the leaflets of the tricuspid valve do not open out till the pressure in the atrium is more than atmospheric. It also appears that the apposition of these leaflets to each other is air tight.

The colour of the heart under hypothermia was paler in comparison to the bright pink at normal temperature. Blueness of the atrium may be observed occasionally after release of the vena cavae. The occlusion of the superior vena cava and azygos vein produces little change in the heart rate. However, the occlusion of the inferior vena cava produces slowing of the heart within a minute or two. The rate becomes slower as the period of occlusion increases. In an average case a marked reduction in the rate occurs after about five minutes of circulatory arrest. The lowest heart rate recorded was 18/minute in three cases, the range varying from 18 to 46 per minute. In two cases there was no lowering of the heart rate. In Dog No. 50 the heart rate before occlusion was 76/min. and after eight minutes of occlusion it was 84/min., a rise of eight instead of a fall. In Dog 56 there was only a slight reduction from 80 to 70/min. Incision of the atrium *per se* did not cause a change in the heart rate, however digital exploration of its interior particularly that of the tricuspid orifice was followed by slowing of the heart, although occasionally the reverse happened. After the release of superior vena cava there was a slight improvement of the heart beat, while the release of inferior vena cava produced a marked change in the heart rate which reached its pre-occlusion level within a minute or two. In two cases however the reverse happened and the release of inferior vena cava caused a further slowing of the heart. In these cases also the rate increased a few minutes later.

The period of increase in heart rate after release of inferior vena cava was followed by a period of slowing of the heart rate. This is clearly seen on the pulse chart (Fig. 4). This slowing may be quite marked and may be as much as noted during the occlusion. It occurs a few minutes after release of occlusion and may continue till the end of operation or till rewarming has begun. Why should this post-occlusion slowing occur? At this time there is no lack of oxygen nor an accumulation of Co_2. A glance at the blood pressure chart (Fig. 8) suggests that this slowing of the pulse may be in response to the above normal rise of blood pressure that occurs after the release of inferior vena cava.

Electrocardiographic findings : Electrocardiographic recordings were made in five cases, many times during cooling and operation, and in Lead II only. The findings in Dog No. 26 are recorded in Table VII. It will be observed that the PR interval is progressively increased during cooling. In the operative period it is further increased and the occlusion of circulation and subsequent release of circulation enhance it further. A maximum of 200 mill.

TABI

Showing Analysis of electrocardiographic tracings taken during the vario

\+ One small division. ++ Two small divisio

Time	Rectal temperature	Resp. per minute	Heart rate as calculated by E.K.J. per minute	Rhythm	Time P.R. Mill seconds	Time Q.R.S. Mill seconds	Time Q.T. Mill seconds
10 : 38 ...	36°C.	55	150	S.R.	80	40	240
11 : 08 ...	31°C.	20	100	Sinus Rhythm	100	40	400
11 : 18 ...	29°C.	46	90	S.R.	120	60	440
11 : 29 ...	25°C.	46	84	S.R.	120	60	480
11 : 33 ...	23°C.	46	84	S.R.	160	60	520
11 : 46 ...	24°C.	46	82	S.R.	160	60	400
11 : 47 ...	24°C.	46	78	S.R.	180	60	460
11 : 47½ ...	24°C.	46	84	S.R.	160	60	440
11 : 50 ...	24°C.	46	64	S.R.	180	40	...
11 : 58½ ...	25°C.	46	58	S.R.	...	60	440
12 : 21 ...	25°C.	46	78	S.R.	200	60	...
12 : 40 ...	25.5°C	46	75	S.R.	160	60	...
1 : 12 ...	30°C.	46	130	S.R.	120	40	320
1 : 35 ...	34°C.	46	152	S.R.	120	40	200
1 : 50 ...	35°C.	46	152	S.R.	120	40	280

VIII

stages of Hypothermia and operation

\+++ = Three small divisions

Description of Waves P.	Q.	R.	S.	T.	S.T. Seg.	Remarks
+ *	Present	Present	Present	Upright	Isoelectric	Control
++	++	Prominent	Defined	Do.	Isoelectric	Being cooled
++	+ *	Do.	Do.	Do.	Elevated.	Dog taken out of ice bath
++	+	Do.	Do.	Do.	Do.	
+++	Absent	Do.	Do.	Do.	Do.	Chest opened
++	Do.	Do.	Do.	Do.	Do.	Just before occlusion
++	Present +	Do.	Present	Do.	Iso.	S.V.C. occlusion
++	Present +	Do.	Do.	Do.	Elevated.	I.V.C. occlusion
+	Absent	Present	Absent	Absent	Iso.	Aur. Incision
Absent	Present +	Do.	Do.	Inverted	Depressed	Circulation released
+++ equal to R.	Absent	Do.	Do.	Absent	Iso.	...
+	Present ill def.	Prominent	Do.	Do.	Iso.	Chest closed
+	Absent	Present	Do.	Upright	Iso.	Rewarming being done
++	Present ++	Prominent	Present	Do.	Iso.	...
+++	Present +	Do.	Do.	Do.	Iso.	...

sec. was recorded after the release of circulation and also at the time of closure of the chest. It seems to progress as the time passes by. The QRS also showed increase and QT showed quite a marked increase from the initial value of 240 mill. sec. to 500 mill. sec. at the time of opening the chest. The conducting system was thus considerably depressed.

The P wave became prominent during cooling (Fig. 9). The maximum prominence was noted at the time of opening the chest and again when the chest was being closed. The incision and suture of atrium did not seem to make much of a difference. The Q wave was occasionally absent. The R remained prominent almost throughout and S was absent or ill defined most of the time. The T wave was mostly upright, it was absent at the time of auricular incision and was inverted when the circulation was released, thereafter it remained absent for some time. The ST segment became elevated as the cooling progressed but later it was isoelectric.

The more important changes, thus, were a marked prominence of P wave, increase of PR interval, widening of QRS complex. The Q was occasionally absent and S was absent or ill-defined. The rhythm in the cases recorded was mostly sinus rhythm.

Irregularities in Rhythm : Under hypothermic conditions till the time the heart or its circulation was interfered with, cardiac irregularities were not observed in this study. The lowest temperature reached in these experiments was 21 C and even at this temperature the heart remained regular and steady. The irregularities were noted when the heart was pricked incised or explored with finger. In experiments at normal temperature it was noted that a prick in the atrium for passing a stay suture invariably resulted in momentary cardiac irregularity. This was usually not so under hypothermia. However in these animals digital exploration of the tricuspid valve and of the region of superior vena cava orifice invariably resulted in irregularity of rhythm.

Auricular fibrillation was noted in seven cases, but it was temporary and resolved spontaneously. It followed venous occlusion or their release, passing of stay sutures in the atrium or its incision. In two cases auricular fibrillation was followed by ventricular fibrillation. Missing of beats and extrasystoles were occasionally noted.

Ventricular Fibrillation : Ventricular fibrillation occurred in six cases. It occurred twice in two of them as the operation was continued after restoring the normal rhythm after its first appearance. In five of these six cases fibrillation followed some form of mechanical stimulation. In three it occurred when stay sutures were being passed in the atrium, in one while the atrium was being incised and in the remaining cases when cardiac massage was being performed for cardiac standstill. Intracardiac suction appeared to be the exciting factor in one of them. The temperature at which fibrillation occurred varied between 24

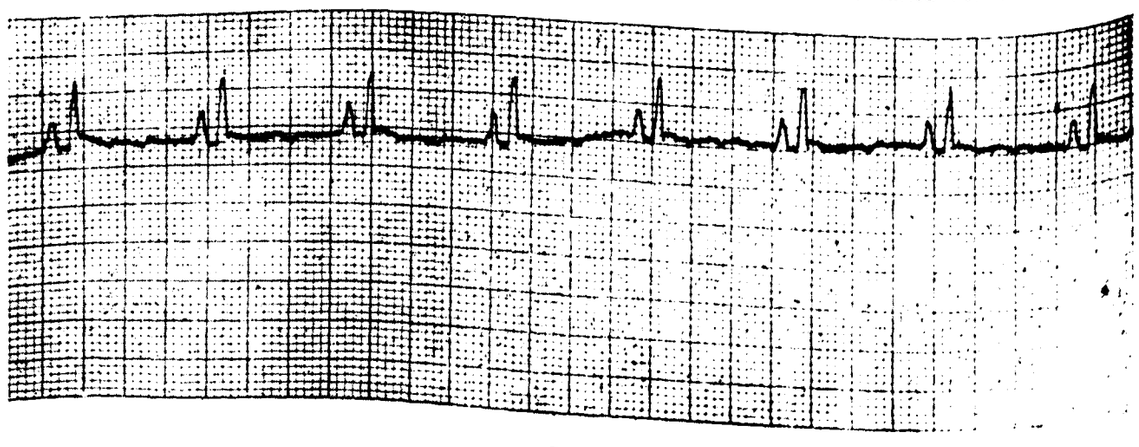


Fig. 9

Electrocardiographic tracing, Lead II. Showing a marked prominence of P wave and widening of QRS complex. This tracing was taken after the chest had been opened but before occlusion of circulation.

and 29 C. The interval between occurrence of fibrillation and restoration to normal rhythm varied between seven and ten minutes.

The method employed for defibrillation and restoration to normal rhythm was as follows : The first step was to restore circulation. In those cases in which the atrium was open, it was immediately closed either by a running suture or with a clamp, and the vena cavae were released. Cardiac massage was then performed for a minute or two. The electrodes of the defibrillator were then applied one in front and the other behind the heart and a shock was applied. It was found that a shock of 200 volt gave good result, and one or two shocks were enough. The shock defibrillated the heart and caused a cardiac standstill. The cessation of cardiac activity was either in a state of intense contraction or it lay just flabby. It was observed that a state of contraction was followed by revival of a good strong beat, while a flabby heart required greater massage and longer efforts to revive it. It is possible that the heart may start beating spontaneously after the shock without any help, as it occurred thrice in these experiments. It has been the procedure in these experiments to wait for a while after defibrillation before starting the cardiac massage.

On all the eight occasions it was possible to defibrillate the heart with electric shocks and to revive it. However in two of the cases the heart beat that followed defibrillation and massage was weak and continued to get feebler till it stopped. In order to make the heart beat strongly in such cases perfusion of the coronary circulation with 2% calcium chloride was tried after the method of Swan et al (1953). It did have a temporary effect but again the heart became feeble and could not be revived.

From this study it is not possible to comment on the causation of fibrillation. However the exciting factor appeared to be mechanical stimulation in most cases. The relationship with serum potassium and blood Co_2 has already been referred to.

Cardiac Standstill : Cardiac standstill occurred in three cases. In two it occurred after the release of inferior vena cava and in one after the release of superior vena cava but before the inferior vena cava could be released. Two of them, Dog 31 and 51, were revived by cardiac massage while in the third Dog 44, the cardiac massage led to ventricular fibrillation. Defibrillation was achieved in this case but ultimately the animal was lost. The occurrence of cardiac standstill after the release of vena cavae seems to be related to the increased Co_2 and other metabolite content of the blood at that time. The role of Co_2 on ballooning and slowing of the heart has already been discussed and there appears to be little doubt from the evidence presented there, that proper inflation of lungs can prevent such happenings.

Some points in Operative Technique

Preference for lower temperatures : On operating at body temperature of 25 to 27 C considerable bleeding was observed from the skin vessels. It appeared to be even more than what is met with during operations at normal temperature. In all probability it was due to congestion of skin vessels and to the lowered coagulability of blood (Delorme, 1955). However when the operation was performed at a temperature of 22 or 23 C the bleeding from the skin and muscles was minimal.

It was also observed that at the lower temperature of 22 or 23 C the heart was more steady and tolerated manipulations without production of irregularities. This observation is in contradiction to the obversation of other workers. However, the difference in haemorrhage and cardiac regularity in this study was so marked that a temperature lower than 25 C is recommended. Dogs 30, 46, 54, 57 were operated on at body temperature of 23 and 24 C and these were the ones who had a most smooth course during the operation. On the other hand Dogs 33, 43 and 51 were operated on at a temperature between 27° and 29 C and they had ventricular fibrillation and the worst cardiac irregularities.

Air embolism and suturing of atrium : The problem of emptying the atrium of its air before closing it was met with in a different way than has been usually described by other workers. The method adopted has been described in detail in earlier part of this paper (Fig. 3) No case of air embolism occurred during the operation, nor were any of the signs of air embolism noted in the post-operative period.

However a most interesting phenomenon was noted in Dog 48. It was rather a large dog weighing 33.5 lbs. and its heart was also large. The vessel running on the anterior surface of the atrium which has already been referred to in the description of operative technique was also large in size and was divided during incision of the atrium. There was a fair amount of bleeding from these vessels, particular

from the margin nearer to the right atrioventricular groove. A little while after the opening of atrium small air bubbles were seen coming out of the divided vessel. The margin of the atrial wound was wiped to confirm if air bubbles were really ? from the bleeding vessel. It was found to be so. The observation was repeated a third time and the same thing was found again. The atrium was completely empty except for a small amount of blood flowing down the coronary sinus. The rest of the operation proceeded smoothly the dog survived and is alive at the time of reporting. At that time it could not be decided whether the air bubbles were emerging from the artery or the vein. If the bubbles were from the artery, it has to be admitted that a certain amount of air circulates through the coronary arteries after opening the atrium and the circulation of air bubbles in this way does not lead to harmful effects. The other possibility that the air was emerging out of the veins would beg the question as to how it reached the coronary veins. It may be that the air entered the coronary sinus or the smaller cardiac veins which open directly into the right atrium. because these veins would have negative pressure due to occlusion of circulation and because there are no valves in these veins. During systole when the muscle fibres contract on these veins the air is likely to be expelled out. Since the air went in and out of the veins only, no signs of embolism coronary or cerebral would appear.

Pericardial Stitching : Pericardial suturing needs special attention because it forms rather a loose covering under conditions of hypothermia and a large bite is likely to be taken which will lead to a tight pericardium on rewarming.

Another important point was learnt from Dog 54. Usually the pericardium is stitched with individual stitches rather apart. In this dog the pericadium in the region of the atrium was stitched with a rather large gap between the stitches. The dog died some hours later in the night. Post-mortem examination showed the margins of the pericardial incision wide apart. A deep groove was seen on the atrium adjacent to the right atrioventricular groove. The anterior atrial wall was purplish in colour over a large area round about the atrial stitch line indicating infraction. Similar, though much smaller, patches of infarction were seen on the ventricular wall as well. The groove was distinct and was in all probability caused by the pressure of the pericardial margin and led to infraction. It was surmised from these findings that the size of the heart increased during rewarming period and this led to the bulging of the atrial wall through the gap in the pericardium. Such mishaps can be avoided. Special attention should be given to stitching of the right upper corner of the pericardial incision. If a large gap is left in this area, the right auricle is liable to herniate through it and get strangulated.

Conclusions and Summary

An experimental study has been undertaken on dogs, which were cooled to 21 to 25 C by immersion in ice cold water. Prior to cooling they were anæsthetised by inducing with ether and were maintained by administration of sodium pentothal. They were hyperventilated at a rate of 46 min. with oxygen. When the body had been cooled to 28 C, the muscles relaxed, chances of shivering were minimal and no more anæsthetic drugs were necessary during the operation or rewarming period. Six to ten cc. of 2½% solution of pentothal was all that was necessary for the whole procedure. A free airway is absolutely necessary, along with proper inflation of the lungs with the pump. Circulation through the heart was stopped from ten to twelve minutes by occlusion of the superior vena cava, the azygos vein and the inferior vena cava. The atrium was widely opened, its interior was inspected and digitally explored. At the end of the operation the animals were rewarmed by immersion in warm water at 45 C. Observations were made regarding temperature, pulse, respiration blood pressure, behaviour of the heart, electrocardiogram, blood pH and Co_2 and serum potassium.

Nineteen dogs were thus dealt with. Of these two died on the table and one died a few hours after the operation. Of those who died on the table, one expired after persistent ventricular fibrillation which was traced to blocked endotracheal tube, the other dog developed cardiac standstill which could not be revived. The dog which died a few hours after the operation showed evidence of constriction of the heart by the edge of the pericardial incision. Of the rest, one died on the fifth, another on 17th and one on the 22nd day after the operation due to intrapleural infection. Two were sacrificed, one on the 17th and another on 28th day. The remaining eleven dogs are still alive three to six weeks after the operation. Considering that 16 out of nineteen dogs survived, the intracardiac operations under hypothermia appear to be safe. However when we consider that six cases had ventricular fibrillation and another three had

cardiac standstill, it shows that almost 50% of cases had reached the brink of disaster, therefore the safety of these operations depends on the success and the certainty with which resuscitation from these two conditions can be performed. From this series the chances of such a resuscitation appear to be bright, although a diseased human heart may not respond so hopefully.

The cooling took 17 to 60 minutes and rewarming 13 to 75 minutes. The respiratory rate fell by about one-third by the time the temperature was 32°C, at this time the pump respirator was connected to the endotracheal tube for hyperventillation. On rewarming when spontaneous respiration returned it continued at a rather high rate upto 100/min. for some time. The high rate of respiration on rewarming has been explained to be similar to panting of dogs in hot weather.

The blood pressure showed a very gradual fall, it became negative during occlusion of the vena cavae. Serum potassium was consistently low during hypothermia, blood pH showed only a slight variation being on the higher side before occlusion and on the lower side one minute after release of circulation. The blood Co_2 was higher soon after release of circulation than before it, indicating, that tissues are respiring during the period of circulatory arrest. The increase in Co_2 was not much and was within the limits of normal variation.

The heart slowed down to 60 to 70 per minute during hypothermia, in comparison to the rate of 140 to 170/min. at normal temperature. It became smaller in size rendering the pericardium considerably loose. Occlusion of circulation led to further reduction in the size of the heart and to inward denting of the walls of the right atrium, and ventricle during diastole indicating a negative pressure. Inspite of the negative pressure no air entered the right ventricle on opening the atrium. This indicates that the contact between leaflets of tricuspid valve is airtight and more than atmospheric pressure is necessary to open them out. The heart became progressively slow during occlusion, and a rate as low as 18/min. was recorded. The P wave became prominent as the cooling progressed, the PR interval was considerably increased and QRS complex widened.

Auricular fibrillation was frequent, but it was temporary and reverted to normal spontaneously.

Ventricular fibrillation occurred in six cases, in five it was initiated by mechanical stimulation. No correlation was observed between fibrillation and serum potassium or blood Co_2 content. On all occasions it was possible to defibrillate the heart by electric shock. Further it was observed that after the shock the ventricles were either in a state of intense contraction or were flabby. The former could be easily initiated to normal rhythm. Occasionally the heart may resume normal rhythm spontaneously after defibrillation, therefore it is worthwhile waiting for a few moments before starting cardiac massage.

Cardiac standstill was observed in three cases. Two of these were revived by cardiac massage, while in the third the massage was followed by ventricular fibrillation. The cardiac standstill occurred soon after the release of the vena cavae and it is quite possible that the raised Co_2 content of blood and presence of other metabolites in blood at that time are responsible for it. The relationship of Co_2 with 'ballooning' of the heart which is more often seen in azygos flow studies at normal temperature and which occurred in one of the cases here was definitely demonstrated.

It is concluded from this study that bleeding is much less and the heart tolerates manipulations much better at a body temperature between 22° and 24° C rather than at 25° to 27°C.

To avoid air embolism a new method was adopted. Most of the atrial wound except its uppermost part was stitched before the release of circulation. The superior vena cava was then released and the blood was allowed to fill the atrium and expel the air out. The remaining part of the atrial incision was then closed before the inferior vena cava was released.

An interesting phenomenon of air bubbles emerging out of a blood vessel (which was divided while making the atrial incision) was observed. The possibility of air entering the small cardiac veins opening into the right atrium has been discussed.

Another interesting observation has been the replacement of blood by saline in the inferior vena cava in one of the experiments due to the fast intravenous drip during the occlusion period.

The pericardial stitches should not be applied too far apart as the heart increases in size during rewarming and part of it is likely to bulge out between the large gaps in the pericardium and get constricted. One such case was observed.

Acknowledgement

The work was conducted at the Research Laboratory of the Department of Surgery, K.G. Medical College, Lucknow, under a financial grant from the Ministry of Health, U.P. The help given by the following is gratefully acknowledged : Drs. R. P. Bajpai, Miss M. Mathur, and M. N. Khanna for assistance during hypothermia and operations ; Dr. S. R. Kapoor, Reader in Physiology and Dr. J. P. Saxena, *Demonstrator* in Physiology, for blood pressure recordings and electrocardiography ; Mr. Satyendra Nath Bose M.Sc. for Co_2 estimations ; the Director C.D.R.I. Lucknow, for kindly providing facilities for estimation of serum potassium and blood pH. My thanks are also due to Mr. Tara Das Sinha, for the excellent charts and to Mr. Sikander Ahmad, our Laboratory assistant.

REFERENCES

1. Andreasen, A. T. and Watson, F. Experimental Cardio-Vascular Surgery. Brit. J. Surg. **39**, 548. (1951-52).

2. Bigelow, W. G., Lindsay, W. K., Harrison, R. C., Gordon, R. A. and Greenwood, W. F. G. Oxygen Transport and Utilisation in Dogs at low Body Temperatures. Am. J. Phys. **160** 125. (1950).

3. Bigelow, W. G., Callaghan, J. C., and Hopps, J. A. General Hypothermia for Experimental Intracardiac Surgery. Ann. Surg. **132**, 531 (1950).

4. Cohen, M. and Udelhr, C. W. A Quantitative Study of the Azygos factor during Vena Caval Occlusion in the Dog. Surg. Obst. Gynec. **98**, 225. (1954).

5. Deforme, E. J. Hypothermia. Brit. Med. Bull. **11**, 201. (1955).

6. Swan, H., Zeavin, I., Holmes, J. H., Montmogomery, V. Cessation of circulation in General Hypothermia. I. Physiologic changes and their Control. Ann. Surg. **138**, 360. (1953).

Received for publication on 23-7-57.

BLOOD GROUPS IN RELATION TO PEPTIC ULCERATION*

BY

M. S. JOSHI, N. V. NIMBKAR, AND A. B. RINDANI, BOMBAY

Introduction

Association between ABO blood groups and diseases is only speculative. Before embarking upon any such investigation, one has to take for granted the null hypothesis that there is no association between ABO blood groups and diseases, and then attempt to collect relevant evidence to disprove it.

The very idea of associating blood groups with diseases has originated from repeated failures in establishing any definite etiological factor in the production of the diseases and peptic ulceration is no exception to it.

Attempts at establishing an association between blood groups and peptic ulceration date from 1921, when Buchanan and Highley (quoted by Buckwalter [3]) concluded that there was no association between ABO blood groups and various diseases, including peptic ulceration. Mitra[7] was probably the first Indian who investigated a small series of cases and found statistically tha' group 'AB' persons were more likely to develop cancer. Ugeli, Lessa and Alarco, quoted by Buckwalter,[3] showed increased frequency of blood type 'O' in peptic ulcer patients.

The recent reports of large series which are fairly representative come from Aird[1], Clarke[4] and Buckwalter[3].

In a series of 3,011 cases of peptic ulceration, Aird[1] has shown a 35 per cent more probability of developing the disease in persons of 'O' group. Buckwalter[3] noted highly significant association between ABO blood group and peptic ulceration, characterised by an increased incidence in group 'O' and a reciprocal decrease in other groups.

With a view to establish the truth of the association of blood groups and peptic ulceration, we have undertaken this study.

* From the Department of Surgery, K.E.M. Hospital, Bombay.

Material and Methods

1. *Collection of Data :* The present series consists of 413 cases of peptic ulceration admitted to the K.E.M. Hospital, Bombay, during the period 1946 through 1956. This series was restricted to the above period in view of the fact that a standard method of blood grouping was available only after 1946.

All the case reports of patients with peptic ulceration who came up for operative treatment were thoroughly scrutinized and relevant data collected under the following headings :

Age, sex, religion, anatomical situation of the ulcer and blood group.

2. *Selection of patients :* The criteria for selecting the patients for the present series have been very strict, as according to Aird,[1] "If relatively small series are to be collected and reported on, it would seem important to limit the data to precise pathological entities of a clear-cut kind, whose recognition is likely to be standard throughout the world."

The patients attending the K.E.M. Hospital come from all over Bombay State and hence fairly represent a cross-section of the general cosmopolitan population. The present series includes cases in which there was definite microscopic evidence of peptic ulceration noted down by the surgeon. A few cases of juxtapyloric ulcers with marked fibrosis were included as chronic duodenal ulcers. In order to abide by the above criteria, we had to forego a large number of cases.

3. *Selection of controls :* In the absence of an authoritative population control series, we have taken two control series.

(1) 766 consecutive voluntary blood donors.

(2) 3,600 patient control series[2].

The professional donors could not be included because of a probable repetition of rarer blood groups.

TABLE I

	Total	O	A	B	AB
Voluntary donors	766	259	215	235	57
Patient controls[2]	3600	1228	953	1096	323

TABLE II

	Total number of cases	O	A	B	AB
Control Series I ...	766	259	215	235	57
Control Series II ...	3600	1228	953	1096	323
X^2 51.920					

As there is a statistically significant difference between the two control series, separate comparisons are made in presenting the data.

TABLE III

Disease	Blood Group O	A	B	AB	Total number of cases
1. Total number of peptic ulcers ...	150	99	123	41	413
2. Chronic duodenal ulcers ...	88	47	74	17	226
3. Duodenal perforations ...	49	45	40	20	154
4. Gastric ulcers	6	6	4	2	18
5. Gastric perforations	5	1	3	1	10
6. Stomal ulcers	2	...	1	...	3
7. Double ulcers	...	...	1	1	2

Only sub-heads 1, 2 and 3 from Table III are taken into consideration to assess the relationship between ABO blood groups and peptic ulceration. The remaining sub-heads have not been compared because of their small number.

TABLE IV

Total Peptic Ulcers

	Total number of cases	O	A	B	AB
Control I ...	766	259	215	235	57
Observed (O) ...	413	150	99	123	41
$X^2 = 6.8052$					

TABLE V

	Total number of cases	O	A	B	AB
Control II	3600	1228	953	1096	323
Observed (O)	413	150	99	123	41
X^2 1.5617					

TABLE VI

Chronic Duodenal Ulcers

	Total number of cases	O	A	B	AB
Control I ...	766	259	215	235	57
Observed (O)	226	88	47	74	17
X^2 2.7271					

TABLE VII

	Total number of cases	O	A	B	AB
Control II	3600	1228	953	1096	323
Observed (O)	226	88	47	74	17
X^2 4.9453					

TABLE VIII

Duodenal perforation

	Total number of cases	O	A	B	AB
Control I	766	259	215	235	57
Observed ...	154	49	45	40	20
X^2 8.9625					

TABLE IX

	Total number of cases	O	A	B	AB
Control II	3600	1228	953	1096	323
Observed (O)	154	49	45	40	20
X^2 3.9043					

The results were calculated from CHI-SQUARE probabilities table using n number of degrees of freedom 3 and p .01. All the values of x^2 are below the significant level of 11.345.

Discussion

We are not able to show association between ABO blood groups and peptic ulceration if at all it exists as claimed by Aird[1] and Buckwalter[3]. This may probably be due to the small number of cases in our series.

Peptic ulceration may be more frequent in the 'O' group population but the severity of the disease may not be so much as to call for surgical intervention in all cases. Hence with the criteria adopted by us for inclusion of cases, our series may have a bias.

Malhone and Lahiri[5] have shown that 'O' group frequency increases as one travels from South to North in India : as opposed to this, the incidence of peptic ulceration increases as one moves from North to South India (Somervell[8]). These two observations at their face value cast a doubt on the possibility of prevalence of peptic ulcer in 'O' group cases.

The relative group frequency of ABO blood groups in different countries is variable to a considerable extent. Mayo[6] has collected data from all over the world wherein he has shown that the frequency of 'O' group varies from 43 per cent to 80 per cent in different populations. Hence it would be difficult to postulate that persons of any blood group are more likely to develop peptic ulcer.

Summary

(1) ABO blood group frequency in 413 cases of peptic ulcer is studied.

(2) Comparison between these and the two control series showed no statistically significant increase in the incidence of peptic ulcer in any particular blood group.

Acknowledgement

We thank the Dean, K.E.M. Hospital, Bombay, for granting permission to publish the above data.

REFERENCES

1. Aird, I.: The blood groups in relation to peptic ulceration and carcinoma of colon, rectum, breast and bronchus. B. M. J., **2** : 315-321, August 1954.
2. Bhatia, H. M.: Thesis submitted to the University of Bombay for a degree in M.Sc. (Microbiology).
3. Buckwalter, J. A.: Peptic ulceration and ABO Blood Groups. J. A. M. A., **162** : 1215-1220, November 1956.
4. Clarke, C. A.: The relationship of the ABO Blood Groups to duodenal and gastric ulceration. B.M.J., **2** : 643-646, 1955.
5. Malone, R. H. and Lahiri, M. N.: The distribution of the Blood Groups in certain races and castes of India. Ind. J. Med. Res., **16** : 963, 1929.
6. Mayo, C. W.: Are certain diseases associated with specific Blood Groups or Rh Antigens ? A.M.A. Arch. Surg., **66** : 406-409, 1953.
7. Mitra, P. N.: Influence of Blood Groups in certain Pathological states. Ind. J. Med. Res., **20** : 995-1004, April 1933.
8. Somervell, T. H.: Some contributions to the causation, pathology and treatment of duodenal ulcer and its complications. B.M.J., **24** : 237-245, 1936.

Received for publication on 1-10-57.

PRIMARY CARCINOMA OF RIGHT ADRENAL *

(A case report)

BY

ELIZABETH THOMAS, VELLORE (S. INDIA.)

In the Christian Medical College Hospital, Vellore, 2,170 autopsies were performed from 1944 to 2nd July 1957. Only one case of primary adenocarcinoma of the adrenal occurred in the series. During a corresponding period no such case occurred in the surgical biopsies. Wu, as quoted by Ackerman[1], found only 82 cases of adenocarcinoma of the adrenal in the literature from 1803 to 1940.

Case Report

A 55-year old Englishman was admitted into this hospital on 27th July 1951 with the chief complaint of attacks of severe pain in the right flank for one year. On physical examination, he had vague tenderness on palpation over the right flank. Examination of the heart, lungs and abdomen showed no positive sign. Rectal examination showed first degree haemorrhoids and uniform enlargement of prostate. Investigations did not reveal any clue as to the underlying disease. Examination of blood, urine and faeces were essentially negative. The blood Kahn test was positive and the blood urea was 27 mgms per 100 ml.

X-ray showed destruction of a localized area of the right 8th rib. This was resected.

Grossy : The specimen was a piece of rib 10 cm. in length showing a fusiform swelling near its middle. This was easily cut with a knife and showed a white, uniform fleshy firm infiltrating tumour mass completely replacing the bone and invading the surrounding soft tissue (Fig. 1).

Microscopic : There were sheets of anaplastic malignant cells with hyperchromatism and variation in the size and shape of nuclei. Some areas showed a glandular arrangement.

Impression : Anaplastic adenocarcinoma, secondary in rib.

In an attempt to locate the primary, various sites were investigated. Barium meal and intravenous pyelogram were negative. Small skin nodules present on the thigh and back were excised, but microscopically showed only benign keratinizing sqamous papillomata.

An exploratory laporotomy was performed on 3rd September 1951. All organs were palpated as far as possible. Liver, omentum, gall bladder, spleen, left kidney, pancreas, small bowel, colon, and rectum were carefully visualized and palpated and found normal. Both adrenals could not be felt as there was a large quantity of fat obscuring them. The right kidney was slightly displaced anteriorly and lower down but moved freely and was not enlarged.

Fig. 1

Resected 8th rib showing infiltration by tumour

X-ray of the chest revealed no tumour. Since all attempts to locate the primary were fruitless, the patient was discharged.

Two months later, the patient returned to hospital with two lumps at the operated site near the 8th rib on the right side. The lumps were irregular, hard, attached to skin and painful : the larger one measured about 4 cm. in diameter. This was removed.

Grossly, the nodules were apparently encapsulated and on cut section uniformly white, firm and fleshy.

* From the Pathology Department, Christian Medical College Hospital, Vellore, S. India.

Microscopically, it showed sheets of tumour cells with anaplasia and an alveolar pattern. Reticulum stain showed reticulum around groups of tumour cells. This was obviously secondary carcinoma. The primary site was still unknown.

The patient's condition deteriorated. He developed a remarkable complaint of excessive sweating. His clothes as well as bed linen became drenched with sweat and had to be completely changed every few hours. He died on 26th December 1951.

Autopsy

Autopsy was performed 50 hours after death by an evisceration technique. No permission was given to remove the brain.

The general appearance was that of a middle-aged man with marked increase in subcutaneous fat over the abdominal wall. Hair distribution showed nothing unusual. Both testes were palpated in the scrotum and felt uniform and equal with no enlargement.

The respiratory system showed no evidence of tumour or inflammation.

The cardiovascular system showed marked atheroma of the aorta which was most severe in the abdominal aorta with ulceration and calcification. The atheroma extended into both common iliac arteries which were seen as rigid tubes. There was a small patch of atheroma in the left coronary artery about 2 cm. from its origin, but with no actual obstruction. The heart and other vessels showed no lesion.

The alimentary system showed no evidence of tumour, stricture or ulcer from oesophagus to anus. The liver, gall bladder, and pancreas were normal. The spleen weighed 175 gms. and on cut section showed two firm white round nodules each about 2½ cm. in diameter resembling secondary malignancy.

Urinary system showed no evidence of tumour, obstruction or inflammation in the kidneys, ureters or bladder. Prostate was slightly enlarged and uniform.

Adrenals : Right adrenal weighed 25 gms. There was a firm white round uniform mass in the right adrenal measuring 4 × 2.5 cm. in diameter. A rim of adrenal tissue was seen attached to the periphery of the tumour mass (Fig. 2). Left adrenal weighed 15 gms. Cut section showed the usual proportion of cortex with medulla. No tumour nodules were seen.

A large mass of greatly enlarged retroperitoneal lymph nodes was present behind the right kidney and this measured 12 × 11 × 5 cm. (Fig. 3). It was lobulated white, fleshy and uniform with no areas of haemorrhage or necrosis. This mass was embedded in fat and not attached in kidney or adrenal.

Misroscopic Findings

Right adrenal showed sheets of malignant cells with pleomorphism and anaplasia. In places there was an acinar pattern. In other areas the cells were in columns and cords forming irregular sheets with no lumina (Fig. 4). The adrenal tissue could be seen adjacent to the tumour and infiltrated by it. The surviving adrenal tissue showed the usual arrangement of cortex and medulla.

Fig. 2

Right adrenal bisected to show tumour. Also slice of spleen showing secondary growth.

Fig 3.

Retroperitoneal lymph nodes with infiltration by tumour

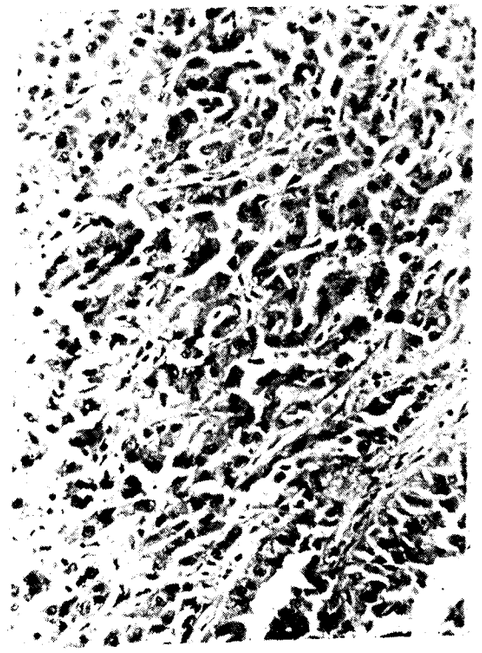


Fig. 4

Right adrenal showing adenocarcinoma. H & E × 210

Left adrenal showed a normal pattern with no tumour.

The retroperitoneal lymph nodes and spleen showed extensive infiltration by a tumour with an adenocarcinomatous pattern. The kidneys showed some evidence of benign nephrosclerosis. The liver showed marked congestion in the centre of the lobules with commencing necrosis of liver cells and fatty change in the periphery. The pancreas showed well marked fatty infiltration in between the acini, and many thickened hyalinized blood vessels were present. The aorta showed atheroma and calcification. The hilar lymph nodes, lung, prostate, small and large intestines showed no significant lesion.

Final Diagnosis

Primary adenocarcinoma of right adrenal with metastatic spread to retroperitoneal lymph nodes, spleen and rib.

Atheroma Aorta.

Discussion

The absence of any obvious endocrine symptoms was striking in this case. In male adults endocrine symptoms of adrenal cortical tumours often do not appear. As this diagnosis was not suspected hormonal excretion and the sodium, potassium and chloride levels were not determined. It is well known that the adrenal cortex influences the metabolism of salt and water. The excessive sweating which soaked the bed linen might possibly have been produced in this way.

Pain is the usual symptom in cases without hormonal changes. The pain is both abdominal and flank, on the side affected. The deep situation of the adrenal often leads to a late diagnosis. Cahill et al[2] reported one case who had loin pain coming on in attacks lasting 4 to 5 days. The reason for the pain may be that non-hormonal tumours grow to a larger size since attention is drawn to them later. A cortical carcinoma may not produce the normal hormonal secretion in cases where there is a degree of anaplasia which is incompatible with usual physiological function (Goldzieher[4]). Six non-hormonal cortical tumours were reviewed by Cahill and Melicow[3], four being carcinomas, one sarcoma and one adenoma.

The spread occurs from cortical carcinoma through the lymph as well as the blood stream. A large retroperitoneal mass of lymph nodes was found in this patient extensively infiltrated by the same type of adenocarcinoma. Lymphatics of the adrenals end in lymph nodes near the origin of the coeliac artery, inferior vena cava and in the para-aortic region above the renal pedicle. Metastatic growths in lymph nodes are sometimes larger than the main tumour itself as in this case. Secondaries which were seen in the spleen must have spread through the splenic artery as there was other evidence of blood spread like metastases in the ribs.

Summary

A case of primary adenocarcinoma of the right adrenal with metastasis to rib, spleen and retroperitoneal lymph nodes is reported. There were no obvious endocrine symptoms. There was only one such case out of 2,170 autopsies performed at the Christian Medical College Hospital, Vellore.

REFERENCES

1. Ackerman, L. V., and Regato, J. A.: Cancer, Second Edition, St. Louis, the C. V. Mosby Co., 1954.
2. Cahill, G. F., Melicow, M. H. and Darby, H. H.: Surg. Gynae and Obst., **74** : 281-305, 1942.
3. Cahill, G. F., Melicow, M. H.: Tumours of the Adrenal Gland. J. Urol. **64** : 1-25, 1950.
4. Goldzieher, M. A.: The Adrenal Gland in Health and Disease, F. A. Davis Co., Philadelphia, 1944.

Received for publication on 15-7-57.

CYSTOSARCOMA PHYLLOIDES AND ITS MALIGNANT VARIANT *

BY

S. AGARWAL, J. B. SHRIVASTAV AND K. D. SHARMA, NAGPUR

Cystosarcoma phylloides of the breast has become a well recognised clinico-pathological entity since it was first described by Johannes Muller[5] in 1838, when the term 'sarcoma' meant a fleshy mass. Lee and Pack[3] in 1931 reviewing the literature collected 105 cases and contributed 6 cases of their own. These authors emphasized the greatness of size, development from pre-existing fibroadenomas, long duration of symptoms with initial period of quiscence, characteristic intracystic polypoid excrescences composed of myxomatous stroma and the benign nature of these neoplasms. Oliver and Major[6] preferred the term 'Giant intracanalicular myxoma' stressing, the large size of the neoplasms. Stewart[8] and Treves and Sunderland[10] have laid much more stress on the pronounced overgrowth of the connective tissue element rather than the size, and tumours as small as 1 c.m. have been reported by the latter as cystosarcoma phylloides. Stout[9] includes within the term cystosarcoma phylloides those fibroadenomas which have unusually cellular stroma and also those which grow with exceptional vigor and attain a large size, although histologically they may reveal the usual fibroadenomatous pattern.

In view of the controversy regarding the criteria to be adopted for inclusion of the tumours in this group, it is not always easy to draw a line between the intracanalicular fibroadenomas and cystosarcoma phylloides. In the present study, therefore, we have included all those fibroadenomas which showed large size of the tumours, rapid growth and pronounced cellular stroma.

Contrary to the earlier belief as to the benign nature of these neoplasms, it was noticed that they are not necessarily benign and a malignant transformation of the tumours has been reported by several authors [1, 3, 7, 8, 10, 11]. Treves and Sunderland[10] have concluded that the criteria of malignancy in these tumours is not their great size but the presence of stromal cellularity and anaplasia. Lester and Stout[4] have found these criteria as unsafe because the area showing the features of malignancy in some tumours may be very small while some tumours with definite histological evidence of malignancy may show a benign clinical course. Our criteria of malignant cystosarcoma phylloides has therefore been a cytological evidence of malignancy in the stroma and presence of epithelial element in the tumour mass. Absence of epithelial element in such a tumour will place it in the category of a well defined histological entity of breast sarcomas.

Material and Methods

Material for the study consisted of the surgical specimens received in the Department of Pathology, Medical College, Nagpur, during the period (eight years) extending from 15th April 1949 to 14th April 1957.

Out of 13,849 surgical specimens received during this period 217 were those of tumours of the breast in females. Analysis of these cases showed the type of lesion to be as follows :

1. Malignant tumours 171 :
   - (*a*) Carcinoma ... 167
   - (*b*) Sarcoma 1
   - (*c*) Malignant cystosarcoma phylloides... 3
2. Benign tumours 46 :
   - (*a*) Fibroadenomas ... 37
   - (*b*) Papilloma ... 1
   - (*c*) Cystosarcoma phylloides ... 8

Thus 11 cases of cystosarcoma phylloides and its malignant variant were available for study. The histologic sections from all these cases were restudied, cut and stained fresh when required. Haematoxylin and eosin was used as a routine stain. The clinical data were obtained from the original case records.

Cystosarcoma Phylloides : All the cases in this series were seen in females. Such tumours in the males, although rare have been reported by Lee and Pack[3]. The age of the patients varied from 25 to 60 years. Two of the patients were below 30 years and two were past 50 years. The average age of the patients in this

* From the Department of Pathology & Bacteriology Medical College, Nagpur.

TABLE No. 1

Cystosarcoma Phylloids and its Malignant Variant Clinical Features

S. No.	Case No.	Age (yrs.)	Gynec. and Obst. History	Side of Lesion	Duration of Symptoms	Lump	Pain	Skin changes	Location in Breast	Size of Tumour	Recent Rapid growth	Treatment given
1	54–286	60	Married. 2 children. Menopause.	Left.	3 months.	...	...	Nil	All quadrants.	25 cms.	...	Radical Mastectomy.
2	54–1212	50	Married. 5 children. Menopause.	Left.	3 years.	...	...	Ulcer	Upper and outer.	14 cms.	...	Do.
3	54–1951	50	Married. 4 children. Menopause.	Right.	2 months.	...	...	Nil	All quadrants.	12 cms.	8 months. ...	Simple Mastectomy.
4	55–265	28	Married. 2 children.	Left.	3 months.	...	...	Nil	Do.	15 cms.	...	Do.
5	55–1899	32	Married. No pregnant.	Right.	2 years.	...	...	Fungating growth.	Upper and outer.	12 cms.	...	Do.
6	55–2058	47	...	Right.	...			Clinical data not available				
7	55–2631	25	Married. 2 children. Lactating.	Left.	1 month	...	...	Nil	All quadrants.	10 cms.	...	Do.
8	56–1546	35	Married. 3 children.	Left.	6 months.	...	...	Nil	Upper and inner.	10 cms.	...	Excision.
1	51–224	24	Married. No pregn.	Right.	2 months.	...	...	Ulcer	All quadrants.	12 cms.	...	Simple Mastectomy.
2	55–1721	19	Unmarried.	Left.	2 months.	...	...	Fungating growth.	Lower and outer.	12 cms.	...	Excision.
3	55–2609–2705.	35	Married. 2 children.	Right.	4 months.	...	...	Large ulcer.	All quadrants.	27 cms.	...	Simple Mastectomy.

group was 40.9 years. Left breast was involved in 5 cases and the right in 3 cases, although one patient (56-1546) had a small nodule in the opposite breast also. The tumour was located in the upper and outer quadrant in 2 cases and the upper and inner in one, while in the others all the quadrants were involved. The duration of the symptoms extended from a month to three years. A 'growing lump' was the usual history and pain was present only in 2 cases. None of the patients gave a history of nipple discharge or any other symptom referable to the nipple. Skin involvement in the form of an ulcer or a fungating mass was present in 2 cases. A history of rapid growth after an initial period of quescence was given in 2 cases, the rest of them had a fairly rapid growth from the very onset. All the patients in this series were married and five of them had borne children. The menstrual history was not significant in any of the cases. One of the patients was lactating at the time of observation and in this case the lump had grown 10 cms. in diameter within a period of one month. (For details of clinical features see Table I).

Fig. 1
A case of cystosarcoma phylloides

Gross pathology : The tumours usually constituted a large mass with an uneven surface having areas of firm and soft consistency. In two of the cases the skin was involved showing a large fungating cauliflower-like mass justifying the term cystosarcoma phylloides. The size of the tumours varied from 10 to 25 cms., the average being 14 cms. The tumours could be bisected with comparative ease presenting cystic and solid areas, their proportion varying in different tumours. The cystic areas showed large white polypoid projections of soft consistency while the solid areas were of a uniform greyish colour (Fig. 2). The cysts in most instances were completely filled with the projections reducing the cavities to mere chinks but in some cases they contained a brownish watery fluid. Areas of haemorrhage were seen only in one case.

Microscopic pathology : The characteristic feature of these tumours as different from the intracanalicular fibroadenoma was the pronounced activity of the mesenchymal element (Fig. 3 and 4). In most of the cases the stroma was of a mixed character showing myxomatous, hyalinised and highly cellular areas. The periductal stroma usually showed a myxomatous nature (Fig. 5). The cellular areas consisted of closely packed fusiform cells with elongated nuclei but with the uniformity in the size of the cells and lack of frequent mitosis, their benign nature could not be doubted. The epithelium covering the intracystic projections was usually cuboidal but also columnar at some places. Squamous metaplasia of the duct epithelium was seen only in one case (Fig. 6)

Fig. 2
Cut surface of the same tumour showing several cysts filled with intracystic projections

Fig. 3
Showing large intraductal projection with cellular stroma. (H. & E. × 130)

Fig. 5
Showing the loose and myxomatous stroma around the ducts. (H. & E. × 130)

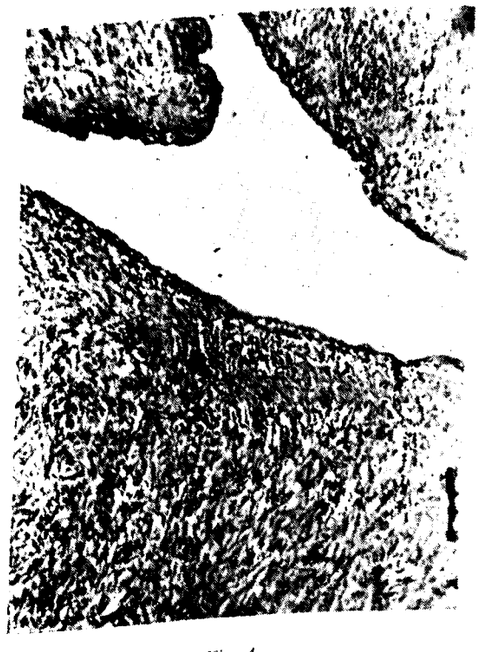


Fig. 4
Showing the cellular stroma which has a pseudosarcomatous appearance. (H. & E. × 130)

Fig. 6
Showing the squamous metaplasia of duct epithelium. (H. & E. × 400)

Fig. 7
A case of malignant cystosarcoma phylloides.

Fig. 8
Showing the cut surface of the same tumour revealing large intracystic projections and a greyish solid area. The tumour measured 27 c.ms. in diameter and weighed 7 lbs.

Two cases showed wide areas of haemorrhage extending even to the papillary projections. The cases with the skin involvement showed a fair number of inflammatory cells in the stroma. Metaplasia of the stromal element was not seen in any of the cases.

As in most of the cases simple mastectomy was done, only in one case were the axillary lymphnodes available for histopathological study. These showed reactive follicular hyperplasia.

Malignant variant of cystosarcoma phylloides : All the three cases in this group were seen in females. The patients were of a younger age in these cases, the youngest being 19 years. The duration of the symptom was in months rather than years, the average being 3 months. A rapid growing tumour with early skin involvement and prominent superficial venous pattern was noticed in all the cases. One patient gave a history of having applied counter-irritants to the tumour mass which accelerated its rate of growth. (For details of clinical features see Table I).

Gross Pathology : The tumours in this group were of a larger size and one of these measured 27 cm. in diameter and weighed 7 lbs. (Fig. 8). Morphologically they were similar

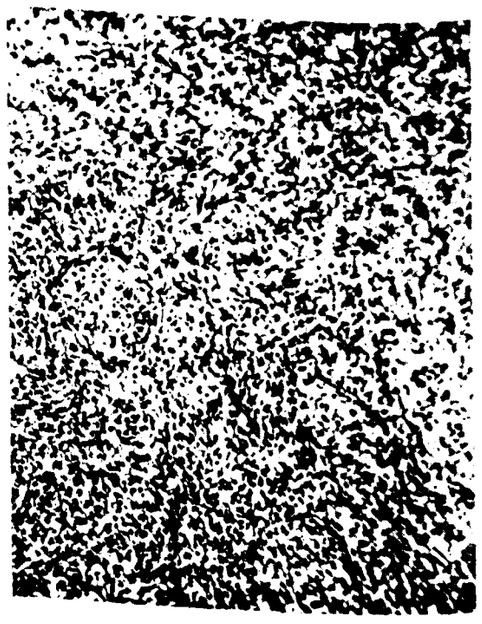


Fig. 9
Showing an area of frank malignancy in malignant cystosarcoma phylloides. (H. & E. × 130)

Fig. 10
Showing details of cellular structure in Fig. 9. (H. & E. × 400)

to the benign forms, but the intracystic projections were much more friable and the solid areas exceeded the cystic areas in dimensions.

Microscopic Pathology : These tumours differed from the benign forms mainly in their predominant connective tissue element which showed signs of malignancy in the form of anisocytosis, anisonucleosis, hyperchromatism of the nuclei and frequent mitosis (Fig. 9 and 10). In two cases all the sections examined showed evidence of malignancy in the stromal element, but in one case the malignant change was limited to some areas only. In none of the cases did the epithelial element show signs of malignancy although it was noticed to be more active at places. Squamous metaplasia of the duct epithelium covering the stromal projections was seen only in one case (Fig. 11). Wide areas of haemorrhage and necrosis were seen only in one case and presence of a few inflammatory cells was noted in all the cases.

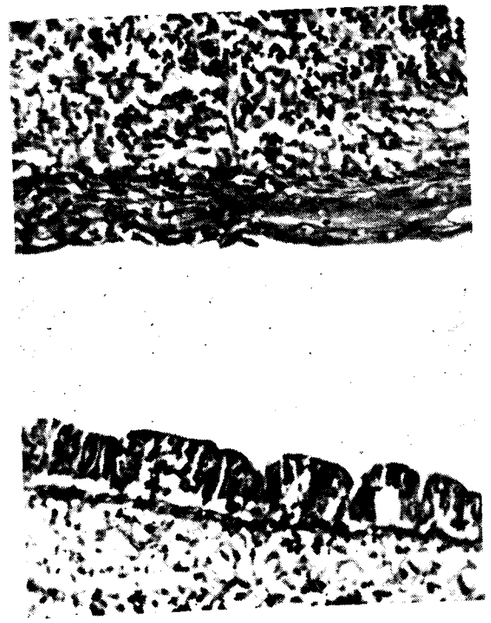


Fig. 11
Showing squamous metaplasia of duct epithelium. (H. & E. × 250)

Discussion

The important point regarding cystosarcoma phylloides is that their clinical course and sometimes their histological structure suggests that they are malignant. The large size of the tumours and the rapid growth are often taken as evidence of malignancy and a radical operation is therefore undertaken. Out of 8 cases included in the benign group radical mastectomy was performed in 2 cases and simple mastectomy in 4 cases.

The question as to which of the fibroadenomas should be classified as cystosarcoma phylloides is a difficult one. As mentioned earlier various authors have taken different criteria. In this series we have included those tumours which had a relatively large size, history of rapid growth and pronounced cellular stroma on histological examination. In some cases the pseudosarcomatous areas present difficulty in evaluating the nature of the tumour and in such cases it is important to study a large number of sections to exclude any areas of frank malignancy.

The relation of these tumours to fibroadenomas is also not clear. Treves and Sunderland[10] have suggested that these neoplasms develop in two ways, from a pre-existing fibroadenoma and as a cystosarcoma phylloides from the very beginning. In our series four patients gave a history of rapid growth after an initial period of quiescence and in two of these the rapid growth could be ascribed either to lactation or application of counter-irritants. One patient (56 1546) had two histologically proved small fibroadenomas apart from the main tumour mass, one in the same breast and the other in the opposite breast. These findings suggest some relationship of these neoplasms to a pre-existing fibroadenoma.

The malignant variant of cystosarcoma phylloides differs from the benign one in having cellular stroma which shows definite evidence of malignancy. The epithelial element present in these cases excludes them from the group of fibrosarcomas. The criteria of malignancy in our cases was only cytological. Information for distant metastasis or involvement of regional lymph nodes was not available in these cases. In the absence of metastasis, the only criteria as to the malignant nature of the tumour would be based on the cytological characters of the cells. Lester and Stout[4] have expressed doubt as regards the reliability of this criterion particularly in cases of biopsy specimens. In the absence of any follow up study of these cases it is difficult for us to opine on this aspect.

It is also very difficult to say as to whether the malignant cystosarcoma phylloides arises in a previously benign lesion or ab initio. In this series in one case the areas of malignancy were limited to some parts of the tumour, thus suggesting a malignant change in an initially benign tumour. In two cases all the sections examined showed areas of malignancy and it is quite likely that these tumours were malignant from the very beginning.

Summary

1. Cases of cystosarcoma phylloides and its malignant variant received in the Department of Pathology, Medical College, Nagpur, during a period of eight years (1949–1957) have been studied. Out of 13,849 surgical specimens which included 217 tumours of the breast in females, 8 cases were classified as cystosarcoma phylloides and 3 as its malignant variant.

2. Their clinical features, gross and microscopic structure have been described.

3. The criteria for the diagnosis of these tumours and their relation to fibroadenomas have been discussed.

REFERENCES

1. Cooper, W. G. and Ackerman, L. V.: Cystosarcoma Phylloides with a consideration of its more malignant variant. Surg. Gynec. Obst., **77**: 279, 1943.
2. Haagensen, C. D.: Diseases of the breast. Philadelphia and London: W. B. Saunders Co. 1956, p. 235.
3. Lee, J. B. and Pack, J. L.: Giant intracanalicular fibroadenoma of the breast: The so-called cystosarcoma phylloides mammae of Johannes Muller. Am. J. Cancer, **15**: 2583, 1931.
4. Lester, J. and Stout, A. P.: Cystosarcoma Phylloides. Cancer, **7**: 335, 1954.
5. Muller, J.: Quoted by ref. 8.
6. Oliver, R. L. and Major, R. C.: Cyclomastopathy: A physiopathological conception of some benign breast tumours, with an analysis of four hundred cases. Am. J. Cancer, **21**: 1, 1934.
7. Steehlar, C. and Landman, M.: Cystosarcoma Phylloides with metastasis. New York State J. Med., **50**: 339, 1950.
8. Stewart, F. W.: Atlas of Tumour Pathology, Section IX, Fascicle 34, Tumours of the breast, 1950. Armed Forces Institute of Pathology, Washington.
9. Stout, A. P.: Quoted by ref. 2.
10. Treves, N. and Sunderland, D. A.: Cystosarcoma Phylloides of the breast: A malignant and benign tumour: A clinico-pathological study of seventy seven cases. Cancer, **4**: 1286, 1951.
11. White, J. W.: Malignant variant of Cystosarcoma Phylloides. Am. J. Cancer, **40**: 458, 1940.

Received for publication on 1-7-57

INVASION OF EPIDERMIS BY MAMMARY CARCINOMA*

(A report of two cases)

BY

S. AGARWAL, J. B. SHRIVASTAV AND K. D. SHARMA, NAGPUR

In cases of cancerous infiltration of the skin the epidermis usually is pressed, thinned out and destroyed by the tumour mass forming an ulcer. The cancer cells usually do not infiltrate in between the cells of the epidermis and spread along its length because the malignant process is probably too rapid to allow such invasion. Destruction of the epidermis takes place much earlier than this. When the infiltration of the epidermis does take place the malignant cells are either seen in the form of nests and clusters or in rare instances give rise to formation of cells which morphologically resemble the Paget's cell[3, 5, 6, 9, 10, 12]. In still rarer instances the infiltrating cells may form acinar structures in the epidermis. This has been observed by Muir[9, 10] Inglis[6] and Haagensen[4] in cases of Paget's carcinoma.

In a study of 126 cases of carcinoma of the breast, in two cases invasion of the epidermis was seen. In addition to the presence of Pagetoid cells the invading cells had also differentiated to form acinar structures in the epidermis. This observation, apart from being a comparatively rare histological finding of true infiltration of epidermis by carcinoma, throws some light on the nature and origin of Paget's cells in cases of Paget's disease of the nipple which has been a controversial subject.

Case Reports

Case 1. A male aged 55 years had a lump in the right breast which had involved the skin forming a small fungating growth 2 cms. above the nipple. The nipple and areola were not affected clinically.

Histologically, the breast tumour was a typical infiltrating duct carcinoma. The nipple and the adjoining skin did not show any evidence of infiltration. The section from the skin adjacent to the growth showed invasion of epidermis by tumour cells. The tumour cells were large with vacuolated cytoplasm and large hyperchromatic nuclei, showing a very close similarity to the Paget's cells. The cells were mainly seen in the lower layers of the rete Malpighii and had extended laterally along the epidermis to a considerable distance from the actual site of invasion. The cells at most of the places were arranged in small acinar structures. The underlying dermis showed infiltration with mononuclear cells. (Fig. 1 and 2).

Case 2. A female aged 45 years had a large fungating growth in the upper and outer quadrant of the right breast. The nipple and areola were normal. Skin showed 'peau d'orange' appearance. Axillary lymph glands were enlarged on the side of the breast lesion.

Histological examination showed an infiltrating duct carcinoma of the breast with metastases in the lymphnodes. The section from the nipple region showed no involvement of the skin. Sections from skin at the margin of the fungating growth showed invasion of the epidermis. The histological features were very similar to those described in case 1 but the differentiation of the tumour cells into acinar structures was not so marked (Fig. 3).

Comment

Broadly speaking there are two schools of thought regarding the origin of the Paget's cells. The earlier view held by Pautrier[11], Arnd[1], Cheatle and Cutler[2] and in recent years supported by Willis[13] suggests that these cells are modified epidermal cells. In support of

Fig. 1

(Case 1). Showing the Pagetoid cells and acinar structures in the epidermis due to its invasion by the underlying mammary carcinoma. (H. & E. × 130).

* From the Department of Pathology & Bacteriology, Medical College, Nagpur.

Fig. 2

(Case 1). Showing two acini and a Pagetoid cell between them in the malpighian layer of the epidermis. (H. & E. × 300).

Fig. 3

(Case 2). The epidermis shows invasion by the tumour cells producing Pagetoid cells. (H. & E. × 70).

this view Arnd[1] demonstrated a transition between the normal epidermal cells and glycogen rich Paget's cells. Tudford[7] after a close cytological study of these cells concluded similarly.

The other view held by Jacobeus[8], Muir[9,10] and Inglis[5,6] suggests that the Paget's cells are not epidermal in origin but as a matter of fact are the malignant cells of duct carcinoma which have infiltrated the epidermis.

The two cases reported here clearly show that invasion of the epidermis by the underlying mammary carcinoma can give rise to Pagetoid cells and that these cells can differentiate into acinar structures in the epidermis indicating their origin from duct carcinoma. This suggests that a similar process of invasion of the epidermis takes place in cases of Paget's disease of the nipple. This is supported by the observation of Muir[9,10], Inglis[6] and Haagensen[4] who have demonstrated the differentiation of the infiltrating cells into acini in the nipple lesion of the Paget's carcinoma.

Summary

Two cases of mammary carcinoma with invasion of the epidermis producing pagetoid cells and acinar structures have been reported. This observation lends support to the concept that the Paget's cells are derived from the intra-epithelial spread of malignant cells arising from the mammary ducts.

REFERENCES

1. Arnd, W.: Quoted by ref. 2.
2. Cheatle, G. L. and Cutler, M.: Tumours of the Breast. London: Arnold, 1931.
3. Dunn, J., Shaw: Invasion of the Epidermis by Carcinoma. J. Path. Bact., **33**: 297, 1930.
4. Haagensen, C. S.: Diseases of the Breast. Philadelphia and London, W. B. Saunders Co., 1956, p. 468.
5. Inglis, K.: Paget's disease of the nipple. Am. J. Path., **22**: 1, 1946.
6. Inglis, K.: The essential difference between the epidermal changes in Paget's disease of the nipple and those in the Bowen's precancerous dermatosis. J. Path. Bact., **54**: 637, 1952.
7. Jacobeus, H. C.: Quoted by ref. 6.
8. Tudford: Quoted by ref. 13.
9. Muir, R.: Paget's disease of the nipple and its relationships. J. Path. Bact., **30**: 181, 1927.
10. Muir, R.: Further observations on Paget's disease of the nipple. J. Path. Bact., **49**: 299, 1939.
11. Pautrier, L. M.: Quoted by ref. 2.
12. Stewart, F. W.: Atlas of tumour pathology, Sec. IX, Fascicle 33, Tumours of the Breast, Washington, Armed Forces Institute of Pathology, 1950.
13. Willis, R. A.: Pathology of Tumours. London: Butterworth and Co., 1953. P. 247-255.

Received for publication on 1-7-51.

TUBERCULOUS THYROIDITIS *

BY

D. J. REDDY, V. KAMESWARA RAO AND M. MUNISWAMY, GUNTUR

Tuberculosis of the thyroid gland may occur in acute miliary or focal caseous form. The former type is frequently observed by the pathologist at necropsy in the younger age group as one of the many organs involved in miliary tuberculosis. The focal or caseous form was first described by Lerbert[5] in 1862. It is always secondary to tuberculosis elsewhere in the body. This form of tuberculosis of the thyroid is extremely rare. The published reports on the subject given in Table I bears ample testimony to this. Klassen and Curtis[1] found only 130 cases of tuberculous thyroiditis reported in the literature. But they regard the diagnosis in many of them as questionable. Among the 34 surgically removed specimens of thyroid registered at the Pathology department, Guntur Medical College, only one each of tuberculous thyroiditis, Hashimoto's and Riedl's struma was met with for a period of 30 months. Review of the literature discloses that very rarely pre-operative diagnosis of tuberculous thyroiditis is made. This has prompted us to record the clinico-pathological findings of a case of tuberculous thyroiditis successfully treated.

TABLE I

Comparative incidence of tuberculous thyroiditis amongst surgically removed thyroids from the published reports

S. No.	Author/s	Year	Number of Thyroidectomies	Number of Tuberculous thyroid	Percentage
1	Colfer and Huggins	1926	1,200	5	4.2
2	Rankin and Graham	1932	20,758	21	0.1
3	Keynes	1938	1,225	1	0.08
4	Levitt	1952	2,114	2	0.09

Case Report

A Hindu female aged 45 years was admitted under M.M. on 29th July 1957 in the Government General Hospital, Guntur, for a painful swelling in the right half of the neck just below the angle of the mandible of 12 months duration. This swelling was one inch in diameter. The swelling was said to have been incised and in its place a sinus discharging serosanguineous fluid is persisting. Adjoining the sinus, she noticed another swelling and this swelling had been there since 6 months. At no time was she troubled by cough or fever. Since two months she has had palpitations and breathlessness on exertion.

Physical examination

A sinus, almost healed is noticed below the ramus of the right half of the mandible. (Fig. 1). An irregularly shaped bosselated swelling in the region of the thyroid was observed. It was to the right of the median line and was 2" in diameter. The swelling was hard and moved with deglutition. It was adherent to the sternomastoid and structures around. There was no clinical or laboratory data of hyper or hypo function of the thyroid in the patient. All other systems are normal.

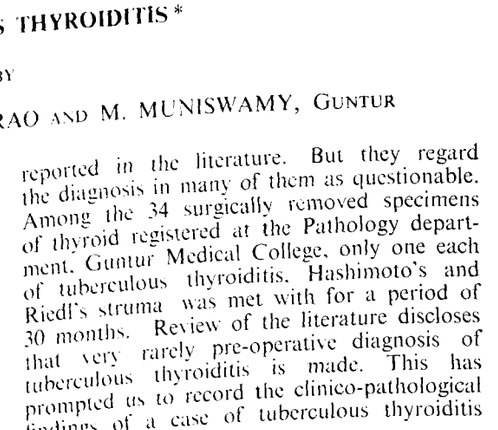


Fig. 1

Photograph of the patient shows a healing sinus just below the right half of the mandible and the healed operation wound of thyroidectomy below. Sectioned surface of thyroidectomy shows well defined zone of caseous necrosis.

* Dept. of Pathology, Guntur Medical College, Guntur.

Investigations

Blood Pressure	:	114 70 mm Hg.
Sleeping Pulse	:	80 per minute.
Urine	:	Nil abnormal.
Blood Urea	:	27 mgms per cent.
B.M.R.	:	+7 per cent.
Cholesterol	:	195 mgms per cent.
Blood Sedimentation rate	:	125 mm first hour.
Chest X-ray	:	Haziness of left basal zone possibly due to thickened pleura.

Pre-operative diagnosis of "Carcinoma of the thyroid" was made. Subtotal thyroidectomy was done by M. M. At operation the tumour was found to be very hard and adherent to the skin, strenomastoid and posteriorly to the trachea.

Morbid anatomy and histology

A firm, ovoid tumour like mass measuring 2" × 1½". At one pole muscle bit and connective tissue were seen. Sectioned surface of the mass revealed geographically marked out area of necrosis of 1" in diameter. (Fig. 1) This lesion was not yielding. The tissue surrounding the zone of necrosis was very firm and rubbery in consistency. Sections of the lesion disclosed caseous necrosis typifying tuberculosis. Peripheral to the necrotic mass were seen epitheloid follicles and giant cells. (Fig. 2) Adjacent to this was noticed compressed thyroid acini, dense fibrosis, in places involving the thyroid tissue. (Fig. 3). Colloid vesicles undergoing regressive changes and formation of pseudo giant cells in and around the colloid were noticed. (Fig. 4).

Fig. 3

Photomicrographs illustrate the compressed thyroid acini adjacent to the lesion and also the zones of necrosis and cellular infiltration of muscle mass. (H. & E. × 30)

Fig. 2

Photomicrographs illustrate contiguous areas of lesion chiefly composed of caseous necrosis, fibrosis and epitheloid reaction with giant-cell. (H. & E. × 30, 30).

Fig. 4

Photomicrographs illustrate giant-cell reaction of the thyroiditis tubercular and the pseudo-giantcell noticed in the same thyroid tissue showing regressive changes. (H. & E. X 225, 225).

In places the tubercuious lesion was noticed to involve the muscle also. (Fig. 3) Acid fast bacilli could not be spotted in the histological sections. The gross and microscopic features were typical of tuberculous thyroiditis.

Comment

Based on the pathology report, the healing sinus noticed beneath the ramus of the mandible is recognised as of tubercular origin and that the first swelling observed by the patient is presumed to be cervical tubercular lymphadenitis. Tuberculous process from the lymph nodes has extended to the homolateral thyroid lobe. The patient was treated with streptomycin and placed on high calorie diet. The sutures were removed, the sinus and operation wound healed. (Fig. 1). She has put on appreciable weight and is progressing well.

Fixation of surrounding structures observed in the thyroid in our case presents morphological resemblance to fibro-lymphoid hyperplasia of the thyroid. Adding to this confusion Crile[10] described tubercle like foci of degeneration in subacute thyroditis. But the histological picture observed by us is characteristic of tuberculosis and only occasionally tubercle bacillus was demonstrated in the cases reported. It is nothing strange that our case was pre-operatively suspected to be carcinoma for a similar mistake was made by Frassi.[2]

Summary

1. Literature regarding tuberculous thyroiditis with special reference to its infrequent occurrence is recorded.

2. Clinico-pathological findings and treatment of a case of focal massive caseous tuberculosis of the thyroid are recorded.

Acknowledgement

We thank Dr. K. Gopalakrishniah Gupta for the help rendered.

REFERENCES

1. Coller F. A. and Huggins, C. B.: Tuberculosis of thyroid gland. Ann. Surg., **84** : 804–820, 1926.
2. Frassi L.: Dtsch. z. Chir. **213** : 416, 1929.
3. Keynes, G.: Lancet **2**, 1357. 1938.
4. Klassen K. P. and Curtis G. M.: Tuberculous abscess of thyroid gland. Surgery, **17** : 552–559, 1945.
5. Lebert, H.: Die Krankheiten der Scilddruse and ihre Behandlung. Breslau, 1862.
6. Levitt T. The Thyroid 1st Edn. E. & S. Livingstone Ltd., Edinborough and London, 1954.
7. Rankin, F. W. and Graham, A. S.: Ann. Surg., **96·7** : 625, 1932.
8. Stubbins, W. M. & Guthrie, R. F.: Tuberculous abscess of thyroid-case South Surgeon., **14** : 351–357, 1948.
9. Rundle, F. F.: Joll's Diseases of the Thyroid gland. 2nd Edn., 1951. William Heinmann Medical books Ltd., London.

Received for publication on 3-10-57.

EARLY AMBULATION AFTER ABDOMINAL AND VAGINAL OPERATIONS

BY

S. L. MALHOTRA, BHUSAVAL

Early ambulation after abdominal operations is now encouraged by many surgeons. Maingot (1957) allows his patients out of bed early, usually on the 2nd or 3rd day following operation. At first they are helped by the nurse, stand erect for a few minutes, breathe deeply and walk around the bed two or three times before being placed in a comfortable chair, in which they remain seated for a short while before returning to bed.

Palumbo et al (1952) have assessed the effects of early ambulation on post-operative complications in a series of 642 primary inguinal hernia operations. It was found that where the patients were ambulant on the first day the complication rate was 7.2% as compared with an incidence of 19.5 and 21.6% for the group of patients ambulant on the 7th and 14th post-operative days.

Wright et al (1952) using radio-active sodium demonstrated the marked slowing of the rate of venous flow at the end of 10 to 12 days, in patients confined to bed ; in ambulant cases there was no such slowing.

Farquharson (1955) in his Honyman Gillespie Oration reported on 485 inguinal herniorrhaphy operations carried out as an out-patient procedure. He concluded that early ambulation reduced the incidence of complications and had no deleterious effects on wound healing.

The purpose of the present paper is to emphasise the advantages of early ambulation which although appreciated and accepted by many surgeons has still not become the general practice. Patients in many teaching as well as non-teaching hospitals still continue to be confined to bed after operation for 8 to 10 days until stitches have been removed. Farquharson (1955), in fact, points out that during the late war an Army Order decreed that after inguinal herniorrhaphy all patients must be confined to bed for 21 days ! Thus although, early ambulation has gained a measure of acceptance conservative practices still linger. Goodall (1951) in a survey of the practice of 8 general hospitals covering 836 patients concluded that " in the great majority of wards studied, the normal practice still approximates much more closely to a traditional than to an early ambulation regime." In her series of 117 surgical patients (mostly gynaecological), Wright (1951) made the interesting observation that in 3 or 5 gastrectomies, in 31 out of 38 colporrhaphies and in all the 3 hernia operations, the patients were still in bed after 10 days.

Materials and Method

The writer started using the early ambulation regime in his appendicectomy cases since September 1955 and encouraged by the results started using this regime on his herniorrhaphies, colporrhaphies and other abdominal operations since January 1956. The paper is based on his series of patients treated on the two regimes since 1955. The series includes 248 patients as follows :

TABLE I

	Bed rest	Early ambulation
Appendicectomy ...	51	84
Herniorrhaphy ...	30	38
Herniotomy ...	Nil	12
Hysterectomy ...	Nil	4
Perforated peptic ulcer	2	4
Caesarian section ...	4	5
Colporrhaphy ...	10	4
Total ...	97	151

Total number of patients ... 248

Appendicectomy

The series includes 135 patients 84 in the ambulant group and 51 in the bed rest group.

Pre-operative care and operative technique used in both the groups was identical. There were 16 in the bed rest group and 23 in the early ambulation group on whom the interval operation was performed ; the rest were all emergency acutely inflammed appendix cases.

General anaesthesia employing oxygen and ether was used in all the cases by the same anaesthetist.

Fig. 1

Note the small 1" appendicectomy incision in a Bed Rest patient. Stitches were removed on the 8th day ; the scar is hypertrophied and patient complains of occasional itching in it.

Fig. 3

Same patient as in Fig. 2 on the 3rd postoperative day. Contrary to general belief, after early removal of stitches, the skin edges do not gape. In fact the healed scar is trouble-free and almost invisible when stitches are removed early.

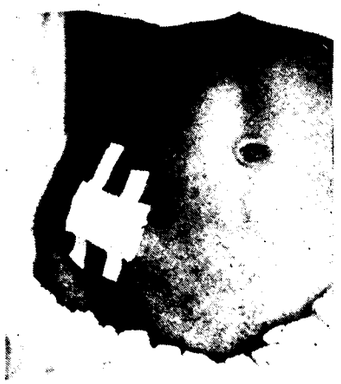


Fig. 4

No abdominal binders or corsets are used. Post-operative dressing in hernia operations and appendicectomies is a simple pad of sterilised lint secured with strips of adhesive tape.

Fig. 2

Note the inconspicuous scar 2" long in and ambulant patient ; stitches were removed on the 3rd.

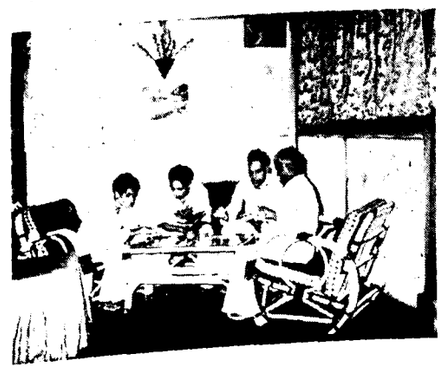


Fig. 5

The two patients on the left are herniorrhaphy and appendicectomy cases respectively on the morning of the 2nd post-operative day using the amenities of the Recreation Room adjoining the ward. The effect of early ambulation on their morale is incalculable.

Fig. 6

Removal of stitches on the 3rd day in a large incision may appear risky but does no harm. Figure shows a patient on whom hysterectomy was performed to remove a massive uterus (fibroids) rising two inches above the umbilicus. The original incision had to be extended upwards to deliver the big mass. Advantages claimed for early removal of stitches are that the scar will not get hypertrophic and will in fact become faint as healing proceeds. The reason is the absence of a foreign body reaction from stitching material.

Gastric suction through Ryle's tube and 5% glucose saline intravenous drip were used in some of the cases, before the operation where the pulse rate was above 120 per minute or abdominal distension was present.

The appendix was excised in the usual manner after simple ligation. The base of the appendix was secured by a double ligature and no purse-stringing has been used in any of the cases in this series. For closure of the muscle layers interrupted nylon sutures secured loosely are employed.

Post-operative care : As soon as post-anaesthetic vomiting has stopped water is allowed freely. The patient is encouraged to move about in bed by his own effort. This consists in turning from side to side, drawing up the legs and straightening them, taking deep breaths and sitting up in bed. This is very important and with a little encouragement even a nervous patient will co-operate satisfactorily. On the evening of the first day i.e., 6 to 8 hours after the operation the patient is encouraged out of bed to stand beside it with the help of the house-surgeon. He is encouraged to take slowly 4–5 steps by the side of the bed before returning to it. With friendly persuasion the patient usually co-operates. He is instructed to sit up in bed with his own effort and to pass urine. On the second morning, *i.e.*, 20 to 24 hours after the operation the patient gets out of bed and walks round it before returning to an easy chair where he stays for an hour or so before lying down. The patient appreciates the relaxation and freedom from pain that early activity provides. Early ambulation breaks the vicious circle of fear pain muscle spasm. On the evening of the second day the patient walks across the ward (10 to 15 steps) and returns to an easy chair for some time, before getting back to bed where he must keep moving about and sitting up as explained before. On the morning of the third day the patient goes to the toilet assisted by a ward attendant, every time he wishes to pass urine. He is encouraged to walk about freely from the beginning of the 3rd post-operative day, and spend as much time as he likes in the Hospital Recreation Room adjoining the ward. In the afternoon of the 3rd post-operative day he receives two ounces of liquid paraffin in two teaspoonful doses every 15 minutes. This ensures a bowel action without the liquid paraffin "leaking out." If bowels have not moved by the morning of 4th day a small enema of two ounces of glycerine and two ounces of water is given. After the bowels have moved the patient is given "full" diet.

Post-operative dressing is a simple pad of sterilised lint secured with strips of adhesive tape. No abdominal binders or corsets, etc., are used. Bed-pan is never necessary as the patient is encouraged to go to the toilet where urinals and commodes are provided.

Stitches are removed on the evening of the 4th day.

In the bed rest series the post operative management was substantially different. The patient remained in bed for 8 days until the stitches had been removed when he was permitted to move about in bed. If he wanted to take a turn in the bed he was not allowed to exert himself but was assisted into that position. During most of this period he was kept in Fowler's position. On the first two days after the operation he was not allowed any fluids by mouth except ice to suck ; instead, fluids were given intravenously. Patient got out of bed only after the 10th or 12th day when he invariably felt very weak and unsteady. Dressings were large and had to be secured by an abdominal binder.

Table II shows the incidence of complications in the two groups.

TABLE II

Showing the incidence of complications in Appendicectomies

S. No.	Nature of complication	Bed Rest. (51 patients)	Early Ambulation (84 patients)
1	Gas colics	8 (15.69%	2 (2.38%)
2	Distension lasting upto 3rd day	20 (39.01%)	Nil
3	Distension lasting upto 36 hours	40 (78. 4%)	3 (3.57%)
4	Retention of urine	23 (45.09%)	Nil
5	Retention of urine necessitating catheterisation ...	6 (11.76%)	Nil
6	Chest complications	11 (21. 5%)	1 (1.19%)
7	Haematoma	1 (1.96%)	1 (1.19%)

TABLE III

Showing other comparative Data in Appendicectomies

S. No.	Nature of complication	Bed Rest. (51 patients)	Early Ambulation. (84 patients)
1	Average period of stay in the hospital in days... ...	15	9
2	Average period before return to work, in days ...	21	12
3	The day on which peristaltic sounds appeared ...	3rd	1st
4	The day on which the patient passed flatus on his own	3–4	1–2

Inguinal Herniae

The series includes 80 patients operated on for inguinal hernia. The practice of early ambulation was started in January 1956 and relates to 38 herniorrhaphies and 12 herniotomies. There has been no difference in the early ambulation and bed rest groups as regards pre-operative preparation and operative technique.

Post-operative care : This is exactly on the same lines as described under appendicectomy, patients under Early Ambulation regime getting up within a few hours of the operation whilst the patients under Bed Rest regime remaining confined to bed for 12 days. The results in the two groups are summarised in Table IV

TABLE IV

Comparing the two groups of Hernia operations

S. No.	Nature of complication	Bed Rest series	Early Ambulation series
1	Post-operative distension	7 (23.3%)	1 (2.00%)
2	Retention of urine	13 (43.3%)	2 (4.00%)
3	Chest complications	6 (20.0%)	3 (6.00%)
4	Sepsis	1 (3.3%)	2 (4.00%)
5	Recurrence	Nil	1 (2.00%)
6	Average stay in hospital	22 days	15 days
7	Average period in days before return to work ...	38 days	23 days

Caesarian section, Hysterectomy, and Peptic Ulcer perforations : In these cases due to the length of the scar and seriousness of the illness, getting out of bed is delayed until the evening of the 3rd post-operative day, but the patient is encouraged to move about freely in bed by his own effort, *i.e.*, turn from one side to the other, draw up the legs, and sit up by own effort, from the beginning of the post-operative period. The results in the two groups are summarised in Table V.

TABLE V

Comparing the Results in 9 Caesarians, 4 Hysterectomies and 6 Perforated Peptic Ulcers

	No.	Retention of Urine	Distension	Chest complications
Bed Rest Series	6	33.3%	66.6 %	16.6%
Early Ambulation	13	Nil	7.68%	Nil

Colporrhaphy

Most surgeons prescribe 12 to 17 days rest in bed after colporrhaphy. Victor Bonney (1952) allowed his patients to get up on the 17th day after perineorrhaphy, colporrhaphy, or amputation of the cervix. Wright et al (1951) in their series of 117 surgical patients found that 31 out of 38 colporrhaphy patients were still confined to bed on the 10th post-operative day. The writer's series of these vaginal operations being small is not suitable for any comparison. Being encouraged by the fact that early rising is not deleterious in abdominal operations, he has only recently started getting up his colporrhaphy patients. Judging from the experience of these four patients the general impression is gained that the convalescence is much smoother by early ambulation and it has no deleterious effect on the operative result.

Discussion

The method of early ambulation has been practised for more than 50 years. Emil Reis (1899) advocated early ambulation after operations but his views did not gain general acceptance.

Nelson (1944) obtained excellent healing and low incidence of post-operative complications in children who were made ambulant within 72 hours following operation.

Leithauser (1946) published his monumental work "*Early ambulation and related procedures in surgical management*" based on 7½ years experience of early rising and a series of over 2,000 patients. He gets his surgical patients up as soon as they come round from the anaesthetic which may be 3 to 4 hours after operation ; by the end of 24 hours most of them have been out of bed several times. He records an average stay of 1.9 days in hospital following interval appendicectomy.

Schafer and Dragstedt (1945) recommended getting patients up on the 1st to 3rd post-operative day.

Rest in bed after operations seems to be based on the following premises :—

(1) It brings comfort to the patient.

(2) It promotes wound healing.

(3) It prevents wound disruption.

(4) Fowler's position has the great advantage that it encourages the gravitation of peritoneal fluid into the pelvis and minimises any risk of general peritonitis.

1. It is not the writer's experience that rest in bed brings comfort to the patient. In fact due to the higher incidence of abdominal distension, chest complications producing cough, it causes more discomfort. After the first steps have been taken on the 1st post-operative day, the fear of pain is gone and the reflex spasm of muscles gives way to relaxation which the patient appreciates.

2. As regards wound healing, it is open to question whether the healing of an operation wound really does require rest in bed, complete and uninterrupted. The Lancet (1951) points out that " the chief need in the post-operative period is that the process of healing in recently divided and resutured tissues shall not be prejudiced. The arrest of capillary haemorrhage, the sealing of spaces, the knitting of gaps by fibroblasts and the bridging of incisions by epithelial cells—all these require rest, complete and uninterrupted, to the injured part, though to that part alone. This can be attained only by rest in bed." Blodgett and Beattie (1946), Burch and Bradley (1947), on the other hand, have deduced evidence that wound healing is actually accelerated by a reasonable degree of activity. In the case of anastomoses in the gut, early ambulation, by promoting the return of normal gastro-intestinal motility, in fact, reduces the strain on the suture line caused by distension of the gut. In the case of fractures it is well-known that early activity and weight-bearing, as emphasised by Perkins (1946) promote and accelerate healing.

3. Wound disruption would appear to be the greatest fear entertained by the surgeon as well as by the patient. In fact, our patients had to be reassured that the stitches would not give way by their walking about and getting up early.

Jenkin (1937) has shown that when a wound does disrupt the patient, with rare exceptions is lying in bed and has usually been confined to bed since operation for 7 to 10 days. In the present series there was only one instance of wound disruption. In one patient of peptic ulcer perforation the wound partly gave way on the 8th day and this patient was treated with complete bed rest in Fowler's position.

Advantages of early ambulation

1. *The lower incidence of post-operative complications.* A study of table two and four brings out this point. Churchill and McNeil (1927) showed that when patients are confined to bed after upper abdominal operations the

vital capacity falls progressively until the 4th or 5th day. If, however, the patient becomes ambulant within 24 hours, lowering of the diaphragm and muscular activity continue to promote full aeration of the lungs.

In the lying down position coughing is difficult so that mucus may collect and atelectasis ensue. Coughing causes much pain and in our ambulant patients its incidence was negligible as compared to patients not made ambulant early.

Although rare, rest in bed also causes considerable slowing of the venous blood-flow and thus favours the onset of thrombosis or embolism in the pulmonary circulation.

2. *The lower incidence of nausea, vomiting and abdominal distension.*—Early ambulation promotes the return of normal gastro-intestinal activity. In our cases intestinal activity judged by the appearance of bowel sounds returned on the 1st to 2nd day enabling the patient to pass flatus whereas in those patients kept confined to bed it took 3 to 4 days. Abdominal distension which causes much distress is eliminated by early ambulation. Patients not made ambulant, complained of distension till the 4th day until an enema had been given.

3. *The earlier return of normal function of the bladder and bowel.*—None of our ambulant patients needed catheterisation or complained of inability to pass urine. Passing urine while lying down in bed is not only difficult because the patient is not used to that, but it is embarrassing and so causes reflex inhibition. Our ambulant patients have always appreciated the privilege of being allowed up for passing urine, and catheterisation or the use of Doryl was not found necessary.

4. *Patient's Morale*—The effect of early ambulation on the patient's morale is incalculable. He is happy to take over the management of his own personal hygiene not to suffer the discomfort of being catheterised or of using a bed-pan. The Recreation Room equipped with books, and playing cards, and a carrom board, etc., has played an important part in building up confidence in our patients, for when he participates with his fellow patients, the feeling of being an invalid is completely dispelled.

5. *Acceleration of convalescence and early return to work.* This has obvious advantages. By early ambulation the patient quickly gains strength and is able to return to work earlier than his fellow patient who was kept confined to bed.

Summary

1. Early ambulation reduces the incidence of complications, uplifts the patient's morale, and accelerates his recovery.

2. Reference has been made to 151 patients who were made ambulant within a few hours after recovery from anaesthesia. Comparison has been made with 97 cases of patients treated on the traditional regime of bed rest.

3. Early ambulation has no deleterious effects on wound healing and has also been most satisfactorily utilised in colporrhaphies and herniorrhaphies without any risk of recurrence.

REFERENCES

1. Bassini : Arch. Klin. Chir., **40** : 429 : 1890 quoted from Rodney Maingot's Abdominal Operations, 1948, Appleton-Century-Crofts, Inc., New York.
2. Blodgett, J. B., Beattie, E. J. : Surg. Gynaec. Obstet., **82** : 485, 1946.
3. Bonney, V. : Textbook of Gynaecological Surgery, Cassel and Co., London : 103, 1952.
4. Burch, J. C., Bradley, C. F. : Ann. Surg., **125** : 768, 1947.
5. Churchill, E. D. and McNeil, D. Surg. Gynaec. Obstet., **44** : 483, 1927.
6. Emil Reis : J. Amer Med. Ass., **33** : 454, 1899 quoted from Goodall.
7. Farquharson, E. L. : Lancet, **ii** : 517 1955.
8. Goodall, J. W. D. : Lancet, **i** : 43 1951.
9. Haxton : Brit. Med. J., **1** : 12 1945.
10. Jenkins, H. P. : Surg. Gynaec. Obstet. **46** : 648, 1937.
11. Lancet : **1** : 95 1951.
12. Leithauser, D. J. : Early Ambulation, Springfield, Ill. 1946.
13. Maingot, R. : The Management of Abdominal Operations, H. K. Lewis and Co., London : 115, 1957.
14. Nelson, H. : Arch. Surg. 49 : 1 1944.
15. Palumbo, L. L. : et el Arch. Surg., Chicago **64** : 384, 1952.
16. Perkins, G. : Lancet, **1** : 49, 1947.
17. Wright, H. P. : Osborn, S. B., Edmonds, D. G. Lancet, **1** : 22, 1951.

Received for publication on 19-10-57.

ORTHOPAEDIC SECTION

BENIGN CHONDROBLASTOMA OF BONE *

BY

M. V. SIRSAT, BOMBAY **

Among the recent noteworthy contributions to the knowledge of bone tumours is the recognition of benign chondroblastoma as a distinct entity. This rare primary tumour of the bone was first described in detail by Jaffe and Lichtenstein[6] (1942). Prior to their report benign chondroblastoma was grouped as a variant of the giant cell tumour. The evolution of the current knowledge of the entity has been well sketched by Kunkel et al[7]. From a survey of the literature, it at once becomes clear that our knowledge of benign chondroblastoma of bone is largely due to the investigations by American workers. Upto July 1956, 60 cases of benign chondroblastoma have been reported in the literature. So far as can be ascertained no case has been reported from our country. It was therefore considered worth recording the following 3 cases encountered amongst 102 benign bone tumours documented in the laboratories of the Tata Memorial Hospital, Bombay, during the years March 1941 through March 1957. In two instances the diagnosis was chondroma so that a revision of an earlier pathology report was necessary. The purpose of this communication is to highlight the tumour which deserves recognition in our country.

Report of Cases

Clinical findings : Table I summarises the data on the 3 cases of benign chondroblastoma of bone.

TABLE I

Summary of the Data on 3 cases of Benign Chondroblastoma of Bone

Department of Pathology, Tata Memorial Hospital, Bombay

S.No.	T.M.H. case No.	Age (years) Sex	Site	Signs & Symptoms	Clinical Diagnosis	Roentgenologic Diagnosis	Treatment
1	R. 5181	23 / M	Iliac Bone.	Pain and swelling. No trauma. No fever.	Chondrosarcoma.	Benign bone tumour.	Curettage.
2	S. 457	15 / F	Upper Humerus.	Pain and swelling. No trauma. No fever. Dilated veins over the tumour.	Chondrosarcoma.	Chondroma.	Curettage.
3	S. 3659	15 / F	Upper Humerus.	Pain and swelling. No trauma. No fever. Dilated veins over the tumour.	Giant Cell Tumour.	Benign Chondroblastoma.	Curettage done 3 times.

* Paper read before the meeting of the Teaching Pathologists, held at the Tata Memorial Hospital, Bombay, on June 29, 1957.

** From the Department of Pathology, Tata Memorial Hospital, Bombay.

Case 1.—A male aged 23 years (No. R. 5181) was admitted to the Tata Memorial Hospital, Bombay, on September 9, 1955, with a swelling over the left iliac region. There was no history of trauma or fever. On examination there was a rounded non-pulsatile swelling over the left loin in its lower aspect. The swelling measured 7.5 · 7.5 cms. and was firm and tender. The surface was smooth. The borders were well-defined. Dilated veins were visible in the skin over the swelling. Laboratory investigations on blood and urine showed no abnormality. The tumour was scooped out. The patient left the hospital on October 15, 1955. The patient reported again to the hospital on June 12, 1956. There was no recurrence of the tumour.

Case 2.—A girl, aged 15 years (No. S. 457), was admitted to the hospital on February 23, 1956, with pain over the right shoulder of 2 years' duration and a swelling of 6 months' duration. There was no history of trauma or fever. On examination, there was a diffuse swelling in the upper 1/3rd of the right arm measuring 12 · 7 · 7 cms. The swelling was fusiform in shape with a smooth surface and had indefinite margins. It was hard and tender. The skin over the swelling showed dilated veins. Movements at the shoulder joint were restricted and painful. Blood and urine examination showed no abnormality. The tumour was scooped out from the humerus. The patient left the hospital on April 10, 1956. There is no follow-up.

Case 3.—A boy aged 15 years (No. 3659) was admitted to the hospital on September 3, 1956, complaining of pain in the left upper arm of 7 months' duration. The pain was severe and continuous. Three months after the pain had started he developed a swelling of the left upper arm near the shoulder. There was no history of trauma or fever. A curetting was done in another city hospital three months before he came to this hospital. On examination, there was a hard swelling at the upper end of the left humerus. Movements of the shoulder-joint were restricted, because of the pain. The tumour was scooped out thoroughly. Six months later he again developed a painful swelling over the same region.

Fig. 1

Roentgenogram showing the typical appearance of benign chondroblastoma. Note that the major portion of the tumour is localised in the epiphysis (shown by arrows). The lesion is round and arched in appearance.

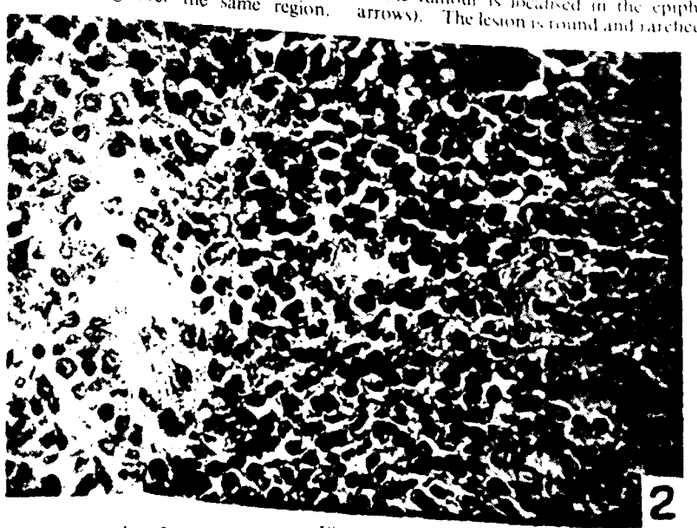


Fig. 2

Photomicrograph of benign chondroblastoma showing chondroblasts. Note the cellularity of the tumour. (H. & E. stain X 460).

This was also scooped out. The patient left the hospital on May 4, 1957. There is no further follow-up.

Roentgenologic findings : In 1 of the 3 cases the appearance was typical, the lesion being round. It was mainly located in the epiphysis (Fig. 1). Our radiologist had made a correct diagnosis on this case. The important points in roentgen diagnosis as stated by Sherman and Uzel[9] are the age, epiphysial relationship, lytic background with fine calcific shreds and an occasional periosteal reaction.

Gross findings : In none of the cases complete specimens were available. The material consisted of scooped out tissue. Some of the bits showed scattered tiny opaque white spots in the matrix of spongy bone, others showed areas which were cartilagenous in appearance.

Microscopic findings : The histological appearance in all the 3 cases showed similar structure and was typical in the sense that it agreed with the description of Lichtenstein (loc cit). The tumour was characterised by proliferating ovoid cells many of which showed an indented nucleus (Fig. 2). Jaffe and Lichtenstein (loc cit) have called these cells chondroblasts, meaning cartilage germ cells. Intermixed with these proliferating neoplastic cells were a number of multinucleated giant cells (Fig. 3). The characteristic histological feature of this neoplasm was scattered areas of chondroid material (Fig. 4).

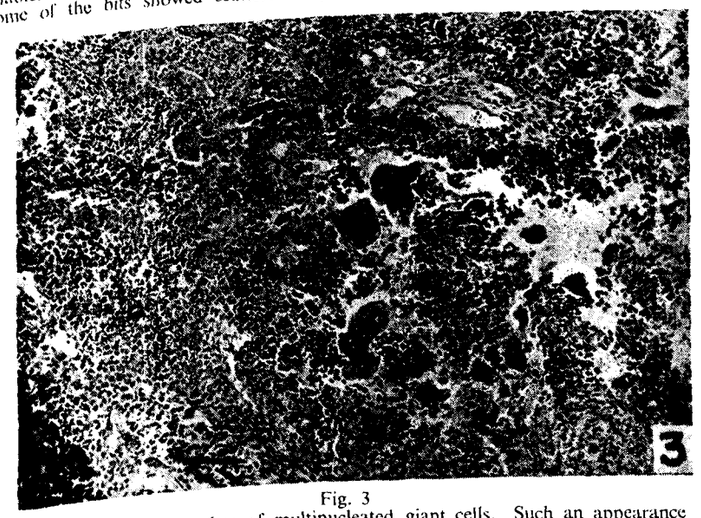


Fig. 3

A field showing a number of multinucleated giant cells. Such an appearance may lead to an erroneous diagnosis of giant cell tumour. Examination of several sections however should not give rise to any confusion. (H.&E. stain X 110).

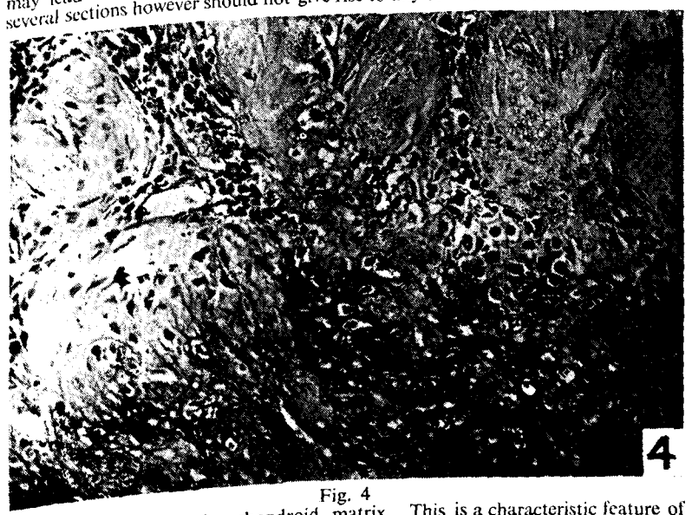


Fig. 4

Photomicrograph showing chondroid matrix. This is a characteristic feature of the tumour. (H. & E. stain X 240).

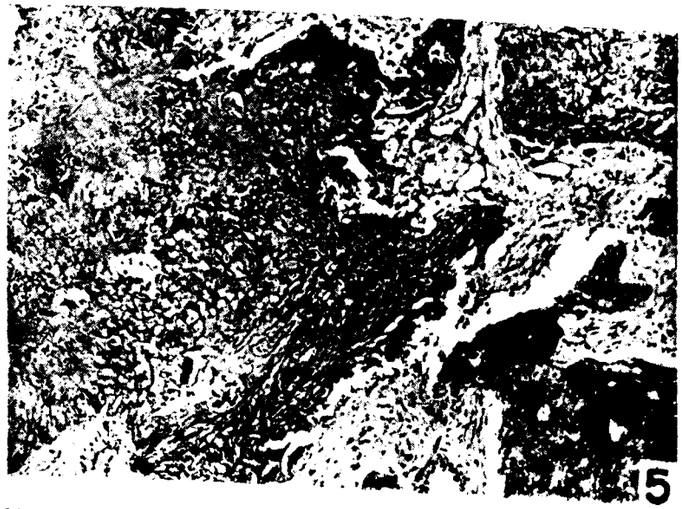
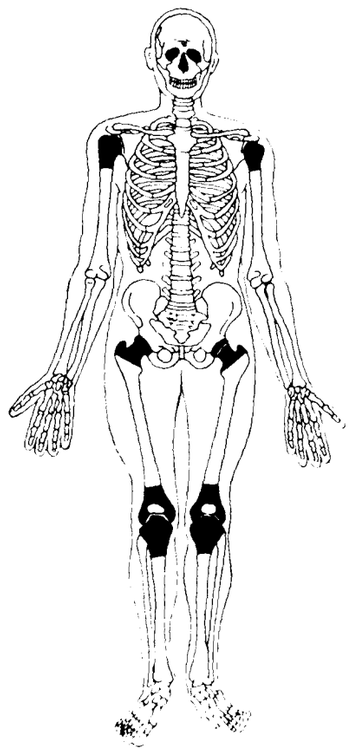


Fig. 5

Photomicrograph showing calcified areas. Note lace-like pattern of calcified matrix. (H. & E. stain X 110).

BENIGN CHONDROBLASTOMA OF BONE



THE EPIPHYSEAL REGIONS OF THE UPPER HUMERUS, UPPER FEMUR AND THE LONG BONES ABOUT THE KNEE JOINTS ARE THE MOST COMMON SITES. FORTY FOUR OUT OF 63 CASES (70 PER CENT) WERE LOCATED IN THESE REGIONS

Fig. 6

The other feature of this tumour was the characteristic lace-like pattern of calcified matrix (Fig. 5). While examining the sections of the tumour it was evident that the statement made by Jaffe and Lichtenstein[6] that "there is a very definite aura of cartilage about the whole tumour" is very correct.

Discussion

The tumour appears to be an uncommon one: as stated earlier only 60 cases have been reported so far all over and I have encountered an additional three cases in a collection of 102 benign tumours of the bone (2.9 per cent). Before the recognition of this tumour entity, it was variously diagnosed by pathologists as chondrosarcoma, osteogenic sarcoma, giant cell tumour and so forth. The symptoms and physical signs are not characteristic. From the clinical point of view the presenting complaint is local pain and swelling. In 2 of the three cases reported here, the clinical diagnosis was chondrosarcoma. As regards the age incidence in benign chondroblastoma, the three cases fall within the range of the ages of the patients reported in the literature, *viz.*, 10 and 25 years. Kunkel et al (loc cit) however have recorded examples in patients whose age span was from 8 to 54 years. The anatomical distribution is also characteristic, the majority occurring in the long bones. Two of the three cases reported herein had the lesion in the upper end of the humerus. One patient had the tumour in the ilium. Table II shows the anatomical distribution of 60 cases from the literature upto 1956, the three cases reported in this paper being included in the series. Figure 6 shows the most common sites of occurrence of benign chondroblastoma. The tumour has been reported from other sites in the skeleton such as innominate bones, scapula, talus and metacarpal bones. (*See* Table II), indicating that the tumour need not be limited to epiphyseal sites. Amongst unusual locations of the tumour, mention must be made of a case reported by Denko and Krauel[3] from the temporal bone. Recently I had an opportunity of examining a slide of benign chondroblastoma of the calcaneous, referred to me by Dr. (Miss) S. D. Bharucha. This is an extremely unusual location.

TABLE II

Anatomical Location of 63 cases of Benign Chondroblastoma of Bone

Location			Total number of cases
Femur —	...	...	6
Upper	...	...	15
Lower	...	...	3
Not localised			16
Humerus —	...	...	2
Upper	...	...	7
Not localised			2
Tibia —	...	...	4
Upper	...	...	1
Lower	...	...	1
Innominate bone	...	...	2
Ilium	...	...	2
Radius	...	...	1
Scapula	...	...	1
Talus	...	...	
Metacarpal	...	...	
Temporal bone			
	Total	...	63

One case reported by Denko and Krauel[3]

Fifty-nine cases collected from the literature by Kunkel et al[7].

Three cases recorded here.

The roentgenologic appearances are also characteristic [1, 4, 6, 8, 9]. The neoplasm is round or ovoid in appearance. The lesion is situated mainly in the epiphysis; this was so in one case in which the tumour was in the humerus. It does partly extend to the metaphysis.

From the literature it appears that the treatment of choice for this lesion is thorough curettement. In all the three cases reported, curettage was done. In one case the tumour recurred twice but every time showed the structure of benign chondroblastoma. It is presumed that the recurrence was due to incomplete curettement. According to Lichtenstein (loc cit) heavy irradiation with or without curettage should not be done. There is no reported instance of benign chondroblastoma with a malignant change. However Hatcher[4] has recorded an example of chondrosarcoma in a patient who had previously a benign chondroblastoma. This lesion was first curetted and then irradiated, somewhat heavily, and Lichtenstein (loc cit) opined that it may have been a chondrosarcoma induced by X-ray irradiation. The malignant variant of a benign chondroblastoma is a chondrosarcoma and need not be designated as malignant chondroblastoma as Copeland and Geschickter[2] have done.

Summary

1. Three cases of benign chondroblastoma studied in this laboratory are reported.

2. The tumour has distinctive roentgenologic and microscopical characteristics.

3. The tumour is entirely benign.

4. Although one tumour recurred twice, the microscopical examination of the recurred tumour did not show malignant change. The literature does not contain an example of malignant change in a benign chondroblastoma of bone.

REFERENCES

1. Coley, B. L., and Higinbotham, N. L.: Tumours of Bone. A Roentgenographic Atlas. pp. 101–102, Paul B. Hoeber Inc., New York, 1953.
2. Copeland, M. M. and Geschickter, C. F.: Chondroblastic Tumour of Bone: Benign and Malignant. Ann. Surg. **129**: 724–735, 1949.
3. Denko, J. V., and Krauel, L. H.: Benign Chondroblastoma of Bone. Arch. Path., **59**: 710–711, 1955.
4. Hanelin, J., and Robbins, L. L.: Radiology in Bone Pathology. New Eng. Jour. Med. **245**: 20–27, 1951.
5. Hatcher, C. H.: The Development of Sarcoma in Bone Subjected to Roentgen or Radium Irradiation. J. Bone and Joint Surg. **27**: 179–195, 1945.
6. Jaffe, H. L., and Lichtenstein, L.: Benign Chondroblastoma of Bone. A reinterpretation of the so-called Calcifying or Chondromatous Giant Cell Tumour. Am. J. Path. **18**: 969–991, 1942.
7. Kunkel, M. G., Dahlin, D. C. and Young, H. H.: Benign Chondroblastoma, J., Bone and Joint Surg. **38-A**: 817–826, 1956.
8. Lichtenstein, L.: Bone Tumours. The C. V. Mosby Co., St. Louis, 1952.
9. Sherman, R. S., and Uzel, A. R.: Benign Chondroblastoma of Bone. Am. J. Roentgenol. **76**: 1132–1140, 1956.

Received for publication on 23-8-57.

BENIGN CHONDROBLASTOMA OF BONES*

A report of two cases

BY

K. S. MASALAWALA AND R. F. SETHNA, BOMBAY

The object of this paper is to report two cases of Benign Chondroblastoma of bones, one in the humerus and the other in the calcaneus, especially as such tumours in the calcaneus are comparatively rare.

The term Benign Chondroblastoma was first applied by Jaffe and Lichtenstein[3] in 1942 to benign tumours arising at the epiphysial ends of long bones. They described nine cases. Before this, the tumour had been described under various names. Ewing was the first to describe it as a separate entity in 1928. He called it a calcifying giant cell tumour. Codman also described it in the Registry records as an epiphysial chondromatous giant cell tumour. The tumours occur only during the first and second decades of life, the commonest age being from 13–18 years. They do not occur after the fusion of the epiphysis is complete as they are related to changes which occur during growth at the epiphysial line. The majority of the tumours occur in the long bones (Jaffe and Lichtenstin,[3] Codman,[1] Sissons[5]). Coley and Santoro[2] have however reported finding such tumours in the small bones of the hands and feet. In one of the cases presented here the lesion was in the calcaneus, while in the second it was in the upper end of humerus.

Fig. 1

Case I. A.P. and Lat. views. Pre-operative (10.11.56)

Case 1.—R. B. Singh. Male. Age 21 years.

Patient stated that he hurt himself while doing a long jump two years back, and since then has suffered from pain in the left heel. The pain is not very severe and does not interfere with his activities. He did not consult any doctor after his initial injury.

On Examination : There was no swelling in the region of the left heel. Skin of the region was normal. There was slight tenderness over the outer side. Movements of ankle and foot joints were normal.

Investigations :

R.B.C.	...	4.8 mils.
H.B.	...	95%
W.B.C.	...	6000
Serum Ca	...	8.2 gms.
Serum P	...	5.5 gms.
Alkaline phosphatase		8.4 units (K.A.)

Radiograms of Lt. Calcaneus (Fig. 1) Radiograms show a localised well-defined area of increased translucency on posterior and medial aspect with loss of trabecular structure which is replaced by short irregular dense bony septa. There is slight expansion of calcaneus in the affected area, more evident on the plantar aspect with evidence of calcified spots. It was decided to curette out the cavity and fill it up with bone chips.

Operation on 5.11.56. The cavity was exposed from outer side. It contained a small quantity of fibrotic tissue with gritty particles. It was completely scraped out and packed with iliac bone chips. The wound was closed and the limb put in plaster of paris cast.

Histological Report (Fig. 2) (Dr. Sissons, Royal National Orthopaedic Hospital, London) The tissue consists of cellular tissue containing numerous giant cells and areas of chondroid material. Majority of the

Fig. 1-A

cells are round or cuboidal, the spindle cell stroma of giant cell tumour being absent.

Diagnosis : Benign Chondroblastoma.

Progress : The limb was kept in a plaster of paris cast for four months, with patient ambulant on crutches after the tenth day. Weight bearing was allowed after two months.

X-Rays : Radiogram taken on 24.4.57 (Fig. 3) shows evidence of gradually increasing consolidation in the affected area. The extent of the lesion shows no appreciable change. Radiogram taken on 27.7.57 (Fig. 4), shows complete consolidation of the bone chips with the host bone and obliteration of the lesion. Enlargement radiogram shows this quite distinctly. (Fig. 4a).

Case 2 : Miss Hiramani. Age 17 years.

Patient stated that she had pain in the right shoulder joint for the last two years. She had not suffered from any injury. The pain was of a dull aching character and had increased in intensity recently in the last two months. The pain does not radiate. At the same time, she noticed that the shoulder was swollen.

On examination : There was a diffused swelling of the upper end of the right humerus 4" × 2" in size and more marked on the anterior aspect. The skin over the swelling was normal and the muscles were not attached to the swelling. Tenderness was present in the region of the lesser tuberosity.

Movements : Only rotation movements were slightly restricted. No enlargement of the Axillary lymph nodes was present. No abnormality was detected in any other bones or joints.

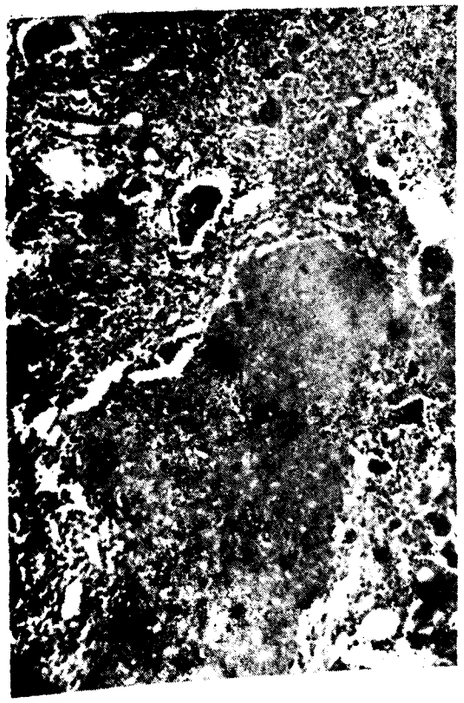


Fig. 2

Case I. Microphotograph to show the microscopic features

Fig. 3

Case 1. Radiogram four months after operation—Progressive fusion is taking place.

*From the Department of Orthopaedic Surgery and Radiology, J.J. Group of Hospitals, Bombay.

Fig. 4

Case 1. Radiogram eight months after operation. Complete consolidation. No evidence of any recurrence of the disease.

Investigations :

R.B.C.	...	4 mils.
H.B.	...	85 %
W.B.C.	...	7000
Serum Ca	...	10.6 gms.
Serum P	...	3.8 gms.
Alkaline Phosphatase		31 units (K.A.)

X-Ray : (Fig. 5) The lesion lies just below the epiphysial line. The upper end of the humerus is expanded. The cortex is thinned out specially on the inner side at the upper end where the tumour has broken through it. Sub-periosteal new bone formation can be seen on outer side. Areas of calcification are seen in the region of the greater tuberosity. The epiphysial line is not invaded.

Operation on 27-12-56 : An incision was made on the antero-medial side of the swelling so as to obtain tissue from the area where the disease has broken through the bony cortex. The tendon of the pectoralis major was divided. A portion of the cortex was removed and the tumour completely scraped out. It consisted of cartilaginous type of tissue with gritty areas. The tendon was stitched and the wound closed. As the humerus is not a weight bearing bone, it was felt that there was no need to pack the cavity with bone chips. The arm was kept tied to the side of the body for 3 weeks. Patient was then allowed to gradually regain full movements.

Histological Report : (Fig. 6) The section shows an admixture of round cells and giant cells intermingled with areas of cartilaginous matrix.

Diagnosis : Benign Chondroblastoma of the humerus.

Progress : Patient had some pain at the affected area for the first two months. X-rays show that the affected tumour area has been succeedingly replaced by new bone and consolidation is now complete. (Figs. 7 and 8).

Fig. 4*a*

Case 1. Enlargement technique radiogram.

Fig. 5-a

Fig. 5

Case 2. Fig. 5 & 5*a* Pre-operative X-Rays (20-1-57).

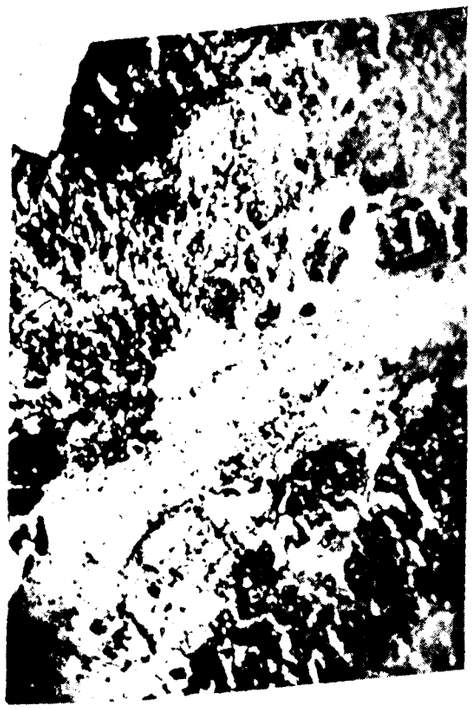


Fig. 6

Case 2. Micro-photograph to show the microscopic characteristics

Fig. 7

Case 2. Radiogram three months after operation. New bone formation in affected area is occuring.

Fig. 8
Case 2. Radiogram seven months after operation. Healing appears complete

Comments

The history of both these cases followed the classical pattern of vague trauma several months before the swelling and pain were noticed.

Radiological Features

Radiograms of both cases had several of the well-known characteristics of this tumour. The lesion starts at the epiphysial line and spreads into the epiphysis or diaphysis. It comprises an area of bony absorption. The border of the defect is usually irregular. The lesion in the calcaneus however showed well defined borders. Irregular mottling due to calcification is a very important diagnostic feature, and has been stressed by both Ewing and Lichtenstin[1]. However, because of the rarity of such lesions in the calcaneus, the correct diagnosis was not thought of pre-operatively, the calcified areas being mistaken for sequestrum. The breaking through of the lesion beyond the cortical bone may at first suggest malignancy. It is however well known to occur in these tumours. The second case showed all these classical characters. The main feature of differentiation from giant cell tumours is the absence of expansion of the bone with a trabecular pattern and the presence of calcification in the tumour.

Treatment

Curettage alone or combined with packing the cavity with bone chips has proved adequate in all cases. Recurrence is unlikely to occur. These tumours do not require irradiation. In fact Lichtenstin[4] states that heavy irradiation may lead to the onset of a malignant chondro-myxosarcoma.

In both the cases presented here, although recent the lesion appears to have healed up. Recurrence is unlikely to occur.

Acknowledgement

We wish to thank Dr. H. A. Sissons for reviewing the slides of the first case.

REFERENCES

1. Codman, E. A.: Epiphysial chondromatous giant cell tumours of the upper end of the humerus; Surgery, Gynaecology, Obstetrics **52**: 543. 1931.
2. Coley, B. L. and Santoro, A. J.: Benign central cartilaginous tumours of bone; Surgery **22**: 411. 194, 1947.
3. Jaffe and Lichtenstein: Benign chondroblastoma of Bone; A reinterpretation of the so-called calcifying or chondromatous giant cell tumours. American Journal of Pathology; **18**: 969. 1942.
4. Lichtenstin, L.: Bone Tumours; C. V. Mosby Company. 1952.
5. Sissons, H. A.: Proceedings of Royal Society of Medicine; 416. 1956.

Received for publication on 22-1-58.

A CASE OF MELORHEOSTOSIS LERI

BY

K. S. BOSE, CALCUTTA

Melorheostosis Leri is a very rare condition of bone in which Osteopetrosis occurs like candle drippings along longitudinal axis of bone radiologically. It is a chance finding during radiography when patients come with symptoms of pain and limitation of joint movements or extreme rigid type or flat foot.

Leri and Joanny (1922) first reported a case in which one arm was affected and suggested the descriptive title of Melorheostosis—molten wax flowing down the side of a candle "coulee de bougie." In 1927 Putti described two cases. In British literature only four unquestionable cases were reported by Fairbank upto 1948, (that of Wakely 1931, Boggon 1938, Fanklin and Matheson 1942, Le Vay 1946). Other reports of cases that appeared were found on critical examination as erroneous by Fairbank (1951). Since 1948, three more case reports have been published that of Eckles (1954 and 1956). Thompson et al (1951), Trevethick (1953), near about 40 case reports have been published in World Literature. The finding of such a rare case in a young girl where both inferior extremities were involved is worth reporting. This case was followed for 4 years and was found to progress gradually.

Fig. 1

Case Report

A.R.G.—Aged 19 attended Orthopaedic Department, Medical College, Calcutta in March 1953 with complaints of pain and stiffness of both feet with gradual onset. She gave past history of enteric fever at age of 11 years followed by pain and deformity of foot. She had subsequent attacks of Chicken-pox, Pneumonia and Cholera. On examination she was of average build and nutrition, looking her age. Nothing abnormal was detected in her general examination. On local examination Bilateral Stiff flat foot were noted, stiffness of right foot was more marked. Bony tenderness was absent, ankle movements were present but inversion, eversion and abduction movements of foot were limited. Skin was not healthy and Metatarso-phalangeal and inter-phalangeal joints were normal. Skiagraphy revealed the condition as Meforheostosis. The condition affected both inferior extremities, spine, skull, facial bones, ribs and pelvis were not affected. Routine blood picture was normal, Serological test of blood was negative, and urine analysis was normal.

The case was followed up clinically and Radiologically for last 4 years and it was found that the condition progressed but without limitation of movements of big joints except stiffness of both feet. Her only trouble was Osteoscopic pains which responded to aspirin, salicylates and other analgesics when required. She

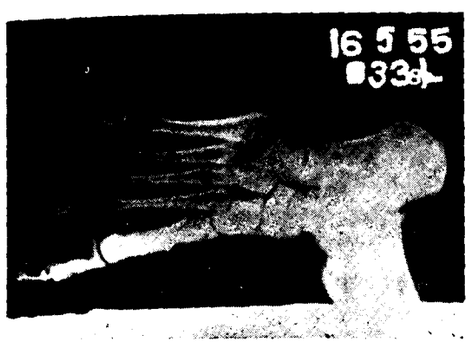


Fig. 2

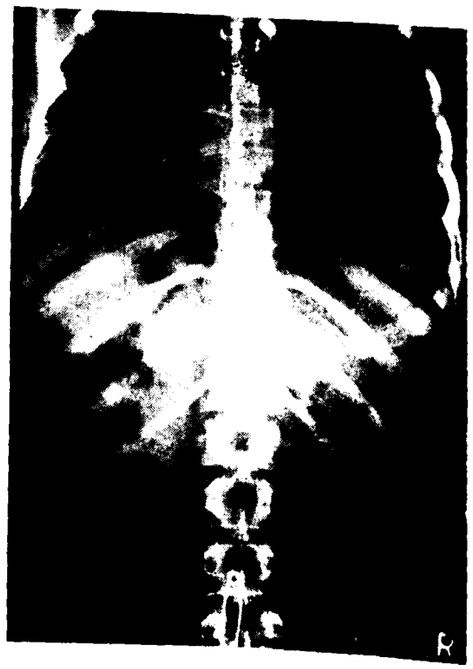


Fig. 3

Fig. 5

had during this period low fever, weakness, cough and her chest was X-rayed to find a round slightly opaque shadow in Right Hilar region. She responded to anti-tuberculous treatment and was symptom free. Biopsy of first Metatarsal bone on 23.4.53 was done. Macroscopic finding was that bone was sclerosed like ivory, very hard to chisel and there was no evidence of medullary cavity. Skin section histologically revealed normal appearances, while that of bone showed Osteosclerosis, absence of typical whorled arrangement of lamella and bone cells.

Fig. 4

Discussion

Melorheostosis is a very unusal bone affection, the etiology and pathogenesis of which is obscure. Ischaemia secondary to local vascular obliteration by Neuro-sympathetic Vasomotor disturbances has been suggested by Putti (1927). Developmental error may be another cause. It is not hereditary or familial. Both sexes are equally involved and onset is usually in early age. It is a distinct condition from other allied and rare condition as Osteopoikilosis and Albers Schonberg disease (marble bones). The bone in this condition is not brittle and is not liable to fracture as in marble bone disease. Skiagraphy is diagnostic as both long and short bones are affected but the affection skips over joint surface and hence stiffness and ankylosis do not occur. Condition is progressive but anaemia seldom develop unlike Albersschonberg disease. No definite treatment is known.

Summary

1. A case of Melorheostosis is presented for its rarity.

2. The Etiology and Pathogenesis is discussed with a detailed Bibliography.

Acknowledgement

I am thankful to Dr. S. C. Bose, Principal-cum-Superintendent, Medical College & Hospitals, Calcutta and to Professor-Director, Dr. S. Dutta, Prof. K. Sarbadhikary & Prof. S. Mukherjee.

BIBLIOGRAPHY

1. Eckeles, A. : Melorheostosis involving all limbs, pelvis, Sacrum : X'ray transaction of Medical Society of London, **70** : 204. (1954)

2. Eckeles, A. : Report of a case involving all extremities Indian Jour. of Radiology, Sovuenir number..... : 127-133. (1956)

3. Fairbank Sir, T. : An atlas of General Affection of the Skeleton : E. and S. Livingstone Ltd. (Edin. & Lond.). (1951)

4. Franklin, E. L. and Matheson, A. Melorheostasis. Report on a case with review of literature, Brit. Jour. Radiology., **15** : 585. 1942 :

5. Leri A. and Joanny, J. Bulletin de la Societica Medical des Hopitaux de Paris., **46** : 1,141. 1922 :

6. Levay, A. D. A case of Melorheostosis. Brit. Jour. of Surgery, **34** : 211. 1946 :

7. Thompson, N. M., Allen, C. E. L., Andersons, G. S., Gil. Wald, F. N. Jour. of Bone and joint surgery., **33-B** : 430. 1951 :

8. Trevethick. R. A. Lancet : **1**, 25. 1953 :

9. Wakeley, C. P. G. Proceeding of the Royal Society of Medicine, **25** : 145. 1931

10. Boggon, R. H. Proceeding of the Royal Society of Medicine. **32** : 439. 1938 :

11. Fairbank, H. A. T. Jour. of Bone and Joint Surgery, **30-B** : 533. 1948 :

Received for publication on 11-1-58.

ASSOCIATION NOTES

GOVERNING BODY

President
S. S. ANAND (Amritsar)

Vice-President
A. E. de SA' (Bombay)

Founder President (Ex-officio Member)
K. G. PANDALAI (Madras)

Three Immediate Past Presidents (Ex-officio Members)
C. P. V. MENON (Madras)
S. J. MEHTA (Bombay)
G. M. PHADKE (Bombay)

Hony. Secretary
A. VENUGOPAL (Madras)

Immediate Past Hony. Secretary (Ex-officio Member)
U. MOHAN RAU (Madras)

Hony. Treasurer
C. P. V. MENON (Madras)

MEMBERS
B. RAMAMURTHI, Madras
R. NIGAM, Nagpur
P. K. SEN, Bombay
B. N. SINHA, Lucknow
V. R. THAYUMANASWAMI, Madras
A. K. SAHA, Calcutta
V. P. MEHTA, Bombay
M. KRISHNAMURTHI, Visakhapatnam

THE XX ANNUAL CONFERENCE

The XX Annual Conference of the Association of Surgeons of India will be held at Visakhapatnam on the 27th, 28th, 29th and 30th December, 1958. The following Papers will be discussed :—

1. Acquried Facial Defects
by Dr. M. Mukherji, Calcutta

2. Hydronephrosis—Experimental and Clinical Studies
by Dr. B. N. Balakrishna Rao, Gwalior & Dr. A. E. deSa', Bombay

3. Cysts of the Lung
(i) Hydatid Cyst of the Lung—
by Dr. S. K. Sen, New Delhi
(ii) Cystic Disease of the Lung—
by Dr. G. S. Karai, Calcutta

Besides this, a few 'Short Papers' will also be read at the Conference. Further details about the Conference will be announced later.

Subjects for Discussion at future meetings

21st Meeting :

1. Place of Vascular grafts in Obliterative Vascular diseases
by Dr. R. Nigam, Nagpur &
Dr. V. V. DaSilva, Bombay

2. Uses of Radio-active Isotopes in Surgery
by Dr. Miss P. Parvathi, Calcutta &
Dr. S. R. Mukherjee, Calcutta

22nd Meeting :

1. Reconstructive Surgery of the Biliary Tract
by Dr. S. J. Mehta, Bombay

2. Clinical & Experimental Studies in Keloids
by Dr. K. K. Ghosh and J. L. Sinha.

CONTRIBUTORS — APRIL, 1958

1. Dr. P. N. Satsangi, B.Sc., M.B.B.S., Lady Tata Memorial Research Scholar, Dept. of Surgery, K. G. Medical College, Lucknow,

   Dr. Bal Krishna, M.Sc., Scientific Officer, Central Drug Research Institute, Lucknow & Dr. Tara Chandra, M.S., F.R.C.S. (ENG.), Reader in Surgery, K. G. Medical College, Lucknow.

2. Dr. G. M. Phadke, M.B.B.S., F.R.C.S. (ENG.), Colony Nursing Home, Sir Balachandra Road, Matunga, Bombay 18.

3. Dr. Pritam Das, M.S., F.R.C.S. (ENG.), F.A.C.S., Surgeon, K. G. Medical College, Lucknow (Now Professor of Clinical Surgery, G. S. V. M. Medical College, Kanpur).

4. Dr. M. S. Joshi, M.B.B.S.,
   Dr. N. V. Nimbkar, M.B.B.S. &
   Dr. A. B. Rindani, M.B.B.S. } Dept. of Surgery, K. E. M. Hospital Bombay

5. Dr. Elizabeth Thomas, M.B.B.S., Dept. of Pathology, Christian Medical College Hospital, Vellore (S. India)

6. Dr. S. Agarwal, M.B.B.S., M.Sc. (PATH),
   Dr. J. B. Shrivastav, M.D., D.B. (LOND.) &
   Dr. K. D. Sharma, M.B.B.S., M.Sc. (PATH.) } Dept. of Pathology & Bacteriology, Medical College, Nagpur

7. Dr. D. J. Reddy, M.S., Principal & Professor of Pathology,
   Dr. V. Kameswara Rao, M.D., Tutor in Pathology, &
   Dr. M. Muniswami, B.A., M.S., Professor or Surgery, } Guntur Medical College, Guntur

8. Dr. S. L. Malhotra, M.B.B.S., B.Sc., M.R.C.P. (LOND.), D.C.H. (ENG.), D.P.H. (LOND.), Dist. Medical Officer, Central Railway, Bhusaval (Now C.M.O., N.F. Railway, Maligaon Rly., H. Q. Pandu, Assam).

9. Dr. M. V. Sirsat, M.D., Pathologist, Tata Memorial Hospital, Bombay,

10. Dr. K. S. Masalawalla, M.B., M.S., F.R.C.S.E., &
    Dr. R. F. Sethna. } Dept. of Orthopaedic Surgery & Radiology, J. J. Group of Hospitals, Bombay.

11. Dr. K. S. Bose, M. S., Hony. Orthopaedic Surgeon, Medical College Hospitals, Calcutta (39, Pudda Pukur Road, Calcutta 20).

INDEX TO ADVERTISERS