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# The Indian Journal of Surgery





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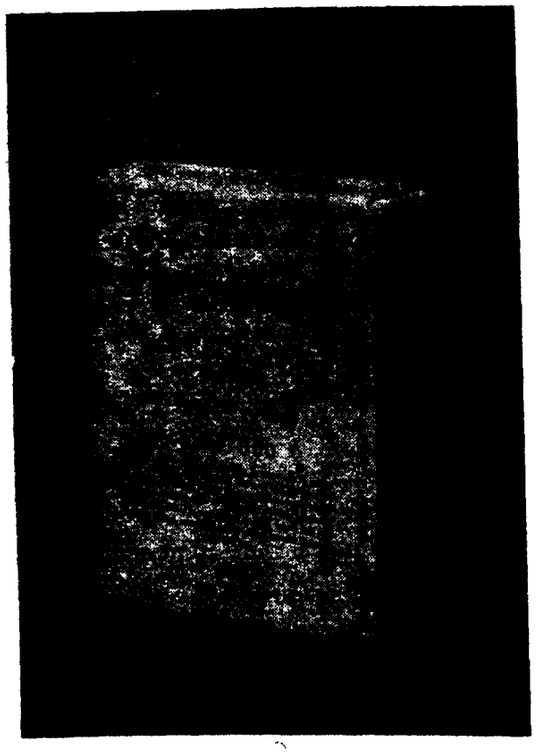

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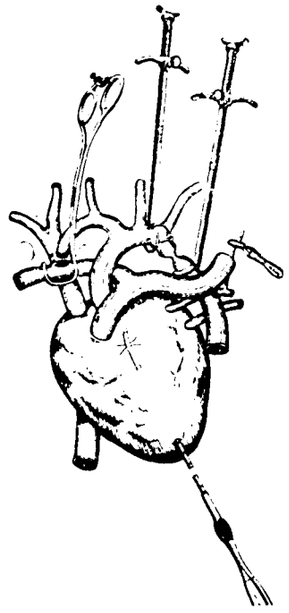

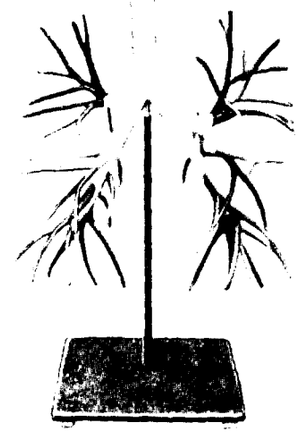

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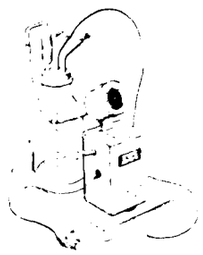

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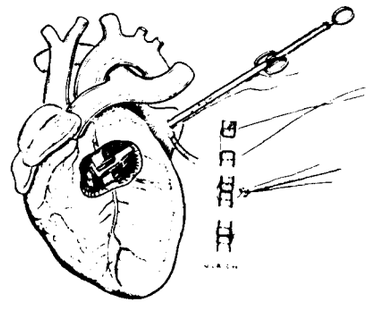

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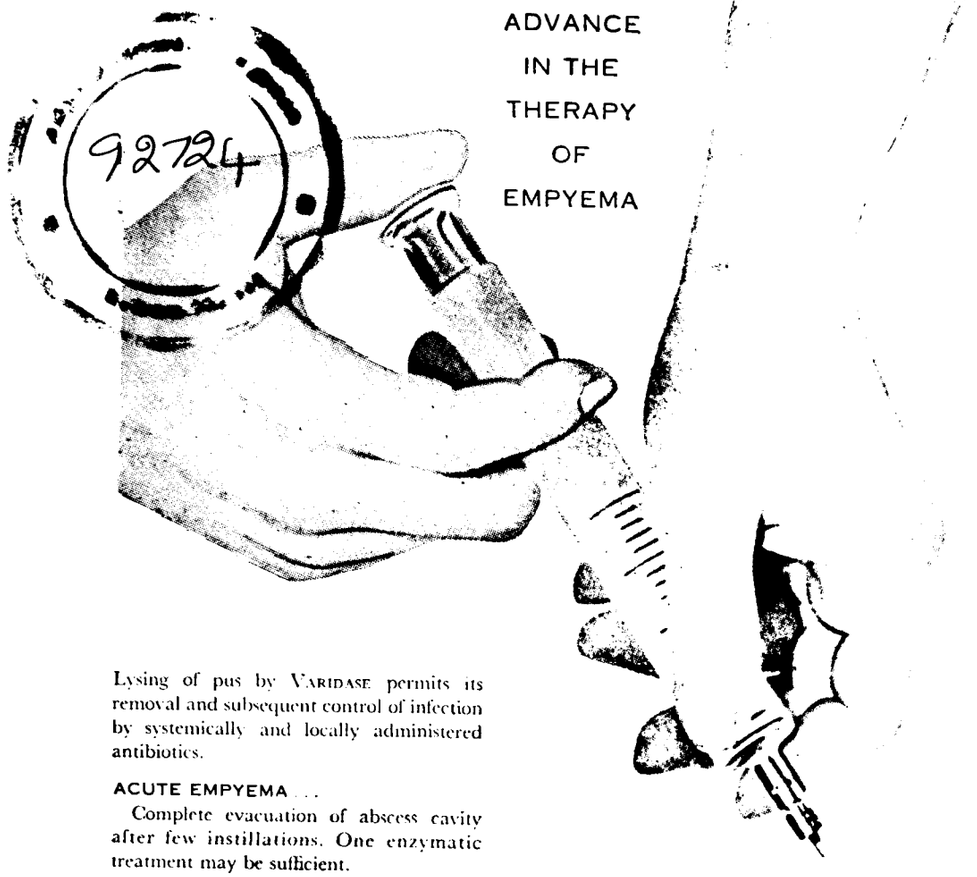

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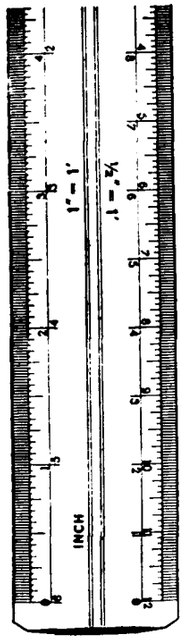


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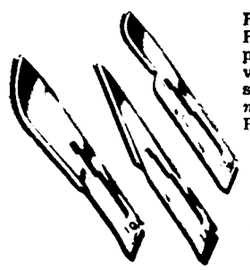

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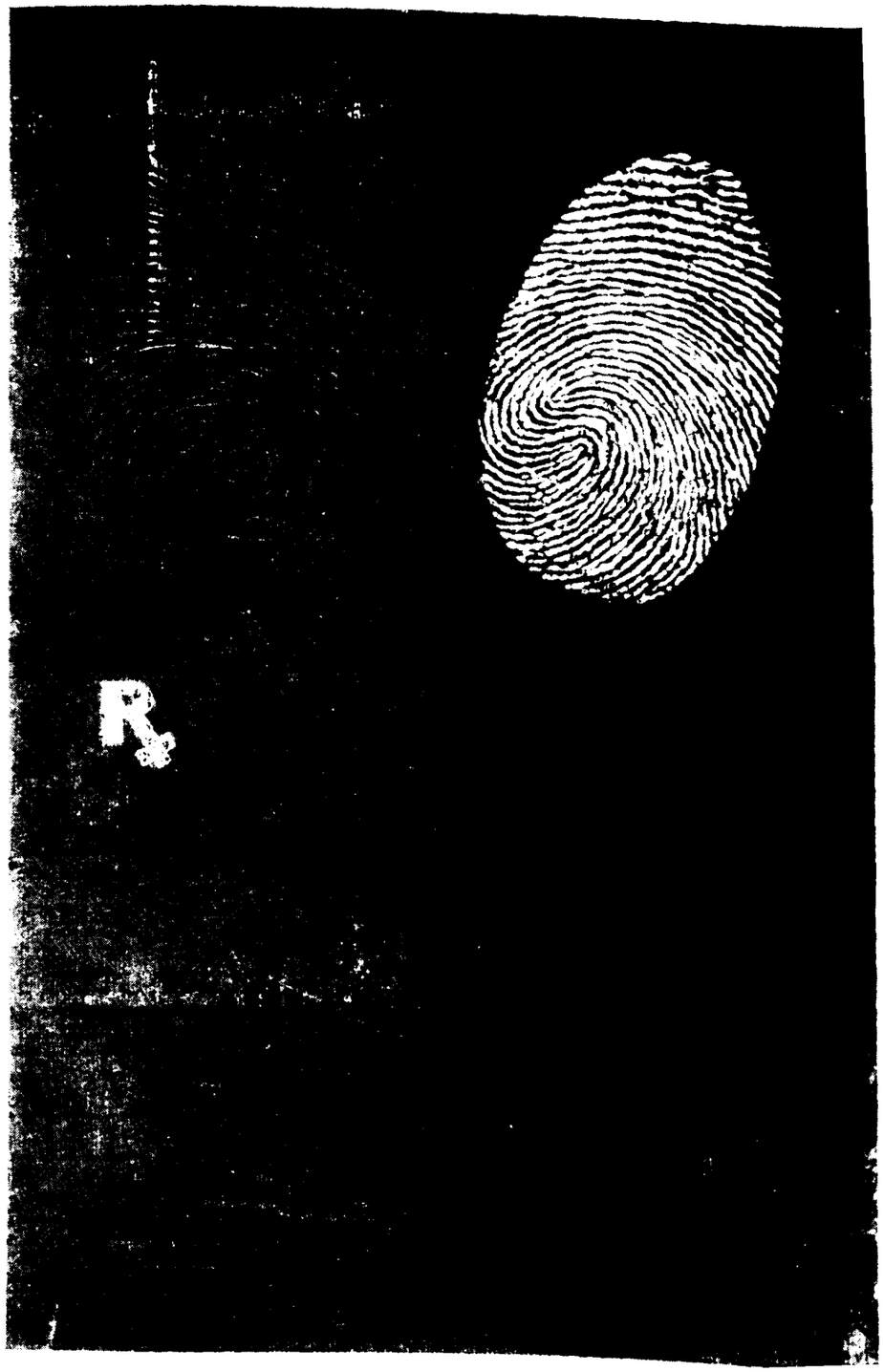


# The Indian Journal of Surgery

Vol. XVIII No. 3


*CONTENTS JUNE 1956*

## ORIGINAL PAPERS



## ASSOCIATION NOTES



## REVIEWS OF BOOKS



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2. Beard, J. W., Taylor, A. R., Sharp, D. G. and Beard Dorothy.: The Nature of a Virus Associated with Carcinoma in Rabbits. Surg., Gynec., & Obst. 74: 509-513, 1942.

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# THE INDIAN JOURNAL OF SURGERY

Vol. XVIII JUNE 1956 No. 3


## POST-TRAUMATIC FUNCTIONAL PARALYSIS FOLLOWING INJURIES OF THE CERVICAL SPINE AND ITS PATHOGENESIS*


*by H. K. SARKAR, Calcutta.*


### Introduction

Surgeons interested in injuries of the Cervical spine have seen cases where all four limbs and the trunk, or the trunk and the two lower limbs are paralysed immediately after the accident. Occasionally, the paralysis comes on after a lapse of time and some cases show only partial lesions. The extent of Motor paralysis may vary, but the escape of sensory loss, although all muscles are paralysed, is a marked feature in many cases. If injuries are not fatal and if there is no transverse section of the cord, many of these cases recover completely with no residual defects. In others, sensory recovery is complete ; but muscle function is restored only partially. Some cases result in spastic paralysis of limbs with exaggerated jerks and extensor plantar response.

The time taken for recovery varies from case to case and depends on the original severity of the lesion. The interval may be measured in days, weeks or months, and in some cases recovery is still taking place after 18 months. Sensory improvement is early and may be complete and takes place long before motor recovery. Some muscle damage may be permanent and if the cord lesion happens to be anything beyond some mild damage, spastic paraplegia may result.

Spinal concussion or spinal shock are the terms used to describe this transient or temporary loss of function of the cord distal to the injury and this interruption of function may be of the nature of 'Physiological Block'. Usually however the terms concussion or shock are very loosely used and cause much irritation to a critical mind. Some authors think both the conditions are the same and some consider them to be separate entities, while others deny the existence of one or both of them. Surgeons do not describe spinal shock while Neurologists deny the possibility of pure concussion as modern Histopathology reveals minute haemorrhages or oedema, and consider contusion or Haematomyelia as the better descriptive terms. A brief reference to statements in the Literature and in Text-books will show the confused nature of our understanding of the subject.

An American Medical Dictionary defines concussion as muscular weakness and atrophy, with anaesthesia and general deterioration, and spinal shock as "loss of spinal reflexes beyond the lesion."

Gould's dictionary does not mention spinal shock. But mentions spinal concussion as the "condition resulting after injury with or without appreciable lesions in the cord and giving rise to functional disturbances analogous to Railway spine."

Erichsen, Harvey Jackson and Russell Brain admit the possibility of spinal concussion as due to molecular disturbances or rupture of axis cylinders. Elsberg and Seraff think concussion is due to 'commotio spinalis'. Wechsler is of opinion that shock and concussion are synonymous terms. Pool and Holmes attribute loss of

* Dr. Sankaran Memorial Prize was awarded for this article in December, 1954.

function to isolation of cord from the Central nervous system. Riddoch uses the name spinal shock only to cases with severe paraplegia.

Frazier is inclined to ignore the terms shock and concussion completely and favours the terms contusion and haematomyelia.

Text books are equally vague about these terms. Romanis and Mitchener do not like the name spinal shock, and consider the case as one of concussion when the functional loss is almost total, but recovery is comparaively early. They however consider the pathological process to be quite different to cerebral concussion. Rose and Carless describe as concussion the case where there is great functional disturbance with recovery after a time. They think that the lesion is in the nature of petechial haemorrhages. Hey Goves supports the theory of molecular disturbance while Handfield-Jones and Porritt are in favour of minute haemorrhages and oedema as the cause of immediate extensive functional disturbances and comparative early recovery in cases of cervical spine injuries.

### Summary of literature

The above mentioned views which are only a cross section of the vast literature on the subject, show the difficulty of forming any definite ideas about spinal concussion and spinal shock. Some authors use the terms very widely while others ignore them completely. Sensory loss is admitted by some while others deny it. Recovery within 72 hours is an important clinical feature described by some Authors; but permanent damage even in spinal concussion is conceded by others. Cases which recover are classed as concussion while complete motor and sensory loss at first, with partial recovery and some residual paralysis later on, is called spinal shock. Injury to bones is denied by some while others concede the possibility of a transient dislocation or displacement. The terms spinal concussion and spinal shock are used most indiscriminately.

The pathological processes described, vary from 'molecular disturbance' (with no histological changes), rupture of axis cylinders with intact myelin sheaths, minute haemorrhages, oedema, necrosis, softening and haematomyelia.

The experimental field also reveals extremes of views many of which seem to be only hypothetical to a practising Surgeon.

However, clinical diagnosis of concussion can be made when a patient is suffering from complete motor paralysis in all four limbs, sphincteric disturbances (but no priapism), and X-ray films do not show fracture or dislocation and if recovery, almost complete, takes place at most within a week. It is a debatable point whether cases showing fracture or dislocation, or cases where permanent damage results should also be classed as concussion. It will be appropriate therefore to view concussion and shock in the following light.

Spinal concussion is a variety of spinal shock following injury to the back when there is no clinical or radiological evidence of bone or joint injury, but there is immediate functional interruption in the cord of a temporary nature below the lesion. Spinal shock is a condition of acute flaccid paralysis. It usually occurs after injury; but may be present at the outset after Myelitis from other causes.

The chief difficulty in forming any definite opinion is the absence of Post mortem material. Patients dying after such injuries usually show gross damage to the spinal cord.

A personal series of cases during the last 5 years, showed wide variation in symptoms and progress. Some cases of injury proved fatal. Complete motor and sensory loss, or motor loss with no sensory loss was found in others. About recovery, almost complete motor and sensory recovery or sensory restoration with persistent motor paralysis was also noticed. The time taken for recovery varied from a few days to even about 18 months to 2 years.



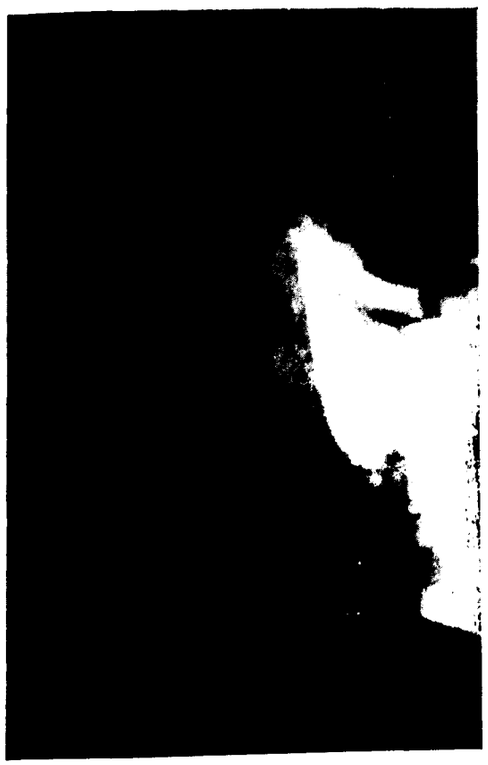

Fig. 1.

Fig. 2.

Some cases showed only motor paralysis. Most of these recovered completely. In a few cases however there was some residual paralysis. X-ray evidence of bone lesion was found in some but not in all the cases.

### CASE REPORTS

Case histories illustrative of the various degrees of functional loss and the different extent of recovery are reproduced here. Only the relevent clinical findings and course are discussed and an attempt is made to form some conclusions about the pathogenesis.

*Group A*

CASE 1.

Bhuloti Ahir, male, age 32, porter was admitted on 22-4-1953 at 3-15 A.M. He was accidently injured in the neck while carrying a heavy bag on his head. There was pain in the region of the injury and weakness of all four limbs immediately after the accident.

*Examination of patient*: The patient was in general shock with pulse rate of 90, respirations 26 and temperature 97.8°F and B.P. was 95|60. There was marked tenderness and rigidity of muscles in the mid-cervical region. Consciousness and sensation were normal. Cranial nerves and pupil reactions were normal. The right lower limb was completely paralysed while the left lower limb and the two upper limbs showed paresis. The respiration was diaphragmatic. Reflexes in upper extremities were present except the supinator reflex. Abdominal and lower extremity reflexes were absent. Sensation, except for fine touch in the left half of trunk and left lower limb, was normal. There was retention of urine after the accident.

Portable X-ray film showed dislocation of 3 C over 4 C vertebra with fracture of laminae of 2 C and 3 C and articular processes of 3 C (Fig. 1).

Immediate skeletal traction with Crutchfield skull caliper and a weight of 15 lbs. was started and an indwelling catheter inserted. Pain was relieved almost immediately. The dislocation was reduced after 5 hours (Fig. 2). The weight of 15 lbs. was changed to 10 lbs. and maintained for 3 weeks, after which a plaster jacket was put on and kept for 4 months. Five months after the injury, there were no abnormal findings neurologically. Except for some limitation in flexion and extension, all neck movements were present. This progress was maintained one year after the accident.

Pupillary reactions were normal throughout. Bradycardia was present for 2 weeks and lowered B.P. for 1 week only after the accident.

From 1 week after the injury, motor power came back in the various muscles in stages and at the end of 4 months there was complete recovery and reflexes became normal. The original minimal loss of sensation was restored after two days. Retention of urine was not present after the third day. Bowels remained normal throughout. Priapism was intermittent for three days and then subsided completely.

Spinal manometry soon after admission showed complete block. At the end of seven days, the pressure was 65 m.m. of water which rose to 75 m.m. on pressure on the right jugular vein and to 90 m.m. on pressure on both jugulars and did not come down on release of jugular pressure. This was obviously due to oedema of the cord. At the end of two months C.S.F. pressures were completely normal.

CASE 2.

Kaloo Jaswara, porter, male, aged 38 years, was admitted on 28-7-1951 at 1-30 A.M. after injury to neck while carrying a load. He became unconscious temporarily and found that there was pain all over the body and inability to move the left hand and the left lower limb.

*Examination of patient*: There was acute tenderness in the cervical spine but no muscle rigidity. There was a superficial incised wound on the right eyebrow. Pulse rate was 70, temperature 98°F, respirations 20 and B.P. 110|80. Neurological examination showed cranial nerves and pupil reactions to be normal and mental condition was quite clear. Motor power showed deficient power in shoulder and elbow movements. Wrist movements were weak and grip was very poor. Reflexes were absent in the arms. Trunk and abdominal muscle action was weak and superficial abdominal reflexes were absent. The right lower limb muscles showed weak action; but the left lower limb was completely paralysed. Knee and ankle jerks were present on both sides and plantar response was extensor. Sensation was somewhat affected; but complete anaesthesia was not present anywhere in the body. Bladder was distended and there was no priapism.

X-ray film revealed dislocation of 4C over 5C vertebra and fracture of laminae of 3C and 4C vertebrae (Fig. 3).

*Treatment*: Skeletal traction failed and an operative reduction was performed, when only a right sided dislocation was found. X-ray films did not give any clue about this. Bladder was drained by a suprapubic cystotomy.

*Progress*: The upper limb showed marked improvement in 3 weeks and the reflexes reappeared. Recovery was almost complete in 6 weeks except for the small muscles of the left hand and abduction in the left shoulder. Abdominal reflexes returned after a month and cremasteric reflexes after 3 months. In the left lower limb, toe movements were present on the second day and ankle movements on the third day. Knee could be moved after fifth day of traction. Knee jerks which were normal on admission became exaggerated and ankle clonus developed on left side and lasted for three months and by this time plantar response again became flexor in type. Bladder control was regained after six weeks.

*Comments*: The above two cases were typical of the group admitted with extensive motor paralysis and some amount of sensory loss following injury to the neck. X-ray films showed fracture and dislocation of the vertebrae. It is also seen that these cases made complete recovery from paralysis. Sensation recovered first, and motor power took a longer time to come back. The time of recovery of sensation was two days in one case and about a month in the other. The time taken for complete recovery of motor function with disappearance of any organic sign in the central nervous system in both the cases was three months. One very interesting phenomenon in case No. 1 is the occurrence of priapism in spite of which the patient survived and made a complete recovery. Another very interesting feature is Brown-Sequard type of manifestations in case No. 2 due to unilateral dislocation which was evident only at operation.

*Group B*

CASE 3.

Timal Kahar, porter, male, aged 45 years, was admitted on 7-8-1953 for injury to neck following fall of a load on it. He had pain in neck and inability to move all four limbs, and retention of urine.

*Examination*: Tenderness in mid and lower cervical region. No muscle rigidity. Pulse was 90, respirations 22, temp. 101°F and B.P. 120|84. There was no priapism. Neurological examination showed a clear mind and pupils and cranial nerves were normal. In the upper extremities, only the trapezeus muscles were acting. Biceps and triceps jerks were present; but the supinator jerks were absent. Respiration was abdominothoracic. Abdominal and cremasteric reflexes were absent. Lower limbs showed complete paralysis.



Fig. 3.

Fig. 4.

Knee jerks were absent; but ankle jerks were present. Extensor plantar response which was present on admission disappeared 4 hours afterwards.

Sensation was blunt in the outer parts of the arms and in the trunk it was normal upto the xiphisternum but blunt upto the umbilicus. In the rest of the body sensation was completely absent. There was retention of urine, but no foecal incontinence.

*Investigations*: X-ray film showed marked osteoarthritis of the cervical spine with diminished disc space between 5C and 6C (Fig. 5). Film taken in flexion of neck showed no radiological change, but the one taken in extension showed displacement of 3C over 4C and widening of the gap (Fig. 6). Lumbar puncture showed normal manometric pressures and no spinal block. C.S.F. examination revealed normal fluid.

*Treatment*: Skeletal traction was instituted and suprapubic cystotomy was done.

*Subsequent course*: The patient was comfortable for a week. Then respiratory and urinary infection came on and bedsores developed. Although there was never any hyperpyrexia, the temperature remained between 103° and 104°F. for about 6 months and was controlled partially by chemotherapy and antibiotics. Even one year after the accident, occasional attacks of cystitis were present.

From the end of the second week, trophic changes began. There was oedema on the body pitting on pressure, effusion in knee and elbow joints and swelling of the finger joints. Bedsores appeared on all pressure points and the sacral sore was 8" in diameter at the end of 3 weeks and took 6 months to heal.

From the end of 3 weeks, muscle movements began to reappear, from above downwards in the upper limbs and from the toes upwards in the lower limbs. Spastic movements appeared in all joints at the end of 3 months. Joint contractures

Fig. 5.

Fig. 6.

were seen about the end of the third month and clawing of the hands with wasting of all small muscles of the palm, was noticed. There was no fibrillation at any time.

The findings one year after the accident were, that there was spastic paralysis in all four limbs with jerky movements and contractures of the knee and elbow joints especially on the left side. Upper limbs and ankle jerks were exaggerated; but knee jerks were absent. Plantar response was extensor on both sides. Muscle wasting except in the hands was not much noticeable.

Reaction of degeration was absent in all muscles except in those of the hands.

Sensory recovery started before motor recovery and at the end of a year, the upper limbs showed normal sensations except loss of kinaesthetic sense in the thumb, touch sensation in the palm and ulnar side of forearm and vibration sensation over the ulnar styloid. In the trunk, except for a zone of hyperaesthesia in the front and on the back, sensations were normal. In the lower limbs, superficial touch sense was absent. But vibration sense was present. Deep pressure and temperature sensation was absent except in the upper part of the thigh. Sense of position was absent and efforts at walking were fruitless as he could not feel the ground.

Bladder control did not return. Urine could be held in the bladder for about an hour after which there was automatic evacuation. Bowels were incontinent and required daily bowel washes. Anal sphincter showed some contraction.

CASE 4.

Rameshwar Malla, male, aged 26 years, was admitted on 19-9-1951. Main complaints were pain in neck, inability to move the limbs and retention of urine for 24 hours. A day before, he fell down from the edge of a well while taking a bath—a



Fig. 7.

Fig. 8.

height of 5 feet. He became unconscious for some time and after regaining consciousness he found that he could not move his limbs. He was brought to the Hospital for this paralysis and for retention of urine.

*Examination*: A fully conscious patient, with complete loss of power in the limbs. Acute tenderness on back of neck about its middle. No sign of external injury. Temp. normal, pulse 92 and respirations 18. The bladder was upto the umbilicus and gaseous distension of the bowels was present. No priapism. Mental condition was clear, and cranial nerves normal. Eye movements normal, but pupils were contracted equally on both sides. Reaction to light was present.

*Motor system*: In upper limbs slight movement in shoulder and elbow. Jerks were absent and muscles were flaccid.

*Trunk*: Intercostals and abdominal muscles were paralysed. Superficial abdominal reflexes were absent.

*Lower limbs*: Complete flaccid paralysis. All jerks were absent and plantar reflexes could not be elicitated.

*Sensory system*: Sensation was normal all over the body except for slight dullness of perception below the second intercostal space and in the lower limbs.

*Sphincters*: Urethral and anal sphincters were in spastic contraction. There was complete retention of urine and inability to pass stool.

*Investigations*: Portable X-ray film showed a compression fracture of 4 C vertebra and loss of alignment of disc between 4 C and 5 C vertebra (Fig. 7). Spinal manometry showed pressure of 140 m.m of water and there was no block in the sub-arachnoid space on pressure over the jugulars.

*Treatment*: Fracture board and Crile's extension with 10 lbs. weight were used, with a pillow beneath the scapulae. A check X-ray in the

Fig. 9.

Fig. 10.

second week after admission with the neck in flexion clearly showed a dislocation of 4 C over 5 C (Fig. 8). Retention was relieved first by catheterisation and then by a suprapubic cystotomy. Bowels were constipated and were cleared by regular enemata for one month.

*Subsequent course*: Pain was relieved after traction. Distension of abdomen was very troublesome and was relieved by enemata and flatus tube. Coughing out mucus was difficult, and swabbing and pharyngeal suction had to be used. Towards the end of the fourth month, fever started and a lump appeared in the right loin due to infection of a non-functioning right kidney. A short course of chemotherapy cleared this up.

*Motor system*: Shoulder movements appeared on the third day and wrist and finger movements after one week and became almost normal two weeks afterwards. Jerks appeared later. Trunk movements returned after one month and abdominal reflexes after six weeks. Hip and knee flexion returned after two days and ankle and toe movements followed. There was complete recovery after two weeks. Plantar reflex was extensor on the fourth day and became flexor after 7 days. Knee and ankle jerks did not return till after 7 weeks.

*Sensation*: The slight dullness of sensation on admission disappeared completely on the second day. Bladder control was regained after one month and enemata were required for three weeks.

*Comments*: These two cases fall in the group where there is complete quadruplegia in the beginning and would have been classified as cases of spinal concussion if repeated check X-ray films in flexion and extension of neck had not been taken to show the dislocation. Case No. 3 is still showing recovery after one year. The motor recovery is more marked than sensory recovery—an unusual feature. An attempt will be made later on to explain this anomaly which is probably due to the dislocation being posterior—a rare event. Case No. 4 is a typical example of a case which may have passed off as so called spinal concussion if check X-rays had not been taken.



*Group C*

**CASE 5.**

Sonai Jaswara, male, aged 30 years, porter was admitted on 9-7-1949 at 12-30 A.M. A sugar bag weighing 3 maunds accidently fell on his neck while he was carrying it. He was unconscious momentarily and found on recovering consciousness that he had pain in all the body, tingling sensation in the arms and legs and complete inability to move the limbs.

*Examination*: A completely paralysed man with tenderness in cervical and dorsal spine. Temp. normal, pulse 60 and respirations 24. B.P. was 95|70. Several minor abrasions on the body. No priapism. Mental condition was clear. Cranial nerves were normal and pupils were equal and reacting to light.

*Motor system*: The left upper limb was completely powerless; but the right limb showed some movement in the shoulder and elbow joints and slightly at the wrist joint. Jerks were absent.

*Trunk*: Respiration was abdominal and superficial abdominal reflexes were absent.

*Lower limbs*: Both limbs showed complete loss of power. Knee jerks were present; but ankle jerks and plantar reflexes were absent.

*Sensory system*: Touch and temperature sensations were normal. Pain sense was exaggerated in the limbs.

*Sphincters*: There was retention of urine, but bowels were continent.

*Investigations*: X-ray film showed slight subluxation of 3 C over 4 C, compression of 4 C and congenital fusion of 2 C and 3 C (Fig. 9). X-ray film 8 months afterwards showed some loss of alignment and osteoarthritis (Fig. 10). Spinal manometry, 10 weeks after injury, showed no subarachnoid block and C.S.F. examination showed normal fluid.

*Treatment*: Fracture board and neck in sand bags. Exploratory laminectomy after 3 months as there was no recovery in muscles. No structure pressing on cord was detected. Urinary retention was treated by suprapubic cystotomy. Bowels required frequent enemata. Urinary infection, pulmonary congestion, suppurative parotitis needing incision and bedsores, developed. These were treated with Penicillin. Sacral sore did not heal for 8 months.

*Subsequent course*: The pain in the limbs subsided; but various infective complications gave rise to intermittent fever.

*Motor system*: Power returned in both upper limbs in 6 weeks except for finger movements and finger palm grip. At the end of 6 months, fingers showed clawing and wasting of all small muscles of palm and fingers on both sides. Jerks appeared in the third week, and became exaggerated as time passed.

*Trunk*: The paralysed intercostals recovered very soon. But superficial abdominal reflexes were still absent at the time of discharge from Hospital.

*Inferior extremities*: Hip and knee movements appeared in two weeks in left limb and three weeks in right limb together with the knee jerks which became exaggerated. Ankle jerks never returned. The plantar response came back in two weeks and remained extensor throughout. Ankle and toe movements were seen at the end of 3 months. Though volition was present in the limb movements, the muscles were very spastic and this spasticity disappeared almost completely one week after the operation. Flexor spasms in lower limb were noted which disappeared after one month.

At the time of discharge two years after admission the findings were as follows:— In the upper limb, full function was present except for clawing of both hands. The jerks were brisk. In the lower limbs, there was some residual spasticity with exaggerated knee jerks, absent ankle jerks and extensor plantar response. The gait was slow and somewhat spastic. The sensations were normal except for loss of kinaesthetic sense which however did not interfere with his walking. Bladder control returned after one year and became automatic for some time. At the time of discharge he had full control over micturition with the frequency of D 6 and N 2.

CASE 6.

Shaikh Kabir, male, aged 35 years, porter, was admitted on 31-10-1951 at 11-30 A.M. A bag of wheat accidently fell on his neck while he was carrying it. The chief complaints were pain in neck, weakness of limbs and retention of urine.

*Examination*: Acute tenderness in lower part of neck and all neck movements were restricted. Pulse 60, respirations 22 and temp. normal. B.P. was 120|80. Priapism was absent.

*Neurological examination*: Clear mental state. Cranial nerves were normal. Pupils equal and reacting to light.

*Motor system*: Superior extremities showed 90% movement at the shoulders. Elbow movements full but weak. Wrist and finger movements were absent and there was no grip action. Jerks were absent.

*Trunk*: Intercostals and abdominal muscles were active. Abdominal reflexes doubtful.

*Lower limbs*: Movements in the lower limbs were present but weak. Jerks were absent and plantar response was extensor.

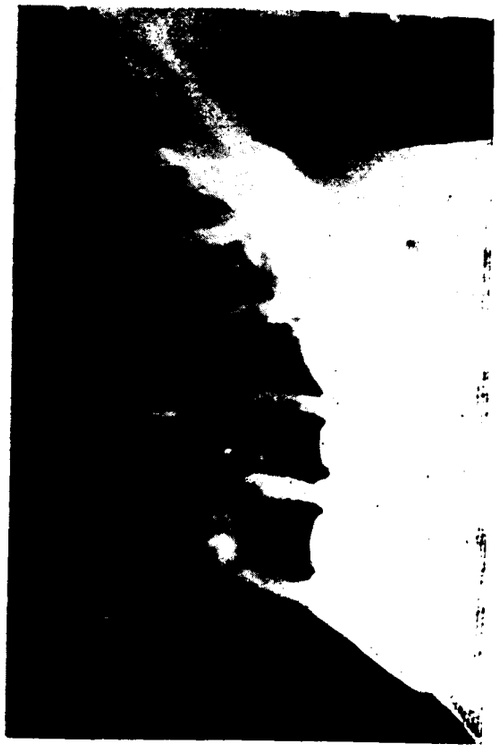

Fig. 11.

Fig. 12.

*Sensory system*: There was no sensory loss except for dulling in both forearms.

*Sphincters*: Retention of urine was present; but no bowel incontinence.

*Investigations*: X-ray film showed no gross abnormality (Fig. 11). Careful scrutiny showed compression fracture of 4 C and chip fracture of margin of 5 C vertebra.

*Treatment*: Fracture board for two weeks and immobilisation in extension in a plaster jacket for six weeks.

*Subsequent course*: Pain was relieved and the slow pulse rate returned to normal in a few days. Respiration, temperature and B.P. remained normal. Shoulder movements came back in two days, and weak wrist and finger movements in one week. But grip remained poor. Tendon reflexes reappeared after four days. Lower limbs became normal during the first week and knee jerk was present on the day after admission. Ankle jerks never returned. Plantar response remained extensor till discharge from Hospital. Burning sensation was present in both legs while plaster jacket was on. Normal voiding of urine returned on the night of admission. Bowels required enemata for evacuation for 15 days. Patient was discharged two months after the plaster jacket was removed. At this time neck movements were almost normal and general weakness of legs and a tingling sensation in them persisted.

*Follow up*: Two months after discharge showed weakness of both legs and right hand fingers which showed clawing and small palmar muscles were wasted. Long flexors of ring and little fingers showed loss of power. The other muscles in the upper extremities were normal except that the biceps and triceps jerks were exaggerated. In the lower limbs power was normal but some spasticity was present. Knee jerks were exaggerated, plantar response was extensor and ankle jerks were absent. Gait was slightly spastic.



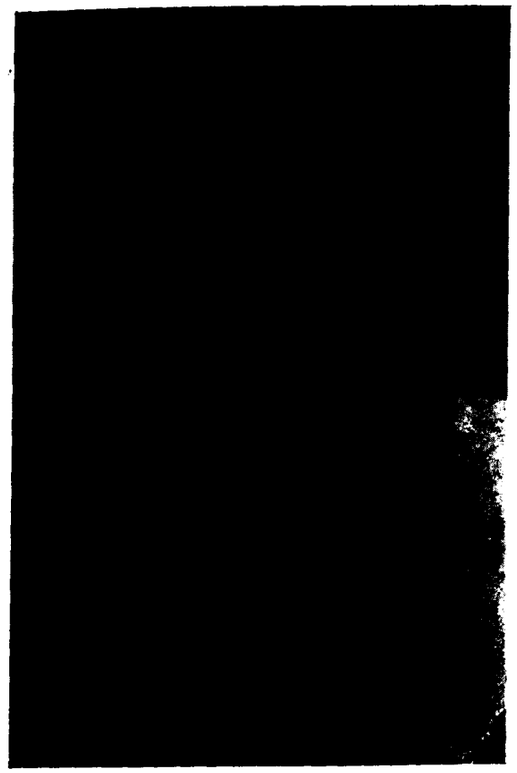

Fig. 13.

Fig. 14.

He was readmitted and further investigations were carried out. X-ray films showed reunion of the chip fracture of 5 C and osteoarthritis of 4 C and 5 C joint (Fig. 12). C.S.F. and spinal manometry were normal and no block was seen after myelography. Kahn tests in blood and C.S.F. were negative.

Two years after accident, clawing of hand had disappeared and small palmar muscles were again normal in size. There was very little spasticity in the limbs, and gait was almost normal. Except for plantar extensor response and slight exaggeration of jerks, there was nothing else abnormal.

*Comments on group C*: This group consists of cases of no apparent fracture on X-ray examination and paraplegia or quadruplegia was present. Sensory loss was minimal. Recovery was almost complete in all cases except that in case 5, months elapsed before recovery. No evidence of dislocation in the spine on X-ray examination was present. But films in flexion and extension were not taken as the cases being early in the series, the idea about it had not occurred. Still the evidence about initial dislocation causing cord damage can be surmised as there were upper motor neuron lesions in the extremities. Loss of alignment between 3 C and 4 C in case 5 and between 4 C and 5 C in case 6, occurrence of osteoarthritis in both cases and absence of C.S.F. block on spinal manometry and myelography, show that these two cases were more in the nature of an initial dislocation rather than of prolapsed discs. The following case (No. 7) will further strengthen the argument that initial dislocation in spite of negative X-ray findings, may cause paraplegia or quadruplegia.

CASE 7.

Parachan Rai, aged 32 years, porter, was admitted on 8-5-1953 at 2 A.M. He was hit by a heavy hook of a crane on the back of his head, and was temporarily unconscious. His complaints

were pain in neck and inability to move the limbs.

*Examination*: Acute tenderness in back of the neck about its middle. No evidence of external injury on the neck; but a long wound in the occipital region exposing the skull bones. The neck muscles were in spasm. Multiple abrasions on scalp and face were present. Pulse 60, temperature 96.4°F., respirations 20, irregular and jerky, shallow and abdominal in type. B.P. 100|80. There was no priapism.

*Neurological examination*: In the beginning, there was mental confusion and answers were vague. This state cleared up after a little time. Cranial nerves were normal and pupils were slightly contracted and reaction to light was sluggish.

*Motor system*: Complete motor paralysis in all four limbs and trunk. All jerks were absent. Sphincters were not affected. There was complete sensory loss on trunk and limbs.

*Investigations*: Portable X-ray film did not reveal any injury to the cervical spine. Three hours after admission, mental condition was clear, plantar response was flexor and some return of sensation on top of shoulder. Six hours after admission, biceps jerk was present and sensation was felt in the upper two intercostal spaces. Some abduction at the shoulder and flexion at the elbow was present. Pupils became contracted and failed to react to light. Respirations became shallow, jerky and rapid. Towards evening temperature was 103°F., respirations 55-58, pulse 100 and B.P. fell to 90|60. The patient died twenty hours after admission.

*Post-mortem report*: There was no fracture of the skull. Moderate extravasation of blood in the prevertebral region was present and dislocation in the articulation of 4 C and 5 C was found. The anterior longitudinal ligament was torn at this level. Slight dislocation could be produced on flexion at this point. Bruising of muscles on the back of the neck was noticed; but there was no fracture of the spines or laminae. The interspinous and interlaminar ligaments were completely torn and the interarticular capsule was severed. On removing the spines and laminae, some extradural extravasation of blood was present. No subarachnoid haemorrhage, but the cord appeared contused and slight oedema seen from the level of 2 C to the 7 C vertebrae. The right side of cord was more bruised and the left side was normal.

Photograph of the sagittal section of the bodies of the vertebrae (Fig. 15) clearly shows the extent of the damage. The fact that dislocation must have occurred and got reduced spontaneously by the recoil of the cervical muscles and other factors is the most probable event.

The above case histories show that clinical examination did not reveal the real organic lesions

Fig. 15.

of the cord. Many of the findings were reversible. This reversal took place in one week in some cases, but took months in others. All injuries were in flexion except in case 3 where hyperextension type of injury was present.

In cases 1—4, dislocation was the cause of the functional paralysis. But in cases 5—6 the cause is conjectural. But because of the evidence in case 7 a suggestion is made that they were cases of dislocation and spontaneous reduction.

## Conclusions

The following hypothesis is suggested in view of the findings in the above series of cases.

"Post traumatic functional neurological manifestations of the spinal cord distal to the site of the injury, loosely called spinal shock and/or spinal concussion is due to dislocation of the spine. Absence of Radiological evidence of such dislocation is due to spontaneous reduction."



The hypothesis will explain the following clinical conditions:—

1. Why some cases show quadruplegia, but no sensory loss. Although tactile sensation may be slightly dull, pain, heat and cold, position and vibration sensory functions are normal.

2. The temporary loss of both moior and sensory functions and the quick recovery in a few days of sensory loss though the motor power recovery may take a longer time and return more gradually. This motor power recovery may be complete in some cases; but exaggeraied reflexes and loss of abdominal reflexes is the more common event.

3. The occurrence of Brown-Sequard type of lesion of sensory loss on one side and motor loss on the other side as in case 2.

4. Loss of both motor and sensory functions and less perfect recovery of sensations than the motor power as in case 3.

In the first and second groups, section of cord shows interruption of crossed pyramidal tracts; while the posterior, antero-lateral and anterior tracts are unaffected (Fig. 16).

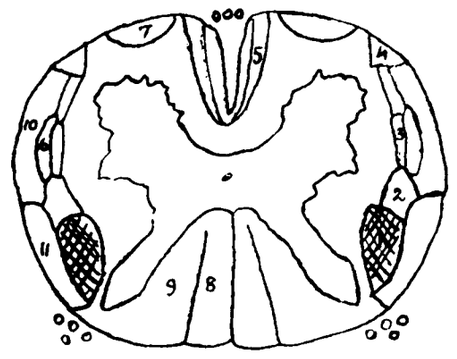


Fig. 16.

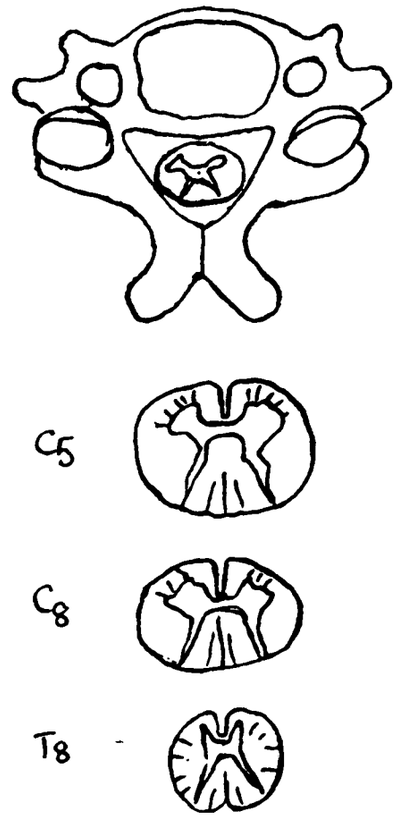


Fig. 17.

Available literature of the last forty years about damage to the spinal cord by extradural or intramedullary haemorrhage, pressure of bone fragments, prolapsed discs, etc., does not explain why all tracts except the pyramidal are spared. The following explanation is suggested:—

Spinal canal in cervical region is triangular and spinal cord is transversely elliptical (Fig. 17). In dislocation, the laminae (two sides of the triangle) press on the cord from the postero-lateral sides, the situation in which the superficial blood supply lies. Pressure on, or damage to the arteries will interfere with the blood supply to the cord. In the early stages therefore the columns of Gall and Burdach are

Fig. 18.

Fig. 19.

Fig. 20.

not affected as they lie in the apex of the triangle. If the displacement is very serious all tracts are pressed upon, resulting in functional transection of the cord. This point is well illustrated in photographs of sections of cord in case 7 (Fig. 18).

It was observed during dissection of the cervical spine of 14 fatal cases, that the cord is not compressed by the superior margin of the vertebra below the site of dislocation though the X-ray appearances suggest it. The course of events probably is that the Nucleus pulposus which is expressed out as the result of a ruptured disc, goes beneath the posterior longitudinal ligament which has been stripped off the posterior surface of the dislocated vertebra and cushions off the sharp superior margin of the vertebra below. This rounding off is not evident in the X-ray pictures and



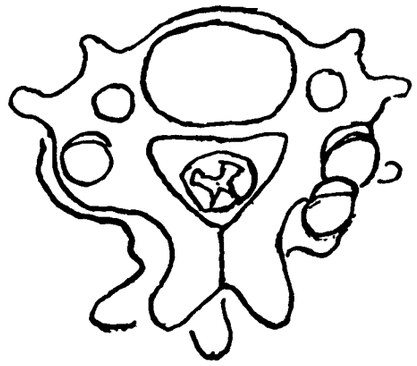

Fig. 21.

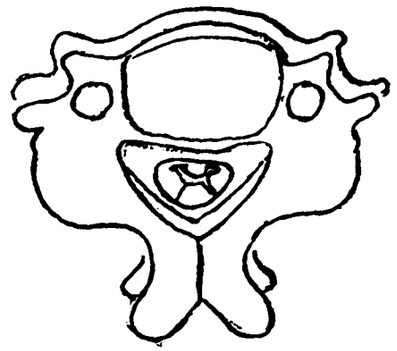

Fig. 22.

explains the apparent crushing effect of the bony margin. Above the level of the disc material, there is blood clot which forms a smooth convex surface and the cord is therefore unlikely to be pressed upon.

Explanation of the Brown-Sequard types :—As the cervical spinal canal is triangular in shape, unilateral dislocation causes rotation of dislocated point round the point on the other side which is fixed (Fig. 22). Thus the cord on the opposite side of the dislocation will be pressed upon. This accounts for the clinical symptoms of hemisection of the cord. Minor disturbances on the side of the dislocation can be explained by the pressure on the cord by the anterior part of the laminae of the caudal vertebra. The posterior sensory paths may not be affected as they are accommodated in the apex of the triangle of the spinal canal. In case 2 where there was only a right sided dislocation as disclosed on operation, there was upper motor neuron loss on the left side and sensory loss on the right side as the lamina of 4 C was pressing on the cord on the left side. The transient symptoms of motor paralysis on the right side and the sensory loss on the left side can be caused by slight pressure on the cord by the right lamina of 5 C.

Explanation in case 3 is as follows :— As the dislocation here was backwards, the dislocating vertebra pressed on the anterior part of the cord, causing pressure on the spinothalamic tracts, uncrossed pyramidal tracts and the anterior spinal artery. The cord thus pressed upon is pushed posteriorly against the lamina of the vertebra below the dislocation. This explanation is only a suggestion put forward, and can be confirmed only after getting more cases of this type and more post-mortem material.

## Summary

Post traumatic functional paralysis following injuries of the cervical spine is attributed to spinal concussion and/or spinal shock. General surgical and neurological literature has given very wide and differing explanations. This is due probably to scarcity of definite pathological data as comparatively few patients die and hence Post-mortem material is not available. An attempt has been made here to arrive at a workable definition without going deeply into controversies about the clinical state of the patient. A personal collection of case histories showing extensive paralysis and a variable degree of recovery has been cited. In case 1 and 2 there was frank dislocation, in case 3 and 4 there was spontaneous reduction of dislocation due to recoil. Post-mortem of case 7 clearly shows that such spontaneous reduction can occur, although some observers like Taylor and Barnes consider this to be only hypotheti-

cal. Others have considered its possibility; but have given no definite proof.

The hypothesis suggested in this paper will explain the enormous variability of the initial manifestations and also the wide nature and differences in the ultimate recovery.

No explanation is offered for some occasional cases of lower motor neuron paralysis in the upper extremity. The suggested reasons for this are being worked out.

## Conclusion

"Post traumatic functional paralysis is due to pressure on the spinal cord by the laminae of the dislocating vertebra affecting the posterolateral surface of the cord."

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# PSUEDO-PANCREATIC CYSTS: THEIR DIAGNOSIS AND TREATMENT

## (An analysis of 8 cases)

*by S. S. ANAND and C. P. SAWHNEY, Amritsar.*

Psuedo-pancreatic cysts are collections of pancreatic secretions and serous exudates in the lesser peritoneal sac. They have no epithelial lining, their walls being formed by the peritoneum of the lesser sac. Although their origin is closely related to the pathological changes within the pancreas yet it differs from true pancreatic cysts in being not located within the pancreas. Because of the relative infrequency of the disease its various aspects have not been properly studied and the progress in the evaluation of various therapeutic methods has been slow. The present study is based on the critical analysis of 8 cases of psuedo-pancreatic cysts that we came across in the last 2 years.

*Incidence :*

Psuedo-pancreatic cyst is a rare entity. Out of a total of 28,000 patients attending surgical outpatients department in the last two years, only 8 cases were diagnosed as psuedocysts. Six of our patients were females as compared to two males, i.e. a ratio of 3 : 1. Rabinovitch and Pines (1942) had all their 11 patients in females. These figures however differ from those of Meyer (1949) who reported equal distribution amongst the two sexes. Bilhart and Priestley (1951) on the other hand found 56% of their cases in males. With such variable figures it is very difficult to draw any reasonable conclusion as to the relative frequency of the disease in the two sexes. Four of our cases were between the ages of 10 to 20 years and the rest were between 30 to 50 years. Bilhart and Priestley (1951) found it to be commonest between the 3rd and the 6th decades. Meyer et al (1949) reported an even distribution between 20 and 60 years.

*Etiology :*

Pancreatitis is most often the fore-runner of psuedo-pancreatic cyst. Seven in our series followed pancreatitis. Generally the attacks which preceded their formation were very acute, lasting for a number of days, but in one case there was history of only mild and recurrent attacks. All the cases of Rabinovitch and Pines (1942), Stoll (1943) and Soderlund (1946) were the result of pancreatitis. However in Bilhart's (1951) series only 21 out of 44 cases followed pancreatitis. Only one case in our series gave history of trauma leading to psuedocyst formation. The reported incidence of trauma in the literature has varied in different series, i.e. Adam and Nishijima (1946) 11%, Pinkham (1945) 20%, Mahorner and Matteson (1937) 23.5%, Korte 28%, Shumacker (1954) 40% and Meyer (1949) 51.6%. It has been suggested that biliary tract disease may be a factor in the development of psuedocysts, in view of the frequent association of abnormal biliary tract findings with these lesions. The incidence of biliary tract disease has varied from 9.7% (Meyer 1949) to 40% (Pinkham 1945, and Adams and Nishijima 1946). In only two of our cases there was evidence of cholecystitis. It is difficult to say whether this has any direct etiological relationship to psuedocyst formation but it seems unlikely. Comfort (1948) provided evidence against the hypothesis that pancreatitis is secondary to cholecystitis. The other explanation that the relationship between cholecystitis and acute pancreatitis is due to a common factor seems more tenable (Probstein 1949). That common factor seems to be obstruction distal to the junction of pancreatic and common bile ducts converting them into a common channel, cholecystitis being the result of reflux of pancreatic ferments into gall bladder (Wolfer 1931).

*Pathogenesis :*

Whatever the precipitating factor, trauma or pancreatitis the sequence which leads to psuedocyst formation is the same. A crushing blow to the upper abdomen may compress the pancreas against the vertebral bodies causing its rupture, with resultant escape of pancreatic secretions into the lesser peritoneal sac. More commonly however, it leads to traumatic pancreatitis, the course and progress of which is similar to the one resulting from other factors, such as biliary reflux into the pancreatic duct or pancreatic ductal obstruction, etc. If the process is very acute the chemical autolysis within the pancreas as a result of the digestive action of activated trypsin (Howard 1949) or local cytotoxic effect of bile salts (Dragstedt 1934) proceeds with rapidity until it approaches the periphery of the gland. The peritoneal covering gives way liberating pancreatic enzymes into the lesser peritoneal sac. This leads to chemical peritonitis with profuse inflammatory exudate from adjacent serosal surfaces. If the foramen of Winslow is sealed off by this exudate, the lesser sac is converted into a closed space in which the exudate collects. Inflammation in the surrounding serous surfaces followed by raparative granulation tissue and fibrous tissue gives it a firm capsule. It sometimes happens that a part of the lesser peritoneal sac may get shut off from the rest by adhesions and in these cases the collections will occupy only a part of the lesser sac. This was noticed in one of our cases where the foramen of Winslow remained patent. Rarely however, as in one of our cases, the pancreatic enzymes and secretions after crossing the limits of the pancreas may track along the posterior abdominal wall in the extraperitoneal tissues forming huge collections.

*Course of the disease :*

Most often the psuedocysts make their appearance within a few days after the acute episode of pancreatitis. In 6 cases they were first noticed within a week. They may however form slowly, taking a number of days. In one of our cases it took fifteen days, while in another it appeared after one month. Having once formed, further increase in size is very rapid, some cysts attaining huge dimensions within a month or so. This growth in size is quite independent of further attacks of pancreatitis and if unchecked the psuedocyst may burst with fatal consequences. One of our cases suddenly collapsed and expired following spontaneous rupture. The mortality following rupture was 66% in Koucky's (1941) series. If, however, the patient survives, and operative interference is undertaken even then a minor procedure such as marsupialization carries 75% mortality as against 4.8% fatality in the unruptured group of cases (Meyer, Sheridan and Murphy 1949). This emphasizes the need for early surgical treatment soon after the diagnosis is established.

The size and site of these cysts is subject to wide variations. In six cases the mass was mainly epigastric occupying the whole of the upper half of the abdomen. In one case it was mainly right hypochondriac extending down to the right iliac region and in another case it extended to the left lumbar region on the back.

*Symptoms and Signs :*

| *Symptom.* | *No. of cases.* |
|---|---|
| Pain | 8 |
| Mass in abdomen | 8 |
| Anorexia | 8 |
| Loss of weight | 6 |
| Vomiting | 1 |
| Jaundice | 1 |
| Fever | 1 |

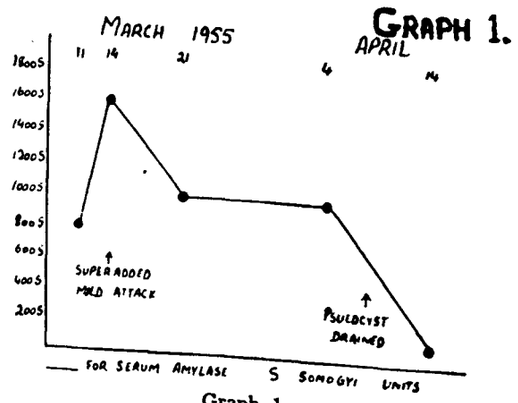
Pain and the appearance of a mass in the upper abdomen were the chief complaints. The pain was mostly epigastric but was also felt in the right and left hypochondriac regions respectively in two cases, depending on the location of the cyst in relation to various regions of abdomen. In all cases pain was continuous, varying from mild to moderate intensity and was often attended with acute exacerbations. At the onset of the illness the pain was generally acute, probably as a result of acute pancreatitis which preceded the appearance of the psuedocyst. The pain was localized to the front of the abdomen except in two cases where it radiated to mid-line, back and

right lumbar region, back respectively. Pain had no accompaniments except for occasional vomiting during acute exacerbations or in the stage of acute pancreatitis. Loss of appetite or aversion to food, not particularly to fatty foods, was another common symptom and it contributed a lot to the general ill health and loss of weight which was present in 6 cases.

A palpable mass in the upper abdomen was the most constant finding and often was a great help in the clinical diagnosis of the condition. It was present in all our cases. It was tense, cystic, slightly tender, well defined, often movable on respiration and was dull on percussion. Movements of the cyst on respiration could be demonstrated only in large cysts which were presumably in contact with the diaphragm. In one case where the psuedocyst was encountered soon after the acute episode of pancreatitis, it was felt as a soft, diffuse, ill-defined mass, probably because the walls were not firm and the cyst not tense enough to offer resistance to the palpating finger. It is our belief that clinical diagnosis is not difficult provided the clinical features are properly evaluated.

*Laboratory Investigations :*

The diagnostic value of serum and urinary amylase in psuedocysts has not been properly assessed. Meyer (1949) noted rise in serum amylase in two out of eight cases of psuedocysts. Pinkham (1945) found elevated readings in 6 cases, but no diagnostic importance was attached to it. According to Priestley (1950) serum amylase rises in cases of psuedocysts during superadded acute episodes of pancreatitis. However repeated estimations of serum and urinary amylase in 6 of our cases have been very revealing. Elevated readings were demonstrated in all cases irrespective of whether there was any pain or not. Higher readings persisted at fairly constant levels except for slight further rise during acute exacerbations. The elevated readings dropped to normal soon after institution of drainage (Graph 1). These findings suggest that the presence of a psuedocyst is invariably associated with high levels of serum and urinary amylase — a fact at variance with observations of other workers. This could be relied upon for diagnosis of the condition.




Graph 1.

Showing persistent rise in serum amylase in the presence of a psuedocyst. There was slight further rise during superadded acute exacerbation. There was a rapid fall in amylase level after internal drainage (Case 3).

Disturbances in carbohydrate metabolism may occur in these cases. They represent the extent of damage to the pancreas produced as a result of associated acute or relapsing pancreatitis. Two of our cases revealed high blood sugar levels, i.e. 143 mg.% each, and sugar tolerance in one of these showed a diabetic curve. It is reasonable to assume that in such cases where the pancreatic damage has been sufficient enough to knock the islets of Langerhans out of function, there will also be accompanying insufficiency of external secretions of the pancreas. Bilhart (1951) found diabetes in 6 of his 44 cases. Meyer (1949) did not however find any evidence of diabetes in 31 of his cases, but this cannot be regarded as very significant because he relied only on the presence of glycosuria for detection of diabetes. Routine blood sugar estimations preferably sugar tolerance curves and estimation of fats and nitrogen in dried faeces are necessary in order to find the nature and extent of associated metabolic disturbances. No evidence of liver damage was found in 7 cases. In one case there was slight parenchymal damage as demonstrated by liver function tests and liver biopsy showed fatty degeneration in the hepatic cells. It is, however, very difficult to attribute it to the formation of psuedocyst because the patient had been a known alcoholic for many years.



*Radiological investigations :*

The significance of roentgenographic findings in the diagnosis of psuedocysts is well established. Plain X-ray of the abdomen in our series revealed only a diffuse radio-opaque mass in the upper abdomen. In one case, the right dome of the diaphragm was raised and immobile (Fig. 1) suggesting the presence of a subphrenic abscess but operation revealed a huge psuedocyst extending from the diaphragm above to the iliac fossa below. On barium meal study, the stomach was often found to be displaced downwards and forwards against the anterior abdominal wall (Figs. 2, 3 & 10). In two cases there was widening of the duodenal loop (Figs. 4 & 7). Another finding was the persistent pressure effect on the duodenal cap, the pyloric antrum and the body of the stomach (Figs. 4, 5, 6 & 7). There may be smooth indentation of the greater curvature of the stomach and downward displacement of the transverse colon. In one case there was an inferomedial filling defect of the gall bladder on cholecystography (Fig. 3) because of the situation of the cyst in the right hypochondrium as well.

*Treatment :*

External drainage is still regarded as the safest procedure because of its simplicity, short duration and low mortality, i.e. 4-6% (Zaoussis 1953). It can be executed by rubber drain and mostly by marsupialization of the cyst wall to the parietal peritoneum. In cases where surgical drainage is undertaken soon after the appearance of the cyst, early obliteration of the cavity and closure of the external fistula can be assured because the cyst at this stage is small, and its walls are thin, soft and collapsible. On the contrary in cysts of long duration, the walls become thick, firm, fibrous and non-collapsible so that external fistulae persist for long. Simple drainage was instituted in 2 cases. In one of these evacuation of contents at the operation lead to its disappearance, while in the other early closure of the external fistula was obtained because of the institution of therapy soon after the appearance of psuedocyst. In two of our long standing cases where marsupialization was done external fistulae went on draining for a long time. The use of external drainage has become limited in view of the reported persistent pancreatic fistulae and repeated recurrences of the cyst. Once a permanent fistula develops, a second operation, i.e. implantation of the fistulous tract into the gastro-intestinal tract, appears inevitable.

In order to eliminate the autodigestion of the abdominal wall, infection of the cyst and sinus formation, severe inanition and repeated haemorrhages consequent upon persistent external fistula, primary internal drainage into some part of gastro-intestinal tract is being practised more frequently nowadays. By so doing, the fluids, electrolytes and enzymes contained in the cyst cavity are reabsorbed into the body. Psuedocysts can be anastomosed to any of the hollow viscera, such as stomach, duodenum or jejunum. Cystogastrostomy has been reported to be an extremely valuable method and is especially useful in small retrogastric cysts and a transgastric approach has been most frequently practised. Out of 50 cases reviewed from the literature, Zaoussis (1953) found only 5 failures following cystogastrostomy. In 33 of 45 successful cases more or less long and satisfactory follow up results were reported. There is only one objection to this procedure and that is the danger of the influx of gastric contents into the cyst with resultant infection and flare up. Its frequency in actual practice has not yet been established. Walzel (1927) and Neuffer (1939) both reported anastomosis of the cyst to the gall bladder. The former in addition ligated the cystic duct to prevent bile from entering the cyst. Kershner (1935) anastomosed the cyst to the duodenum while

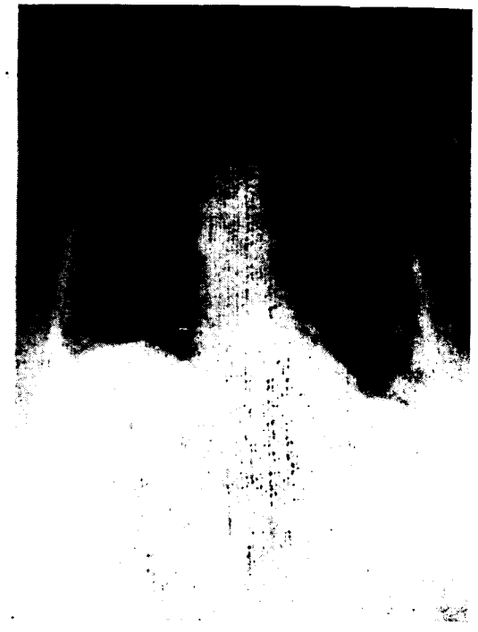


Fig. 1.

X-ray chest showing raised right dome of the diaphragm ; on screening its movements were restricted.

Fig. 2.

Barium meal study showing pushing forward of the stomach against the anterior abdominal wall by the Psuedocyst in the lesser sac.

Fig. 3.

Barium meal study showing pushing downwards and forwards of the stomach by the psuedo-pancreatic cyst.

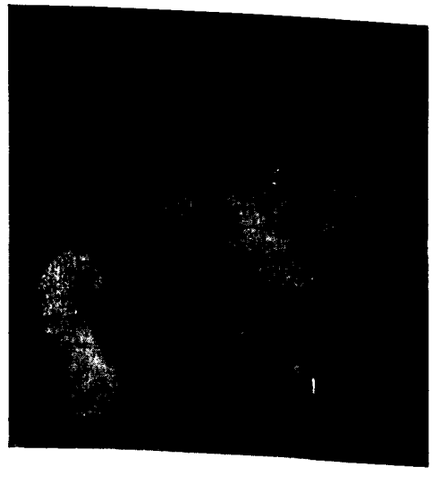


Fig. 4.

Barium meal study showing widening of the duodenal loop with pressure effect on the pyloric antrum and greater curvature of stomach.



Figs. 5 & 6.

Barium meal study showing persistent pressure effect on the duodenal loop, the pyloric antrum and the body of the stomach. The duodenal loop was not opened out (Case 1).

Hahn (1927) drained the cyst into the jejunum. Of the various anastomoses between the cyst and the upper intestinal tract the one with the jejunum is the easiest and the best.

However, the recent trend is to employ Roux Y loop of jejunum for anastomosis to the cyst rather than a direct side to side anastomosis (Fig. 11). It is based on the contention that there is no retroperistalsis in such a defunctioned jejunal loop. This prevents the reflux of intestinal contents into the cyst and overcomes the theoretical objections to performing an internal drainage by direct anastomosis to the hollow viscera. It is a more physiologic operation in so far as it drains the pancreatic juice into the intestines where it normally enters, rather than into the stomach or gall bladder. Rosi (1951) reported two cases treated by this method. Shumacker (1953) treated five cases with excellent results. We employed this procedure in 3 cases. One got massive haemorrhage from the gastro-intestinal tract and expired on the 26th post-operative day. The cause of this massive haemorrhage, however, remains unknown. The other two cases are progressing well 6 to 9 months after the operation. There has been complete disappearance of the mass, increase in appetite and a definite gain in weight. In these cases barium meal study after the anastomosis did not reveal any evidence of reflux of barium into the cyst (Fig. 12) thus confirming the efficiency of defunctioned jejunal loop in preventing entrance of intestinal contents into the cyst. The anastomosis can be made either anterior to the transverse colon through the gastrohepatic or gastrocolic

Fig. 7.

Barium meal study showing enlargement of the duodenal loop. A smooth pressure effect is also seen in the region of pyloric antrum and greater curvature of the stomach (Case 2).

Fig. 8.

Barium meal study in the post operative period after execution of internal drainage by Roux en Y technique still showing widening of duodenal loop and pressure effect on the pyloric antrum and greater curvature of stomach.

omentum, or posterior to the transverse colon through the mesocolon. We have used the posterior approach in all our cases. This will probably obviate the necessity of preparing a long Roux loop and thus avoid complications inherent in that procedure.

It may not be out of place to mention here that in those cases where there are relapsing attacks of pancreatitis, external or internal drainage of the cyst should always be followed by sphincterotomy. We performed sphincterotomy in two cases in addition to marsupialization at a later stage.

Before closing, a brief record of the three cases in which internal drainage of the cyst by Roux Y loop anastomosis to the jejunum was attempted is given below :—

## CASE REPORTS

CASE 1.

S.S., 36 years, male, was admitted on 29-7-1954 with the complaint of pain in the abdomen for 6 years. The pain used to follow excessive intake of alcohol. It was severe, constant and was felt all over the abdomen more so in the epigastrium It used to last for 4—10 days. There were no accompanying symptoms. He had in all 3 attacks of pain. One month after the last attack which came on 3 months back, he noticed a lump in the epigastrium which rapidly increased in size. Along with it he also started getting mild, continuous pain localized to the epigastrium. His appetite was diminished and he lost about 40 lbs. of weight. He was of moderate build, was well nourished. A tense, cystic, well defined mass, about 8" x 8", was felt in the upper abdomen, more so in the epigastrium. It was mobile on respiration and was dull on percussion.

*Investigations :*

Urinalysis revealed no abnormality, haemoglobin was 11.8 gm., R.B.C. count : 4.47 million



Fig. 9.

Cholecystography showing normally functioning gallbladder with evidence of pressure effect seen on the infero medial surface (Case 2).

Fig. 10.

Barium meal study showing pushing forward of the stomach by the psuedopancreatic cyst in the lesser sac.

per c.mm. T.L.C. : 8050 per c.mm., D.L.C. : Polymorphs 60%, lymphocytes 36%, mononuclears 3%, eosinophils 1%. Serum amylase : 320 Somogyi units, urinary diastase : 60 Wohlgemuth units, serum bilirubin : 0.2 mg.%, Thymol turbidity : 3 u, Thymol flocculation 1 +, cephaline cholesterol flocculation after 24 hours : 1 +, after 48 hours : 2 +, blood sugar 143 mg.%, sugar tolerance test revealed a diabetic curve, plain X-ray of the abdomen revealed a diffuse opacity in the upper abdomen, Barium meal study revealed a persistent pressure effect on the duodenal loop, the pyloric antrum and the body of stomach. The duodenal loop was not opened out (Figs. 5 & 6).

He was operated on on 5-8-1954. The abdomen was opened through a left paramedian incision, stomach was found to be distorted and lying against the anterior abdominal wall. A large cyst could be felt in the lesser sac. Several plaques of calcification were found in the transverse mesocolon which was also very much thickened. 750 c.cs. of dark brown fluid was aspirated and the cyst anastomosed to the jejunum by Roux en Y loop technique. Pancreas was found to be enlarged and firm. Gall bladder showed no pathology. Serum amylase dropped to 160 Somogyi units after the operation. He was allright for two weeks. On 18-8-1954 he started vomiting anything he took. On 19-8-1954 he passed 11 loose motions and complained of pain in the abdomen. In the night he passed a lot of frank blood per rectum ; serum amylase rose to 458 Somogyi units on 20-8-1954. Condition deteriorated on 21-8-1954, became comatose and expired on 22-8-1954. Liver biopsy taken at operation revealed evidence of fatty degeneration. Necropsy was not permitted.

CASE 2.

C.D., 20 years, male, was admitted on 13-12-'54. Five months back he was struck by a bamboo stick in the epigastrium. It was followed by a severe, constant epigastric and right hypochondriac pain for 15 days. There was accompanying mild fever for a few days. Soon after the onset of pain he noticed an epigastric mass which subsided a little after subsidence of attack but mild, constant pain persisted. Fifteen days back pain became severe and he noticed an increase in the size of the mass. He lost appetite and complained

of diminution of weight. Local examination revealed a firm, well defined mass in the epigastrium, about 4" x 5" in size. It was not tender and there was no movement on respiration. It was dull on percussion.

*Investigations :*

Urinalysis revealed no abnormality, 22-12-1954 : serum amylase—320 Somogyi units, urinary diastase—70 Wohlgemuth units, 27-12-1954 : Serum amylase—293 units, urinary diastase—60 units, 3-1-1955 : Serum amylase—266 units, 5-1-1955 : Serum amylase—400 units, urinary diastase—40 units, 11-1-1955 : Serum amylase—320 units, blood sugar—100 mg.%, Serum bilirubin—0.3 mg.%, Thymol turbidity—1 u, Thymol flocculation ±, Cephaline cholesterol flocculation after 24 hours—1+, after 48 hours—1+, Plain X-ray abdomen revealed no abnormality ; on cholecystography gall bladder was normally visualized and evidence of pressure effect was seen on the infero-medial surface (Fig. 9). Barium meal study revealed enlargement with pressure on the duodenal loop. A smooth pressure effect was also seen in the region of the pyloric antrum and greater curvature (Fig. 7).

He was operated on on 22-1-1955. A right transverse incision was made midway between the umbilicus and xiphisternum. A psuedopancreatic cyst 5" x 4" was found in the lesser sac. The cyst was presenting itself through the transverse mesocolon. The foramen of Winslow was patent. On aspiration dark brown fluid was withdrawn. An opening was made in the cyst through the transverse mesocolon and the contents evacuated. The cyst was anastomosed to the jejunum by a Roux en Y loop technique. Post-operative recovery was uneventful. Examination of the fluid from the cyst revealed a lot of necrotic debris, no organisms could be grown, pancreatic amylase was present in large amounts and protein content was 3.5 mg.%. Serum amylase dropped to 160 Somogyi units after surgical drainage. Barium meal study in post-operative period did not reveal any evidence of reflux of barium from the jejunum into the cyst (Fig. 8). He reported for follow up after 6 months. There was complete freedom from pain, the mass had disappeared, there was increase in appetite and some gain in weight.

CASE 3.

S.K., 13 years, female, was admitted on 9-3-1955 with the complaint that she got an attack of epigastric pain 1¼ months back. The pain was severe, constant and radiated to the back. There was frequent vomiting accompanying it. The attack lasted for 4 days. Another attack of pain followed after 4 days. 15 days later she noticed a small lump in the abdomen which rapidly increased in size. During this period she was getting mild, continuous pain with occasional acute exacerbations. She lost her appetite and complained of considerable loss of weight. She was of moderate build, but was poorly nourished. Local examination revealed a mass in the upper half of the abdomen about 6" x 4" in size. It was tense, cystic, well defined but not tender. It moved on respiration and was dull on percussion.

*Investigations :*

Urinalysis revealed no abnormality. Haemoglobin : 9.2 G, R.B.C. count : 3.4 million per c.mm., T.L.C. : 7200 per c.mm., D.L.C. : Polymorphs 62%, lymphocytes 35%, mononuclears 1%, eosinophils 2%, serum bilirubin : 0.1 mg.%, Thymol turbidity : 0.5 u, Thymol flocculation : -ve, Cephaline cholesterol flocculation after 24 hours : ±, after 48 hours 1+, Total serum proteins : 5.8 mg.%, serum albumin : 3.5 mg.%, serum globulin : 2.3 mg.%, Blood sugar : 72 mg.%, sugar tolerance curve was normal, 11-3-1955 : serum amylase—800 Somogyi units, urinary diastase—80 Wohlgemuth units, 14-3-1955 : serum amylase—1600 units, urinary diastase—120 units, 21-3-1955 : serum amylase—1000 units, urinary diastase—120 units, 4-4-1955 : serum amylase—1000 units, urinary diastase—80 units, Plain X-ray abdomen revealed a diffuse opacity in the upper abdomen, cholecystography showed a normally functioning gall bladder, Barium meal study showed that the stomach was pushed forwards (Fig. 10).

She was operated on on 9-4-1955. A left paramedian incision was made. A big psuedopancreatic cyst was found in the lesser peritoneal sac. A large amount of dark brown fluid was aspirated. An internal anastomosis of the cyst to the jejunum through the transverse mesocolon by Roux en Y loop technique was accomplished. Pancreas was felt to be enlarged and firm. Gall bladder and bile duct was found to be normal. Post-operative recovery was uneventful. Serum amylase fell to 145 units and urinary diastase to 20 units after institution of drainage. Fluid from the cyst was found to contain a lot of necrotic debris, and altered blood. No organisms could be grown. Amylase was present in large amounts and protein content was 0.8 mg.%. Barium meal study in the post-operative period did not reveal any evidence of reflux of barium into the cyst from the jejunum. She reported for follow up after 3 months. There was complete freedom from pain, the mass had disappeared, the appetite increased, and there was slight gain in weight.

## Discussion

Psuedopancreatic cysts are extremely rare, their incidence being .029 per cent in our series. Although their relative frequency in the two sexes varies in the different series, it seems reasonable to assume that psuedocysts are more common in females as seen in our series. This is because pancreatitis which is a fore-runner of psuedopancreatic cysts is more common in females. It has no predilection to any particular age group, the disease being uniformly distributed over various age groups. Children are not exempt from it.



Gall bladder disease does not seem to have any causal relationship to psuedocyst formation. Neither should we consider trauma as an independent etiological factor. It is more logical to assume that there is only one factor in the causation of psuedopancreatic cysts and that is, acute pancreatitis, which may in turn be due to any of the following factors, i.e. trauma, biliary reflux into pancreatic duct, pancreatic ductal obstruction in an hyperactive gland, vascular factors, etc. Rarely however trauma may primarily be the cause of psuedocyst formation and that is when the severity of injury results in rupture of acini and tearing away of the serous coat covering the pancreas and consequent discharge of pancreatic enzymes into the lesser peritoneal sac.

The clinical diagnosis is not difficult but it only requires correct interpretation of the clinical manifestations. A cystic upper abdominal mass, relatively fixed with only slight movements on respiration, if preceded by an acute attack of epigastric pain should make one suspect the presence of a psuedopancreatic cyst. This can be easily confirmed by estimation of serum and urinary amylase, and barium meal study of stomach and duodenum. An elevated reading of serum amylase is always obtained and is of considerable help in suspicious cases. It will not be wrong to say that persistence of high serum amylase levels after the subsidence of acute pancreatitis should make one think of the possibility of a psuedo-pancreatic cyst.

Once the diagnosis is established there should be no hesitancy about the line of treatment. Unnecessary delay may prove disastrous, for not only may it result in spontaneous rupture of the psuedocyst but also the prolonged misery of the disease and the malnutrition resulting from marked anorexia, may make the patient a poor operative risk at a later date. External drainage by marsupialization may be helpful in speedy obliteration of the cyst in early cases but the persistence of external fistulae for long in chronic cases does not recommend it for universal application. Internal drainage is the only appropriate procedure because not only does it shorten the post-operative morbidity but also avoids the ill effects of prolonged draining external fistulae. Internal drainage into the gall bladder seems irrational and instead of serving any useful purpose may be positively harmful. Internal anastomosis directly to the stomach and jejunum may be useful but it carries with it the risks inherent in the reflux of gastro-intestinal contents into the psuedo-pancreatic cyst, however small the risk may be. Internal drainage into the jejunum using a defunctioned Roux loop is the procedure of choice and appears to be the most physiological method at present. In addition to the use fulness of internal drainage it obviates the risks of entrance of jejunal contents into the psuedopancreatic cyst because we do not expect retroperistalsis in the defunctioned jejunal loop. The aforementioned treatment is only symptomatic. It does not aim at prevention of further recurrences of the pancreatitis which resulted in the formation of a psuedopancreatic cyst. The only rational approach would be to do sphincterotomy at a later date when the patient has had complete relief from the psuedo-pancreatic cyst.

## Summary and Conclusions

1. A critical analysis of 8 cases of psuedocysts has been presented with a view to assess the various diagnostic and therapeutic aids currently practised.

2. Psuedocysts are rare in occurrence. There is always an antecedent history of acute pancreatitis which may be the result of trauma or other factors such as biliary reflux into the pancreatic duct or pancreatic ductal obstruction, etc.

3. Clinical diagnosis is easy but needs proper evaluation of clinical features. Estimation of serum and urinary amylase is helpful in diagnosis as is the radiological examination after giving an opaque meal.

4. Once the diagnosis is established an early operation is indicated in order to avoid the risks of spontaneous rupture.

5. Marsupialization is useful but internal drainage into some of the hollow viscera in the gastro-intestinal tract is preferable. Internal drainage into a defunctionalized loop of jejunum (Roux en Y loop anastomosis to jejunum) is the method of choice as it obviates the risks of entrance of intestinal contents into the cyst.

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# EVALUATION OF SERUM AMYLASE TEST AS A DIAGNOSTIC AID

*by S. S. ANAND and C. P. SAWHNEY, Amritsar.*

In the early part of this century the clinical diagnosis of pancreatitis was difficult, well nigh impossible. The diagnosis depended on operative findings or autopsy observations. Elman (1942) first demonstrated the value of determination of amylase in serum in acute pancreatitis. Since then the procedure has become well established and now for all practical purposes an elevated serum amylase is considered as diagnostic of acute pancreatitis, provided the estimations are done at the height of the attack or soon after it. Normal serum amylase levels range within constant limits in an individual when determined by a reliable method of analysis (Lewison, 1941). When the amylase test is done within the first two or three days of acute illness, a low or normal reading is of considerable value in eliminating the likelihood of acute pancreatitis. There is a rapid rise in serum amylase following the onset of pain of acute pancreatitis. A peak level is reached within 48 to 72 hours according to Warren (1948), within 48 hours according to Lewison (1941) and in the 4th to 6th hour according to Wapshaw (1941). Howard, Smith and Peters found significant rise in serum amylase in 15 to 30 minutes in experimental pancreatitis in dogs. Following the arrival at a peak level the serum amylase may return to normal or subnormal level with great rapidity (Heifetz 1941, and McCorkle 1942) or remain elevated for a number of days (Olander 1952). Thus there are wide variations in the behaviour of serum amylase levels during the course of pancreatitis and their proper assessment is imperative before any conclusions can be drawn as regards their diagnostic value. This study is based on an extensive trial of this test in normals and in diseased, and an attempt has been made to evaluate its real significance.

*Normal range*: The normal range of serum amylase must be known and its variations must be realised before a correct interpretation of the results can be made. The amyloclastic activity of the serum of any given normal individual is usually very nearly at the same level regardless of fasting, feeding, kind of food, time of day, and exercise (McCorkle and Goldman, 1942). We studied one hundred normal individuals to find out the normal range of serum amylase. We have used King's modification of Somogyi's method for the estimation of serum amylase.

In the majority of our cases, i.e. 87% the serum amylase values ranged between 80 and 200 Somogyi units. However 11 per cent had figures above 200 units. Only rarely, i.e. 2 per cent of cases, values above 250 Somogyi units were obtained.

Serum amylase estimations were carried out at the height of pain in 81 cases of acute upper abdominal pain. They were repeated after the subsidence of pain in cases where the serum amylase levels were raised to suspiciously high levels.

In 87.6 per cent of cases serum amylase values varied from 80 to 200 Somogyi units. 9.8 per cent had values ranging from 200 to 250 units. In only 2.6 per cent values ranged from 250 to 320 Somogyi units.

*Serum amylase in gall bladder disease*: This study was necessitated because of the reported evidence that serum amylase can be elevated in acute and chronic chole-

TABLE I.

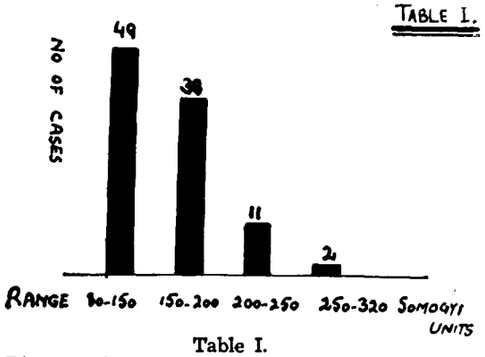



Table I.
Diagramatic representation of serum amylase levels in normal individuals.

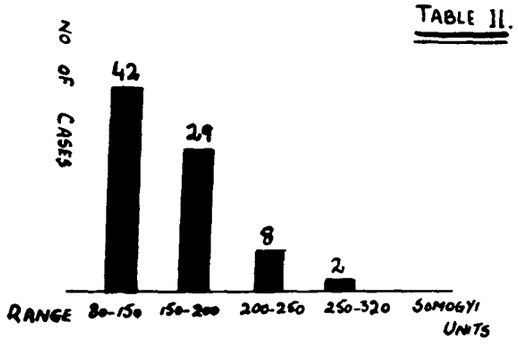



Table II.
Diagramatic representation of serum amylase levels in cases with upper abdominal pain.

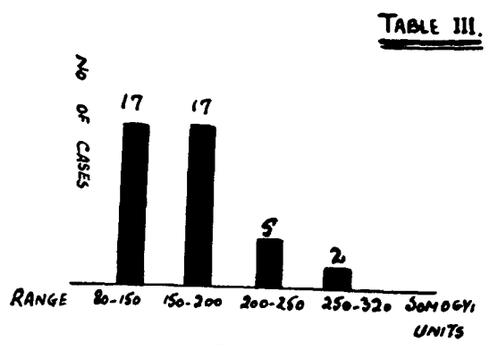



Table III.
Diagramatic representation of serum amylase levels in cases of acute cholecystitis.

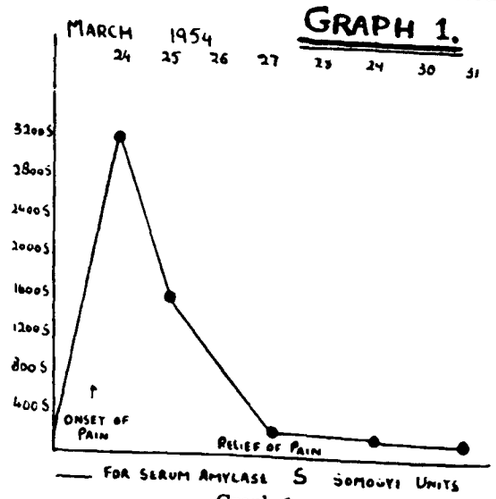
cystitis and common bile duct stone (McCorkle and Goldman 1942). Were it so, there is likelihood of difficulties arising in distinguishing acute cholecystitis from acute pancreatitis in view of the close resemblance in their clinical pictures. Serum amylase determinations were done in 41 cases of acute cholecystitis soon after the onset of pain and were repeated after relief of pain.

In 83 per cent of cases serum amylase values ranged between 80 and 200 Somogyi units. 12.2 per cent of cases had values varying from 200 to 250 Somogyi units. In only 4.8 per cent were the values between 250 and 320 Somogyi units.

In the light of the above facts it seems reasonable to assume that there is no significant difference in the behaviour of serum amylase levels between normal healthy individuals and cases with acute upper abdominal pain including acute cholecystitis. In those few cases where serum amylase levels rose to 320 Somogyi units, repeated estimations of serum amylase revealed that this figure was sustained even after subsidence of pain, indicating thereby that such a figure was normal for that individual.

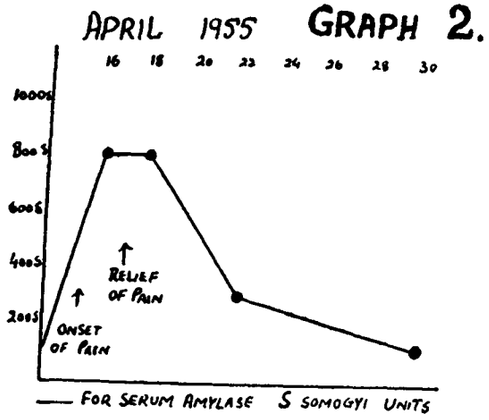
*Serum amylase in pancreatitis*: Serum amylase levels do not behave uniformly during the course of acute pancreatitis in all cases. Several types of variations occur and they have a bearing on the diagnosis of the disease. In order to understand these variations patients with pancreatitis were studied over a period of several days and serum amylase determinations were done at varying intervals. We were able to demonstrate the following types of variations.

1. *Sharp rise and fall to normal* (Graph No. 1): There was a sudden rise in serum amylase levels with the onset of pain. The peak level being reached at the height of attack. This was followed by a rapid fall in serum amylase to normal levels within 24 to 96 hours. The degree of rise varied

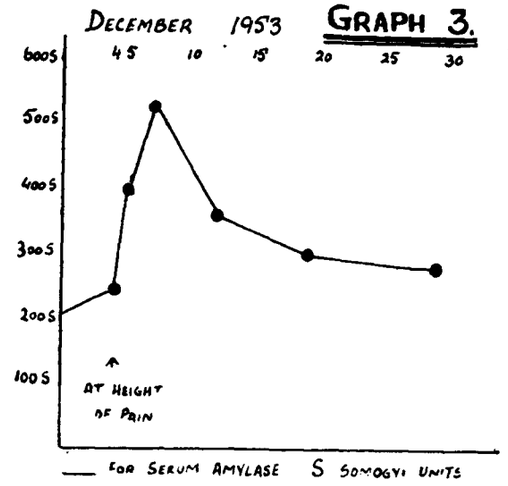



Graph 1.
Showing sharp rise in serum amylase with the onset of pain followed by an immediate fall after relief of pain.

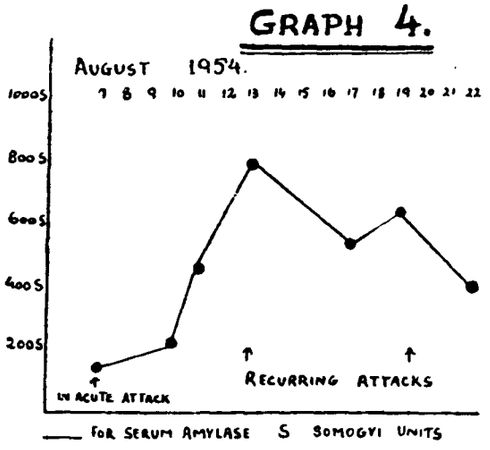




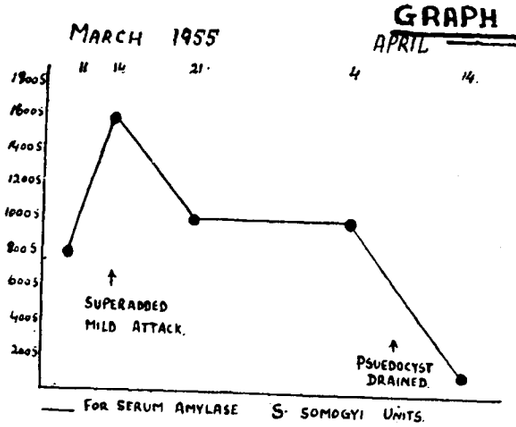

Graph 2.
Showing sudden rise in serum amylase followed by gradual fall after relief of pain.




Graph 3.
Showing gradual rise in serum amylase followed by a gradual fall after relief of pain




Graph 4.
Showing delayed rise in serum amylase at the onset of pain. There was in addition persistent rise in serum amylase due to recurring attacks of pain.




Graph 5.
Showing persistent rise in serum amylase in the presence of a psuedo-pancreatic cysts followed by a rapid fall after internal drainage.

directly with the severity of the attack and the decline in curve exactly corresponded to the subsidence of the acute process. Thus repeated estimations of serum amylase could be of prognostic value in such cases.

2. *Sudden rise but gradual fall to normal* (Graph No. 2): In this group of cases serum amylase rose to significantly high levels with the onset of pain but the elevated levels persisted for a longer time and gradually fell to normal taking 8—15 days. In these cases serum amylase levels did not follow the course of the disease because the attack had subsided long before serum amylase levels came down to normal.

*Gradual rise and gradual fall to normal* (Graph No. 3): In one of our cases serum

amylase estimation at the height of pain revealed a slightly raised level. Subsequent estimations showed a rising level and the peak level was reached on the 5th day—at a time when the attack had subsided, and then serum amylase level fell gradually taking fifteen days to reach normal level.

4. *Delayed rise in serum amylase* (Graph No. 4): In two clinically suspected cases of pancreatitis serum amylase did not show any rise on the day after the admission although the pain had continued. Subsequent estimations at short intervals revealed rise in serum amylase which soon touched high diagnostic levels. In these cases repeated determinations of serum amylase helped us in arriving at the correct diagnosis which would otherwise have been missed.

5. *Persistent rise in serum amylase* (Graph No. 5): One of our cases was having recurrent episodes of pancreatitis following one another in quick succession. The repeated estimations of serum amylase revealed that high levels were sustained for a period of 20 days. There were only slight variations in serum amylase levels which corresponded to each exacerbation. This persistent rise was probably because serum amylase levels did not get enough time to fall to normal before the next attack came on.

Another instructive fact is that in one of our cases who started getting acute episodes of pain in the abdomen following cholecystectomy estimations of serum amylase on the first four occasions revealed normal serum amylase levels. It was on the 5th admission that serum amylase levels rose to high diagnostic levels and the diagnosis was established. It is clear how important it is to estimate serum amylase in each episode even though one gets normal figures in one of the attacks.

*Serum amylase in the diagnosis of psuedo-pancreatic cysts*: The diagnostic value of the estimation of serum amylase in psuedo-pancreatic cysts has not been properly assessed. Meyer (1949) noted rise in serum amylase in two out of eight cases of psuedo-pancreatic cysts. Pinkham (1945) found elevated readings in 6 cases, but no diagnostic importance was attached to it. Priestley (1950) stated that serum amylase rises in cases of psuedo-pancreatic cysts during superadded acute episodes of pancreatitis. However repeated estimations of serum amylase at short intervals in 6 of our cases have been very revealing. Elevated readings were demonstrated in all cases irrespective of whether the estimations were done during pain or not. High readings were maintained for a long time at fairly constant levels, except for a slight further rise during superadded acute exacerbations. The elevated readings fell to normal immediately after institution of drainage of the psuedopancreatic cyst (see Graph No. 5). It can be safely assumed that high serum amylase values are invariably associated with the presence of a psuedocyst and thus estimations of serum amylase can be of definite diagnostic aid.

## Discussion

The estimation of serum amylase is the most reliable diagnostic aid at present in acute pancreatitis. The values in normal healthy individuals vary widely. Figures between 80 to 250 Somogyi units should be considered as normal and those between 250 and 320 units as high normals. Any rise above 320 units especially if the estimations are done at the height of pain and if it falls down after the subsidence of attack, should be taken as suggestive of pancreatitis. Normal values for each individual are fairly constant and their knowledge is essential in the correct interpretation of higher readings, for a person who has 250 Somogyi units as his normal, in him values of 320 Somogyi units may not be of much consequence, as against the one whose normal serum amylase value is 80 Somogyi units. At it is difficult to know normal level of an individual (patient) greater stress needs to be laid on the subsequent fall to normal, after the relief of pain.

Comparing the serum amylase values found in normal individuals and in cases of



acute upper abdominal pain including those of acute cholecystitis, it can be safely assumed that serum amylase levels remain well within normal limits in most of the upper abdominal emergencies uncomplicated with pancreatitis. Thus although clinical differentiation may be difficult yet a finding of raised serum amylase suggests the diagnosis of acute pancreatitis.

A single estimation of serum amylase in a clinically suspected case is not enough to rule out the diagnosis of pancreatitis. Repeated estimations at frequent intervals are imperative in the light of the fact that serum amylase may show a slow or delayed rise even in the presence of pancreatitis. Not only that but estimations of serum amylase must be carried out in all attacks of pain in the upper abdomen in an individual, even though the levels were normal in one of these episodes, for it is possible to have episodes of pancreatitis unassociated with any rise in serum amylase. The importance of raised serum amylase at the height of pain is established but at times when one comes across elevated values after the subsidence of the attack one should be careful enough not to dispose it off as meaningless. We do get persistent rise of serum amylase for a long time or a slow and a gradual fall to normal after relief of pain. That an elevated value of serum amylase may be of diagnostic value at times even after the subsidence of pain, calls for its estimation in cases seen late, when there is no pain. In the majority of cases the degree of rise in serum amylase varies with the severity of the disease and the subsequent fall parallels the subsidence of the attack. It thus appears that estimation of serum amylase may be of prognostic value, but considering the cases in which serum amylase remains elevated for a long time before coming to normal although the attack had subsided long ago, the above hypothesis does not appear uniformly applicable.

Once the psuedopancreatic cyst forms we expect elevation and persistence of high levels of serum amylase till the time when the collection is drained. The high levels persist even if there are no superadded attacks of pancreatitis. These elevated readings can thus be of great help in the diagnosis of suspected cases of psuedopancreatic cyst. Following acute pancreatitis if high readings of serum amylase persist, one should always keep in mind the possibility of a psuedocyst forming as a complication of acute pancreatitis. In view of the fact that serum amylase readings fall after institution of drainage it seems probable that elevated readings were the result of constant absorption of amylase contained in the psuedocyst, into the systemic circulation via the vascular granulation tissue lining the cyst walls. It is also possible that in chronic cases with marked fibrosis and less vascularity of the cyst wall the absorption of the amylase into the general circulation will diminish and consequently serum amylase values fall to insignificant levels. This can also happen if the communication of the cyst with the pancreatic duct closes after some time, resulting in the absence of amylase from the contents of the psuedopancreatic cyst. Thus the reason why some of the investigators have failed to get elevated serum amylase in their cases of psuedopancreatic cysts, may be that their cases were of long duration with fibrous and relatively avascular walls or had less amylase content of the psuedocyst fluid because of closure of the communication with pancreatic duct.

## Summary

1. One hundred normal healthy individuals were investigated to set up normal standards for serum amylase.

2. Eighty seven cases of acute upper abdominal pain, including 41 cases of acute cholecystitis were studied to find the behaviour of serum amylase in these conditions.

3. Serial estimations of serum amylase at short intervals were carried out in twenty five cases of acute and relapsing pancreatitis to study the variations in the pattern of its curves during the course of the disease.

4. Repeated determination of serum amylase in six cases of psuedopancreatic cyst were done in order to assess the diagnostic significance of this aid.

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# URINARY DIASTASE IN HEALTH AND DISEASE

## (With special reference to its value in acute pancreatitis)

*by S. S. ANAND and C. P. SAWHNEY, Amritsar.*

Several biochemical changes accompany an attack of acute pancreatitis and their proper interpretation is of great significance in arriving at a correct diagnosis, which is extremely difficult clinically. Following an attack of acute pancreatitis, pancreatic enzymes are liberated into the interstitial tissue of the pancreas as a result of rupture of smaller pancreatic ducts and acini. These enzymes find their way into portal and then into systemic circulation, thereby raising their level in the blood. Subsequent to that, there is an increased excretion of enzymes in the urine, consequently the level of the urinary diastase rises. The time elapsing before an elevated serum amylase results in increased excretion of diastase, in the presence of normal renal function, is less than two hours (Dankner 1951). It has been pointed out that estimations of urinary diastase can be of help in the diagnosis of acute pancreatitis but its real value is still controversial. Popper and Necheles (1948) considered this procedure less reliable as compared to estimations of serum amylase. Dozzi (1940) discouraged it because he found urinary diastase estimations too unreliable to be of any routine diagnostic value. On the contrary, others have stressed its great practical value not only in the diagnosis at the height of attack, but also in the later stages of the disease when the serum amylase has come to normal, on the ground that elevated urinary diastase levels persist for a longer time than those of serum amylase (Dozzi and Bockus, 1946).

### Methods and Material

The present investigation is based on a critical analysis of the data obtained after an extensive trial of this test in normal and in diseased persons. We have tried to assess its real significance in the clinical diagnosis of acute pancreatitis. An attempt has also been made to find out the interrelationship between serum and urinary amylase in the light of our investigations. We have used Wohlgemuth method for the estimation of urinary diastase in this study. In all, 112 normal healthy individuals were studied to find out the range of variations in health. In addition urinary diastase estimations were done in 78 cases of acute upper abdominal pain including 43 cases of acute cholecystitis to find the changes in urinary diastase levels in these conditions. Repeated estimations of urinary diastase were carried out in 18 cases of acute pancreatitis, at short intervals, to detect the variations in the pattern of curves of urinary diastase during the course of disease. Besides, determinations of serum amylase were done in all these cases along with those of urinary diastase in order to find whether or not there exists any relationship between levels of serum and urinary amylase.

TABLE 1

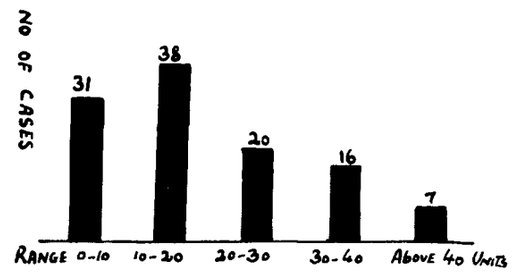



Table 1.
Showing variations in range of urinary diastase in normal individuals.

### Results

#### NORMAL RANGE

In 79.5% of cases of urinary diastase readings ranged between 0—30 Wohlgemuth units. 14.3% of cases had values varying from 30 to 40 Wohlgemuth units.

In only 6.2% of cases figures were raised beyond 40 Wohlgemuth units. There were indeed wide variations in the normal values in different individuals.

It may be worth-while considering the effect of variations in concentration of urine on levels of urinary diastase. This can be known by studying a group of individuals at short intervals by simultaneously estimating urinary diastase and taking specific gravity of urine, and finding whether or not urinary diastase levels vary with varying concentrations of urine in an individual at different times. In a few normal cases thus investigated there was a suggestion that urinary diastase levels were directly related to the changes in specific gravity, i.e., concentration of urine. Thus a large quantity of low specific gravity urine will have a lesser quantity of various salts and enzymes including diastase than a scanty high specific gravity urine in the same individual provided serum amylase levels do not vary. The kidney is the only barrier to be crossed before diastase appears in the urine and consequently variations in the concentration of excreted matter (urine) is bound to be reflected in the variations in amount of urinary diastase.

If we study a group of individuals with exactly similar serum amylase content we expect to find almost same amount of urinary diastase in all of them, but our observations have been to the contrary in many such cases.

| First group | | Second group | | Third group | |
|---|---|---|---|---|---|
| Serum amylase | Urinary diastase | Serum amylase | Urinary diastase | Serum amylase | Urinary diastase |
| 160 Units | 10 Units | 123 Units | 8 Units | 228 Units | 10 Unit |
| 160 Units | 20 Units | 123 Units | 20 Units | 228 Units | 20 Units |
| 160 Units | 30 Units | 133 Units | 30 Units | 228 Units | 30 Units |
| | | 133 Units | 40 Units | 228 Units | 40 Units |

From the afore-mentioned examples we find wide variations in the concentration of urinary diastase in persons with same serum amylase levels. This is presumably due to variations in concentration of urine secreted by the various individuals. As the concentration of the urine is a very variable dependant on the intake and output of fluids and electrolytes, and also because the urinary diastase content is going to vary correspondingly, the urinary diastase cannot be representative of true levels of serum enzymes. As is true in healthy individuals, the same is also true in the diseased. The urinary diastase levels will fluctuate with fluctuations in concentration of urine.

### Urinary Diastase in Disease

In the 78 cases of acute upper abdominal pain investigated 88% had urinary diastase values ranging from 0—30 Wohlgemuth units. In 10.5% urinary diastase varied from 30—40 Wohlgemuth units. In only 1.5% were the values raised above 40 units.

88.4% of cases of acute cholecystitis had urinary diastase values between 0—30 Wohlgemuth units. In 9.3% figures varied between 30—40 units. In only 2.3% were the values raised above 40 Wohlgemuth units.

### Urinary Diastase in Acute Pancreatitis

Following types of variations in the levels of urinary diastase were observed in cases of acute pancreatitis.

1. Sudden rise in urinary diastase with rapid fall (Graph 1). There was a sudden and significant rise in urinary diastase levels soon after the onset of pain, the peak being reached at the height of pain. Thereafter the levels rapidly fell to normal after relief of pain, usually taking 24 to 72 hours.

2. Sudden rise and gradual fall (Graph II). In this group of cases sudden rise in urinary diastase levels was followed by a slow and gradual fall after subsidence of the attack, the base-line being reached in



TABLE 2.

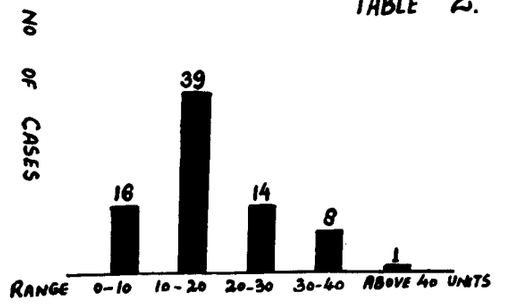



Table 2.
Showing variations in range of urinary diastase in cases with acute upper abdominal pain.

TABLE 3


Table 3.
Showing variations in range of urinary diastase in cases of acute cholecystitis.

5—6 days. Thus relatively higher levels persisted a little longer after the subsidence of pain.

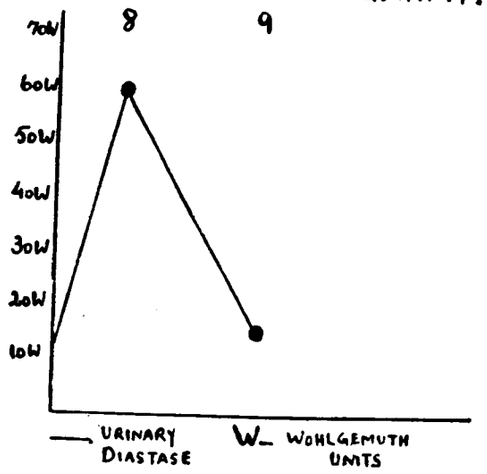
3. No significant rise (Graph III). In these cases although the attacks were typical of pancreatitis as confirmed by rise in serum amylase, there was no significant rise in urinary diastase. Urinary diastase levels remained below 40 Wohlgemuth units in spite of repeated determinations during the course of disease. In this group sole reliance on the estimations of urinary diastase would have been misleading.

4. Delayed rise in urinary diastase (Graph IV). In one of our cases where the history of the attack suggested acute pancreatitis the estimations of urinary diastase at the onset of pain showed urinary diastase levels within normal limits. However repeated urinary diastase determinations at subsequent intervals showed a significant rise, thus confirming the diagnosis.

Urinary diastase in psuedopancreatic cyst: Repeated examinations of urinary diastase at short intervals, over a long time, in 6 cases of psuedopancreatic cysts have brought forward valuable evidence. Urinary diastase values were significantly elevated at all stages of the disease even in the absence of attacks of pain although a little further rise was noticed during super-added exacerbations. The high levels were sustained for as long a time as the cyst was present but dropped suddenly following institution of surgical drainage (Graph V).

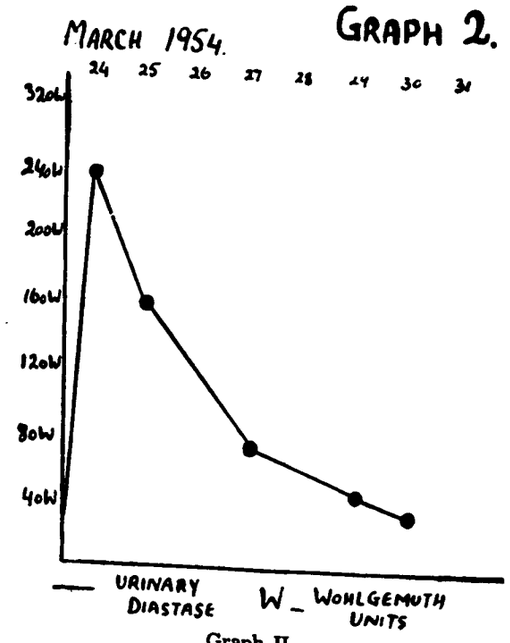
Inter-relationship between serum amylase and urinary diastase:—Soon after the rise in serum amylase, excretion by the kidney starts resulting in raised urinary diastase. As long as the kidney is normally functioning we expect to find a rise in urinary diastase to be proportionate to that of serum amylase. To find whether this really exists in practice, data obtained after simultaneous estimations of both serum amylase and urinary diastase in health as well as in disease, have been critically analysed.

Although in majority the expected proportion was kept up, still a large number of cases behaved to the contrary. In 38% of the normal healthy individuals and 47% of cases of acute cholecystitis this relationship was broken up. There was either a greater or relatively lesser rise in urinary diastase as compared to serum amylase. In 8 out of 30 acute episodes (26.7%) in 24 cases of acute pancreatitis, urinary diastase did not show a proportionate rise relative to serum amylase. In 3 attacks however urinary diastase levels were comparatively higher (i.e. 40, 30, 60 units) as compared to those of serum amylase which were 100 units in all the three attacks. During the



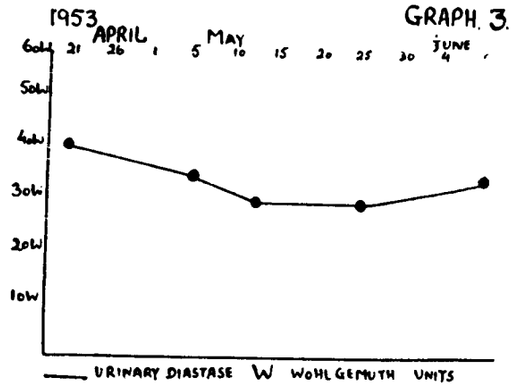

Graph I.

Graph showing sudden rise in urinary diastase followed by a sudden fall after relief of pain.



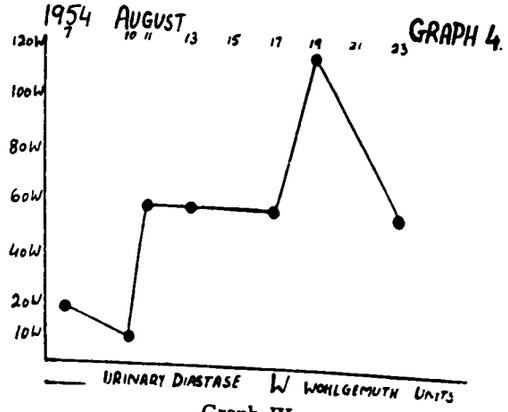

Graph II.

Graph showing sudden rise in urinary diastase followed by a gradual fall after relief of pain.




Graph III.

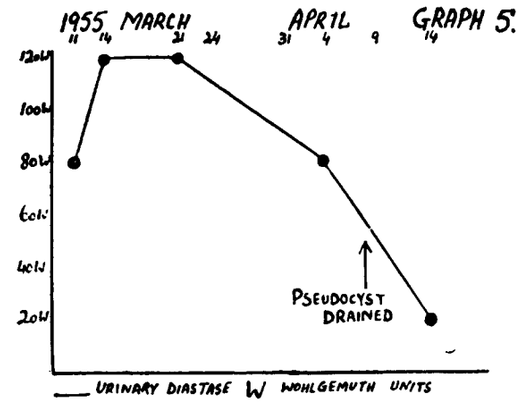
Graph showing no significant rise in urinary diastase in a case of acute pancreatitis although there was a significant rise in serum amylase.




Graph IV.

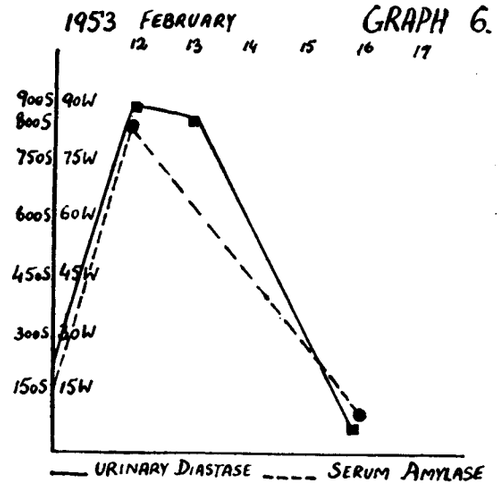
Graph showing delayed (late) rise in urinary diastase in a case of acute pancreatitis.






Graph V.

Graph showing persistent rise in urinary diastase in a case of psuedopancreatic cyst. The levels fell to normal after drainage of the psuedopancreatic cyst.



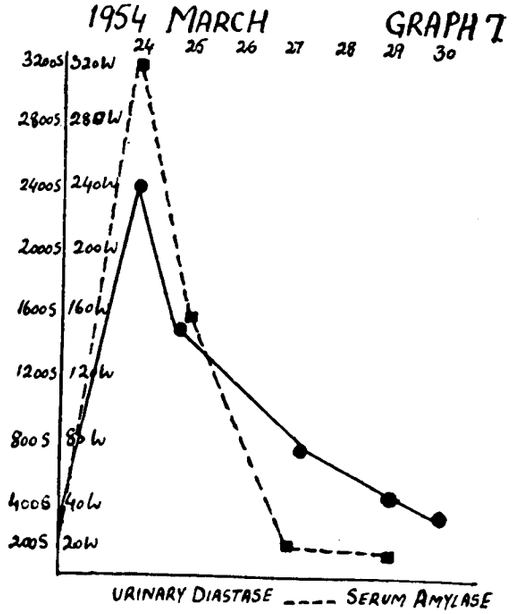

Graph VI.

Graph showing close inter-relationship between the levels of serum amylase and urinary diastase during the course of acute pancreatitis.

course of acute pancreatitis also urinary diastase levels did not exactly correspond to the pattern of curves of serum amylase, as would be expected if the kidney had no part to play in breaking this relationship, but here again the results did not conform to our expectations. In only 50% of cases did urinary diastase follow the pattern of serum amylase curves (Graph VI). In 16.7% cases the higher urinary disease levels persisted for a longer time than those of serum amylase which had returned to normal soon after the subsidence of the attack (Graph VII).

## Discussion

There is a wide variation in the levels of urinary diastase in normal healthy individuals. In the majority, the figures range between 0—40 Wohlgemuth units. There is no material difference in the range of urinary diastase in healthy individuals and in cases of acute upper abdominal pain including those of acute cholecystitis. The figures above 40 units, i.e. 60 or above should therefore be regarded as abnormal. The urinary diastase levels can vary in the




Graph VII.

Graph showing persistence of high urinary diastase readings for a longer time than those of serum amylase during the course of acute pancreatitis.

same individual at different times, although the serum amylase remains constant. This depends on the variations in concentration of urine secreted at different times, which in turn are related to the total intake and output of fluids and electrolytes. In majority of cases, both in health and disease there is no definite inter-relationship between the values of serum and urinary amylase and why this relationship is not kept up in all cases is also probably due to the variations in concentration of urine at different times. As the urinary diastase values fluctuate widely, dependant on variations of concentration of urine, they can never be the true index of the amount of enzymes in blood. There may be a significant rise in serum amylase but there may not be much rise in urinary diastase if the urine is of low specific gravity, either due to greater dilution of urine or inefficiency of kidney due to some parenchymal damage as in uraemia. On the contrary there may be a significant rise in the urinary diastase with relatively normal serum amylase, in opposite circumstances. These instances were observed in our small series. This may also explain the cases in which there was no rise in urinary diastase although the case was of pancreatitis with significant rise in serum amylase. Urinary diastase may be regarded as a test of some diagnostic value in view of significant rise in urinary diastase in majority of cases of acute pancreatitis, but the presence of many false positive and false negative results in quite a number of our cases throws doubts on the universal applicability of this test. It shows that although significant rise of urinary diastase is suggestive of diagnosis in majority of cases, this does not occur in all cases, and if we wholly rely on estimations of urinary diastase we are likely to miss quite a number of cases. It is apparent that in order to avoid mistakes in diagnosis, urinary diastase should not be relied upon singly. It is best to do serum amylase estimations simultaneously. If serum amylase shows a rise, the diagnosis should be suspected even in the absence of simultaneous rise in urinary diastase, the contrary is not however true. If on the other hand serum and urinary enzymes both are raised the evidence is corroborated. The view that urinary diastase may be of help at a later stage of disease when serum amylase has come to normal is not incorrect; but it is present in too few cases to be of any significant value.

## Summary and Conclusions

There are wide variations in the range of urinary diastase levels in normal healthy individuals and in cases of acute upper abdominal pain including those of acute cystitis. However there is no significant difference in urinary diastase levels in these groups of cases. Figures above 40 Wohlgemuth units, i.e. 60 units or above should be considered abnormal but not diagnostic of pancreatitis. Variation in urinary diastase levels occur in an individual at different times and is dependant directly to some extent on the variation in concentration of urine. This factor adds to the unreliability of the test in diagnosis of acute pancreatitis. Sole reliance on urinary diastase test for diagnosis can often be misleading and a plea is made for doing simultaneous estimations of serum amylase before arriving at a diagnosis of acute pancreatitis.

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# SPINAL CORD CHANGES IN TRAUMATIC PARAPLEGIAS

*by B. RAMAMURTHI and V. C. ANGULI, Madras.*

The spinal cord may be affected in many ways in vertebral trauma. The cord may be completely transected or pulped in which case healing occurs by fibrosis and no functional restoration is possible. Often the damage is only partial and the cord is contused.

In contusion of the spinal cord there are both microscopic and macroscopic haemorrhages into the cord substance and intracellular oedema. This oedema makes the cord swell up and may make it fill up the entire dural space and make the dura tense. This may last from a few hours to two or three days. The longer the oedema persists, the less is the chance of functional recovery, as the pressure of the oedema cuts off the vascular supply of the cord. Some authorities believe that decompression of the cord at this juncture will relieve the oedema and increase the chances of recovery. Many others firmly believe that any decompression at the acute stage to be useful must imply opening of the dura. Mere laminectomy is not of any use. But if the dura is incised at this stage of acute oedema of the cord, the cord herniates through the dura, just like the brain does under pressure. This herniation might result in increasing the damage to the cord and hence it is (Scarff[3]) believed that decompression is definitely harmful.

After a few days when the oedema subsides the haemorrhages are absorbed and healing occurs by gliosis. This involves both the neurones and the long tracts of the spinal cord, resulting in various degrees of permanent functional impairment. A haematomyelia may result from injury with residual symptoms simulating an intramedullary tumour.

In some cases the intrinsic injury to the cord is minimal. The cord may be compressed by the narrowing of the vertebral canal caused by dislocation of the vertebra and by the backward protrusion of the injured intervertebral disc. At the site of injury the ligamentum flavum may also get thickened considerably, thus narrowing still further the vertebral canal. When there is such external compression, functional impairment of cord function occurs. If the compression is longstanding, local vascular obstruction may occur resulting in permanent damage. In case of proved compression of the cord following injury, a decompression laminectomy undertaken sometime after the injury may be useful in increasing the function of the cord.

It is not an uncommon event in our country for a patient to seek medical aid for the first time long after he sustains an injury to his spine resulting in paraplegia. When the pain in the back subsides and the patient is in a position to move, he finds that he has difficulties in using his lower limbs and controlling the bladder. Usually in his case, some recovery has occurred in the function of his lower limbs for some time and then stopped. More than the paralysis of his lower limbs, what worries him is his bladder, as he finds that he is becoming a social outcast because of the constant stench. This is what drives him to seek relief in hospitals hundreds of miles away from his home.

In such problems of residual neurological disability caused by old fractures, our experience has shown that laminectomy is a worthwhile procedure, if there is any evidence of persisting cord compression. In about 1/3 of such cases, laminectomy has given relief and the patient is able to regain his bladder function[1-2]. This is specially useful if the fracture compression involves the cauda equina. In the rest of the cases where there has been no relief after laminectomy, operations on the urethra have been done. Either resection of the transurethral bar or a sling operation to reinforce the external splincter has been found useful in many patients.

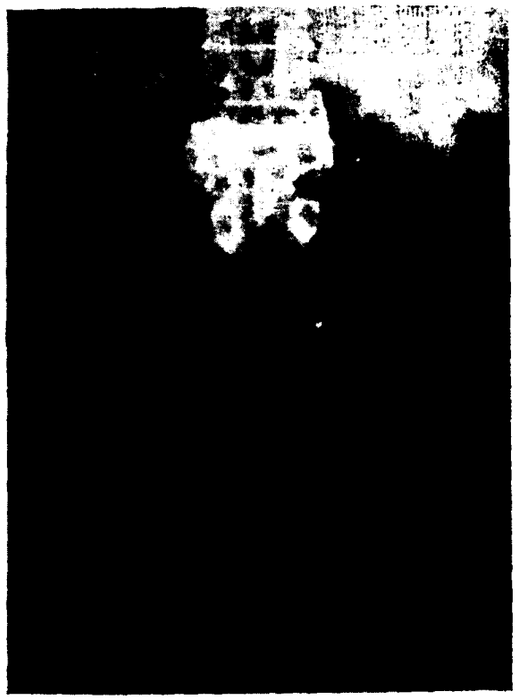

Fig. 1.
SKIAGRAM—A.P. View: Fracture 1st Lumbar Vertebra.

Fig. 2.
SKIAGRAM—Lateral View: Compression Fracture 1st Lumbar Vertebra. Note narrowing of the spinal canal.

In cases where there is no improvement after decompression of the cord it is obvicus that intrinsic damage has occurred to the cord substance. As these patients are not acutely ill, it is not often that one gets a chance to do a postmortem examination in these cases to examine the changes in the spinal cord when there has been injury to the conus with compression. In one case it was possible to do so and the case is reported below with the pathological findings.

## CASE REPORT

Male 'A' (NS. No. 1417) was admitted into the Neurosurgical Unit on 11th October 1952, with a complaint of difficulty in passing urine. Four months before this the patient fell from a tree and found that he was not able to use his lower limbs or void urine. He gradually recovered the power in the lower limbs. In a local hospital, a suprabic cystotomy was done a few days after the injury.

On examination, the patient had kyphosis at the first lumbar level. He had loss of sensation in the saddle area and wasting of the calf muscles. The lower limb jerks were exaggerated. X-rays of the spine (Figs. 1 and 2) showed old compression fracture of the first lumbar vertebra, with new bone formation and a narrowing of the spinal canal. As the patient was running a low temperature he was put on antibiotics and bladder drainage was instituted. A myelogram showed a complete hold up of lipiodol at the first lumbar level. A laminectomy was done; the dura at the first lumbar level was found compressed. After the operation the patient showed improvement in the power of his limbs and jerks returned to normal. He did not progress regarding his urinary functions. The patient was discharged and was readmitted a month later with a complaint of



Fig. 3.
*Section of cord at site of injury.* Motor anterior horncells showing early chromatolysis. (x 160)

Fig. 4.
Acute swelling in a Motor anterior horn cell, chromatolysis is complete, except at the peripherey—an irreversible end stage. Another neurone shows pyknotic change. Gliosis is evident. (x 160)

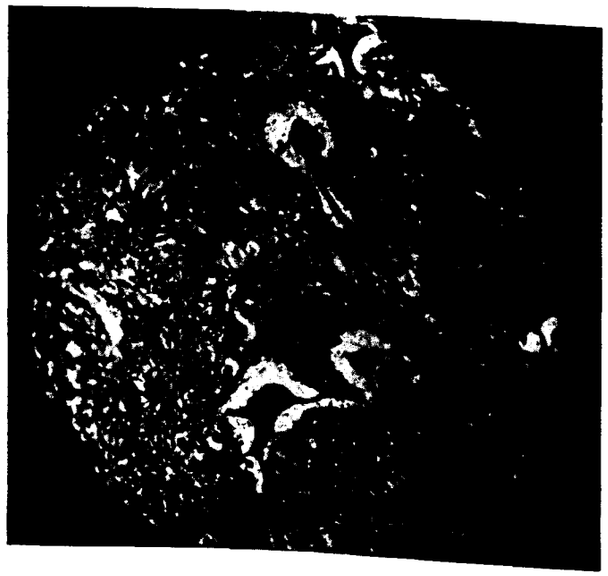

Fig. 5.

Acute swelling of neurones with resistant neurofibrils; nuclei show relatively little change indicating that the pathological process is reversible. (x 160)

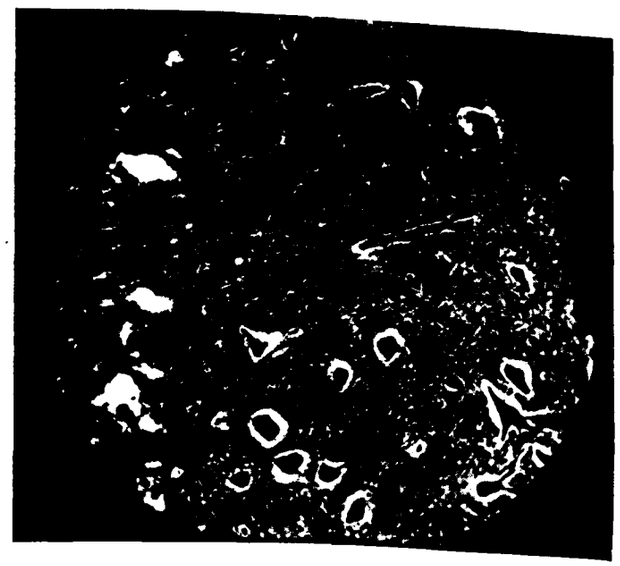

Fig. 6.

Liquefaction and Vascularisation of neurones. (x 160)



Fig. 7.

GLIOSIS: (Cajals Gold Sublimate.) (x 160)

fever with rigors. On admission he was found to have advanced urinary sepsis for which he was treated. He expired on 16th December 1952.

*Post Mortem Examination:*

*General*: The body was that of an emaciated man of about 35 years of age. Decubitus ulcerations with sloughing of the skin and subcutaneous tissues were found over the sacrum, the trochanters and the heels. There was a suprapubic cystotomy wound with excoriation of the skin around. Besides, there was a clean healed linear incisional wound over the spine—about 6" long, on the lumbodorsal region.

*The Kidneys* were swollen, engorged and of a purple colour. Cut sections revealed small abscesses throughout the substance of the kidney. Extending from the pelvis to the cortex, numerous faint linear areas of suppuration were seen. The perinephritic tissues appeared oedematous and inflamed. The bladder was contracted in size and the walls were thickened. The mucous membrane was rough and swollen; some areas of the oedematous mucosa were projecting into the cavity, simulating polyposis. A number of areas showed ulceration and the ulcers were covered with flakes of pus.

The other organs appeared mainly normal showing only varying degrees of congestion.

The spinal cord was exposed from the level of the mid thoracic spine—after cutting the laminae on either side—through a mid line incision. Three laminae were missing at the fracture level. The spinal cord with its coverings was removed after severing the neurovascular connections to the spinal canal.

The spinal canal surface of the body of the first lumbar vertebra was rough and spiky. The dura was densely adherent to it.

The spinal cord was normal in appearance. There was no evidence of obvious compression or constriction. Gross sections at ½ cm. levels did not reveal any area of intramedullary haemorrhage.

*Microscopic Examination:*

Section at the level of injury showed the following microscopical changes (Figs. 3—7).

The nerve cells in the anterior horn appeared few and far between.

A few nerve cells showed shrinkage in their size. The nucleus was elongated, its rim serrated and uneven. This was associated with overstaining.

A few cells showed early chromatolysis with eccentric nucleus. It was very difficult to state whether the process started in the neighbourhood of the nucleus or in the periphery for there was a diffuse distribution of large and small particles of the chromophile substance.

Many cells showed enormous swelling, the chromophile substance being dissolved into a dust like mass with the exception of a small remainder at the periphery of the cell body.

This swelling was accompanied by alterations in the glial elements, the oligodendrocytes and microglia which surround the diseased nerve cell. Fine vascular channels were seen to surround the diseased cell. There was evidence of gliosis all around. The swelling of nerve cells appeared to be the fundamental predominant finding. The shrinking of the cell and pathological endocellular deposition of chromatin were also evidenced.

## Discussion

When recovery does not occur after traumatic paraplegia, even after decompression, intrinsic injury to the cord is thought of. This may be either a complete division of cord due to crushing, or a haemorrhage into the grey matter causing haematomyelia, or oedema resulting later in partial neuronal damage and partial neuronal recovery. The findings in the spinal cord in the above case have shown clearly why neurological recovery does not take place even after decompression of cord. The changes in the neurones and the gliosis prevent any improvement. Hence no measure directed at the spinal cord will help such cases.


## Summary

The various ways in which the spinal cord may be damaged in vertebral trauma are discussed. The methods available for treatment are presented. It is difficult in our country to get a post mortem of a case of partial injury to the cord. The post-mortem report of one case of partial cord damage is presented and the pathological findings discussed. Intrinsic injury to the cord if present prevents any improvement in the clinical picture even after cord compression is relieved.


Our thanks are due to the Dean, Government General Hospital, Madras for permission to publish this article.

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# EWING'S SARCOMA

## (An autopsy report of a case)

*by D. BHASKARA REDDY, Visakhapatnam.*

In spite of the fairly extensive literature, the malignant tumour of bone commonly designated as Ewing's Sarcoma remains one of the moot and controversial problems in the field of bone tumours. Positive indentification from biopsy specimens alone is particularly difficult and more so when the tumour tissue undergoes degeneration necrosis and secondary leucocytic reaction. It becomes much more difficult if the tumour has been irradiated prior to biopsy and virtually impossible to determine its nature. Even when pertinent cases are followed to autopsy, the validity of a final diagnosis of Ewing's Sarcoma depends largely upon the thoroughness, with which the autopsy is performed and the exclusion of other neoplasms of round cell aetiology particularly neuroblastoma, undifferentiated carcinoma or a small primary malignant lymphoma. Colville[3] and Willis have emphasized the pitfalls in arriving at a diagnosis through biopsy and the diagnostic surprise frequently encountered when a case suspected of being Ewing's Sarcoma is finally subjected to detailed post-mortem examination. Autopsy reports on Ewing's Sarcoma are rare. Coley[2] in 1948 could collect only 14 cases out of 74, Geschickter[5] and Copeland in 1936 recorded only 12 autopsy cases in a collection of 125 cases of Ewing's Sarcoma. Many cases which have been diagnosed as Ewing's Sarcoma prior to autopsy, proved to be otherwise during a complete autopsy examination. Periodical perusal of the literature of our country from time to time reveals scanty reports on Ewing's Sarcoma and the following case of Ewing's Tumour with detailed autopsy and histological findings is recorded for its rarity.

*Case Report inclusive of Necropsy Findings:*

G.A., Hindu, Male, aged 13 years, was admitted on 30-1-1954 in the Surgical Wards of King George Hospital for a swelling of the middle of the right leg of 8 months' duration. The complaint started with a small swelling on the front of the middle of the lower part of the right leg after a slight trauma and grew gradually to the present size. The patient was operated on 4 months before admission without any relief. Ten days prior to admission patient developed fever and has since lost weight considerably.

Examination revealed a bony hard smooth fusiform swelling 10" x 4" over the anterior and medial aspect of the right tibia with a scar, 2" x ½", in the middle of the swelling. Skin was healthy and no visible pulsations could be seen. Not tender. The swelling merges with the bone and the upper and lower ends of the bone are not involved. The inguinal group of lymph nodes both superficial and deep were enlarged, discrete and firm. Multiple skin nodules of varying sizes from a pea to a marble were seen over the face, left arm, thigh, and abdomen. They were firm, movable and some were pigmented.

Other systems: Nil contributory.

*Investigations:*

R.B.C.—1.25 mill./cmm. Hb.—45%. Total W.B.C.—8000. B.P.—110/70. Urine and motion—Nil particular. Skiagram of right tibia—Suggestive of Ewing's Sarcoma.

9-2-1954: Under local anaesthesia a gland was dissected out from the right inguinal region and a nodule from the lateral aspect of the thigh was removed and both were sent for biopsy.

Biopsy Report: The histological picture is in favour of Ewing's Sarcoma.

Patient expired on 12-2-1954.

*Autopsy Findings (P.M. No. 2363):*

An emaciated young individual of about 13 years. Markedly anaemic. Multiple skin nodules of varying sizes from ½" to 1" diameter situated over the face, upper portion of chest, thigh, right axilla and abdomen were seen. Skin smooth. Not adherent and moved freely over the deeper structures. Cut section of these revealed firm white circumscribed nodule beneath the epidermis. A bony hard swelling over the middle of the right tibia 6" x 3" with a central scar was seen. Skin smooth and the tumour was seen arising from the bone. The tumour was occupying the anterior and medial portions of the front of the tibia. Cut section of the Bone revealed a soft disintegrating tumour occupying the medullary cavity, in the middle of the shaft of the bone with the overlying periosteum showing reaction in the form of many

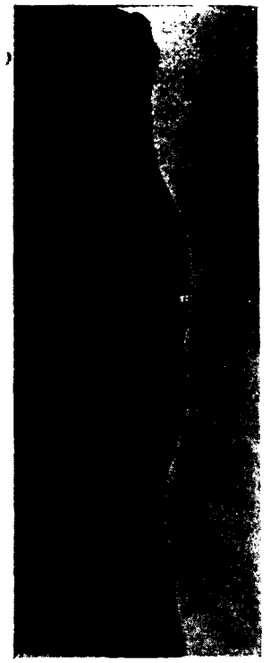

Fig. 1.
Photograph showing the cut section of the tumour area demonstrating the origin of the tumour from central medullary region with periosteal reaction. The cortex is thickened.

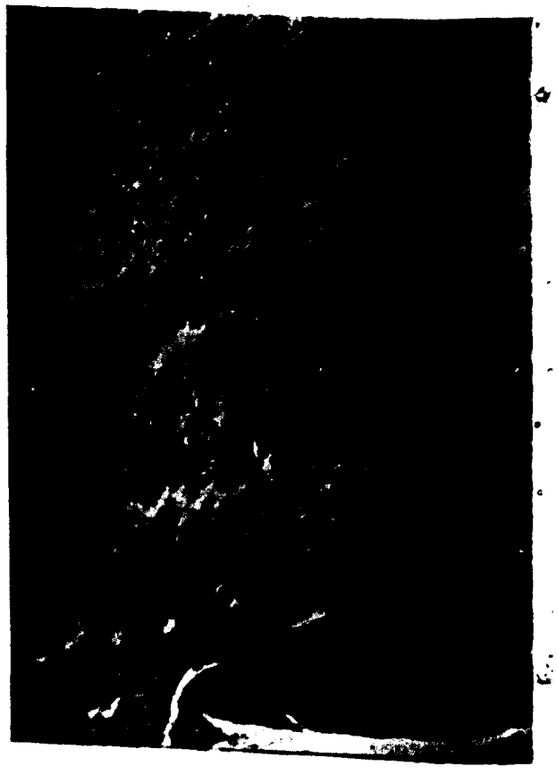

Fig. 2.
Photomicrograph from the tumour area illustrates the uniform round cell pattern with pseudo rosettes. (H & E x 40)

layers of new bone formation (Fig. 1). The cortex was thickened.

Internal examination showed no free fluid in the serous cavities. Inguinal group of lymph nodes both superficial and deep were enlarged, soft and section showed a homogeneous appearance.

Cardio-Vascular system and Respiratory system: Nil contributory.

*Stomach :*

Showed submucosal haemorrhages. A nodule, ¾" diameter, situated in the region of the fundus of the stomach apparently arising from the submucosal region was seen. Cut section of the nodule revealed homogeneous appearance.

*Kidney Right :*

Weight 210 gms.

Circumscribed nodule ½" diameter was seen over the upper pole in the vicinity of a blood vessel. Cut section of the nodule revealed haemorrhagic areas.

*Kidney Left :*

Nil abnormal.

*Vault of Skull :*

Showed an erosion over the frontal region with a corresponding secondary nodule over the duramater ½" in diameter.

*Brain :*

Did not reveal any secondary deposit.

*Testis :*

Cut section of the testis revealed haemorrhagic areas but were normal in size.



Fig. 3.
Photomicrograph shows the number of spaces lined by the tumour cells in the medullary cavity (H & E x 500)

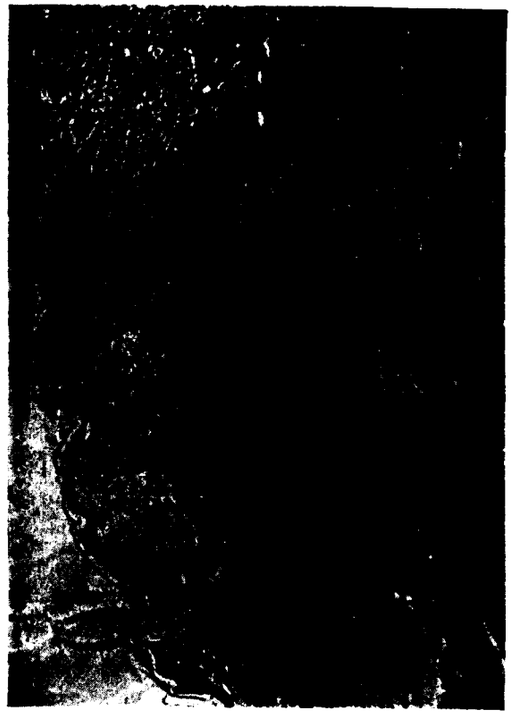

Fig. 4.
Photomicrograph showing the subepidermal collection of tumour cells. (H & E x 40)

*Microscopic Examination :*

Sections were studied from all the organs of the body. They were routinely stained with Haematoxylin and Eosin. The tumour mass from the tibia was studied in detail and several sections were taken both from the medullary and extramedullary portions of the bone. These sections were also stained with Van Gieson and reticulum Stains.

*Bone :*

Sections studied from the tumour area showed uniform round cells throughout. The nucleus completely fills up the cytoplasm and in places the cytoplasm could not be made out. There are no nucleoli but fine chromatin network could be seen. All the nuclei showed hyperchromatism. Sections studied from the medullary region showed these uniform round cells with large numbers of pseudo rosettes (Fig. 2). Under higher magnification, these cells were seen actually lining the spaces in the medullary area (Fig. 3). Neighbouring muscles were also infiltrated with the tumour cells. Very little of bone tissue could be made out from the tumour bearing area. Section studied with reticulum stain revealed very fine delicate reticulum fibres in the meshes of which could be seen the tumour cells.

*Skin Nodules :*

Sections were taken from all the skin nodules over the body. Epidermis is in tact. Circumscribed tumour nodules the cells of which have a close resemblance to the parent tumour are seen (Fig. 4). Here and there pseudo rosettes also could be seen. No evidence of bony tissue.

*Lymph Nodes :*

The lymph nodes examined showed complete loss of architecture with replacement by tumour cells. In some areas fibrous tissue surrounds a group of cells.

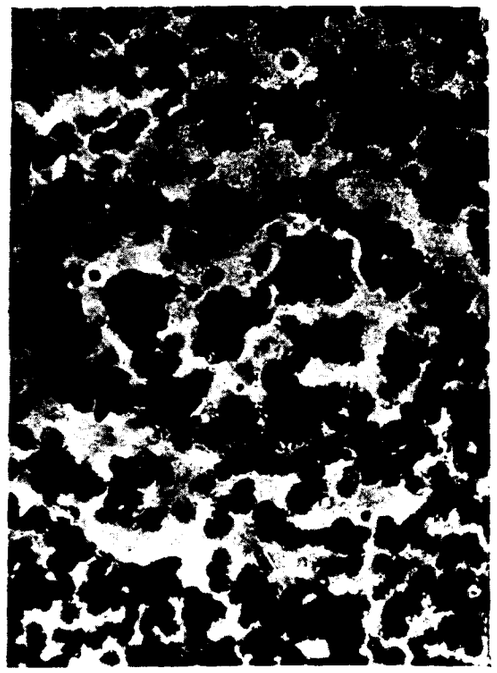

Fig. 5.
Photomicrograph illustrates the tumouremboli in a blood vessel. (H & E x 80)

Fig. 6.
Photomicrograph illustrates the secondary infiltration in the kidney with tumour cells. A surviving glomerulus could be seen. (H & E x 60)

*Kidney :*

Sections from the kidney revealed a circumscribed tumour nodule consisting of the same uniform round cells resembling the parent tumour. These tumour cells lined some of the blood spaces (Fig. 5). A few surviving glomeruli could be made out amidst these tumour cells (Fig. 6).

*Duramater :*

Histologically proved to be the secondary deposit of a similar nature.

*Stomach :*

Shows submucosal and muscular infiltration with round cells. The mucosa is intact (Fig. 7).

*Spleen :*

Shows an area of infarction. Some of the blood vessels are filled with tumour cells.

*Testis :*

Showed malignant cell infiltration into the intestitial tissue of the testis leaving behind the seminiferous tubules intact (Fig. 8).

Liver, suprarenal and other organs did not reveal any abnormality.

## Comment

The absence of primary tumour elsewhere, typical gross appearance of the neoplasm, the uniform round cell pattern with pseudorosettes, clearly proves the tumour to be of the nature of Ewing's and thus establishes itself as a distinct pathological entity. Ewing's tumour forms 10% of bone tumours though the percentage incidence is given variedly by different authors. On a review of the biopsy and autopsy records of the Andhra Medical College, only 3 cases of Ewing's tumour were encountered and the comparative incidence is recorded in Table I. It forms 2.5% of all bone tumours and 4.1 per cent of malignant neoplasms of bone.



Fig. 7.
Photomicrograph shows the submucosal and muscular infiltration of the stomach with the tumour cells. (H & E x 40)

TABLE I

| | | Incidence % |
|---|---|---|
| Osteoclastoma (Benign) | 32 | 26.6 |
| ,, (Malignant) | 2 | 1.7 |
| Osteogenic Sarcomas | 11 | 9.2 |
| Multiple Myeloma | 3 | 2.5 |
| Ewing's Sarcoma | 3 | 2.5 |
| Adamantinomas | 31 | 26.6 |
| Squamous cell carcinoma | 9 | 7.5 |
| Fibro-Sarcoma | 10 | 8.3 |
| Fibroma | 6 | 5 |
| Osteoma | 1 | 0.8 |
| Chondroma | 6 | 5 |
| Chondro-Sarcoma | 4 | 3.3 |
| Osteotis Fibrosa | 1 | 0.8 |
| Eosinophilic Ironuloma | 1 | 0.8 |
| Total No. of Bone Tumours | 120 | |

Table I indicates the percentage of bone tumours from the biopsy records, Andhra Medical College, 1941—1954.

These tumours are most commonly observed in the young and adolescents and supposed to be rare after 20 though a few cases have been recorded even at the age of 70. In the three cases the author has come across the age of the patients was 16, 24 and 13. All the three patients gave a history of trauma. Lichtenstein[6] and Jaffe in their review on 11 cases recorded a history of trauma in 5 only. Christensen[1] recorded history of trauma in only 40% of his 81 cases. Coley et al[2] in 1948 noted only in 15 cases a history of trauma in a record of 91 cases. Mc Swain et al[7] in 1949 in a review of 20 cases recorded history of trauma in 10 cases. How far trauma is responsible for the production of these tumours is difficult to say.

Various views have been expressed as to the nature of the tumour changing from the endothelial origin ; primitive mesenchymal cell to lymphoblast and a haemoblast. The histological picture in the case clearly demonstrates a number of spaces lined by the peoplastic cells thereby indicating in all probability its origin from the lymphatic endothelium of the Haversian canals and hence it may be of the nature of a lymphangio endothelioma. Desonto[4] has recorded a case of Ewing's tumour and is also of a similar opinion. Lichtenstein is of the opinion that Ewing's Sarcoma arises in the marrow spaces of the interior of the affected bone rather than in the Haversian spaces of the cortex or beneath the periosteum.

Ewing's tumour frequently metastasises in the lymph nodes, occasionally to the viscera and rarely to the skin and other bones. The spread is mainly into the marrow cavity, then to the surrounding tissues and invades lymphatics and blood stream producing widespread metastases. Geschicter[5] and Copeland in a review of 122 cases found metastases in lymphnodes in 18, in the viscera in 4 cases and multiple nodules on the undersurface of the dura not invading the brain substance and no

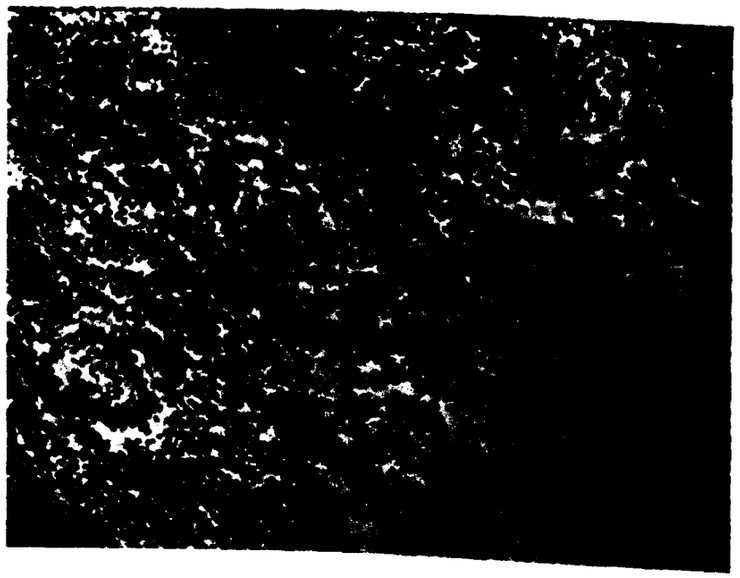

Fig. 8.

Photomicrograph illustrates the infiltration of the interstial tissue of testis with tumour cells. Seminiferous tubules are free. (H & E x 40)

skin metastasis. Visceral and skin involvement seems as seen in the case recorded seems to be rare and the mode of spread by the blood stream is very well illustrated by the photomicrographs. Prognosis in these cases is grave as these patients do not survive for long periods through temporarily relieved by deep X-ray therapy.

## Summary

1. Difficulties in the diagnosis of Ewing's tumour are briefly discussed.

2. A case of Ewing's tumour of the tibia inclusive of detailed autopsy findings is reported.

3. The histogenesis is briefly discussed.

4. Emphasis is laid on the rarity of metastases in the skin and viscera in these cases.

## ACKNOWLEDGEMENT

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# SURGERY OF THE HEART AND GREAT VESSELS *

*by A. K. BASU and A. DAS, Calcutta.*

## Introduction

This paper is a review of the operations on the heart and major blood vessels performed during 1954 and 1955 at the Thoracic Surgical Service, Calcutta. It includes one case operated on during 1952. It is not possible in the time at our disposal to deal in a comprehensive way with all the different facets of this work and besides a fairly exhaustive review of our experiences on surgical treatment of Mitra stenosis (Basu & Das 1955) as also a number of other reports concerning some of the congenital cardiac anomalies have already been reported (Konar et al 1952, Konar et al 1955). It is proposed therefore at this time to bring out only the significant points in our experience in this branch of surgery. 6 cases of spleno-renal venous anastomosis have been deliberately included in this series—for a number of reasons which will be discussed later on.

## Material

During the period under review, a total of 42 major Cardio-vascular cases have been operated on in our service. As will be seen (Table I), the majority of the cases are of Mitral stenosis—19 as against 11 congenital cardiac lesions. There has been slow but gradual recognition of the value and usefulness of this operation of Mitral commissurotomy and cases are being referred to us fairly regularly. The same cannot be said yet of other type of cardiovascular disorders particularly congenital cardiac cases. As will be seen, our results in the P.D.A. and fallot group have been fairly satisfactory—we had only one death amongst 9 and that also from a cause which cannot really be ascribed to the operation itself and yet, we were able to get only 3 cases of patent ductus and 6 cases of Fallot's tetralogy during 2 years. Constrictive pericarditis does not seem to be very common in our part of the country as besides our 4 cases, we know of only one other case operated on in another hospital in Calcutta.

TABLE 1

| | | |
|---|---|---|
| 1. | Mitral Stenosis | 19 cases |
| 2. | P.D.A. | 3 cases |
| 3. | Fallot's tetralogy | 6 cases |
| 4. | Constrictive pericarditis | 4 cases |
| 5. | Coarctation of aorta | 2 cases |
| 6. | Aortic embolectomy | 1 case |
| 7. | Spleno-renal venous anastomosis | 7 cases |
| | | 42 cases |

## Discussion

(A) *Mitral Stenosis.*

An enormous literature already exists with regard to selection of the proper type of case suitable for commissurotomy (Baket et al 1950, Wood, P. 1954). In the suitable age group between 20 to 40 years, the case with the typical rumbling diastolic murmur with pre-systolic accentuation, short and sharp 1st sound, opening snap and absence of evidence of significant pulmonary congestion or hypertension and with cardiothoracic ratio averaging between 50 to 60% is ideally suitable but often not available. Initially and except for the 1st case in our series, we restricted ourselves as far as possible to such type of cases. Latterly we operated on 3 cases, who in addition to having signs of predominant Mitral stenosis also had a significant systolic murmur in the mitral area. In 2 of these cases, the heart size was small but the 3rd case besides having a large sized heart showed evidences of congestion in the lungs and a prominent jugular vein. All these cases were operated on after a period of preparation. 2 of them have had satisfactory improvement—particularly the 3rd case. One case however has not been significantly improved. This case had unfortunately a recrudescence of a sharp rheuma-

* Paper read at the XVII Annual Conference of the Association of Surgeons of India at Amritsar, Dec. 1955.

tic attack 1 month after the operation and his set back seemed to date from this episode.

It will be seen therefore that our criteria for selection of suitable cases is still rigid and until a proper and satisfactory method of dealing with significant mitral regurgitation is evolved, we feel that cases with pure or predominant stenosis should only be accepted for operation. Cases associated with obvious insufficiency should for the present be excluded unless the Surgeon is prepared to tackle the latter condition at the same time. We have however accepted one case of Mitral stenosis complicated by aortic incompetence and another with mild pulmonary incompetence. Both have done well after the operation.

With regard to the operative technique itself, we have made some variations from our original method—particularly with regard to dealing with the auricular appendix. In the 1st 8 of our cases, we used a purse string suture of No. 1 silk around the base of the auricle in addition to a clamp for control. We have had diffculty in the placement of this suture. Frequently the height of the appendix is such that there is not enough room for both the suture and the clamp. The result is that particularly during the extrusion of the finger and the reclamping procedure the jaws of the clamp often overlie and crush the suture making it useless. We have therefore in the last 10 cases dispensed with this suture and depend on the clamp for control during ingress and egress of the finger.

With regard to the method of closure of the auricular incision, we dispensed with the mass ligature around the base of the appendix in the last few cases and have carefully approximated the lips of the opening in the auricular appendix by 2 layers of continuous silk suture—the 1st layer as everting transverse mattress and the 2nd layer as over and oversuture (Fig. 1). It is felt that where possible, this is a better procedure for 2 reasons. There is less likelihood of dislodgement of a thrombus by this method and secondly it would enable the Surgeon to gain a second entry inside the auricle, if necessary.

## Results

There has been 3 deaths in our series. Besides the 1st case in our series, who died some hours after the operation due to development of acute oedema of the lungs. We lost our 13th and 16th cases. The 13th case died 36 hours after operation without recovering consciousness due to a major cerebral embolic complication. The operation was completely uneventful. The commissures were split easily and well. The 16th case was lost due to a tear in the wall of the auricle and massive loss of blood.

We have carefully followed up our cases and in addition to periodic clinical examinations have checked them with electrocardiographic (Fig. 2), and skiagraphic studies (Fig. 3). 4 of our cases have covered an 18 month period since the operation—4 cases a period of 12 months and 3 cases 9 months period and 2 cases a period of 6 months. We have carefully analysed all the criteria with regard to the post-operative status of these patients and have divided the state of post-operative improvement under 3 categories.

(1) Significant improvement —

(a) Freedom from dyspnoea in running a distance of 30 yds.

(b) Weight gain of more than 10 lbs.

(c) Improvement on radiological and E.C.G. examinations—6 cases.

(2) Moderate improvement — Satisfactory improvement of the capacity for exertion as compared to pre-operative state with little improvement in X-ray or E.C.G. —5 cases.

(3) Slight improvement — Slight improvement in the capacity for exertion as compared to pre-operative state but with occasional attacks of paroxymal dyspnoea—2 cases.

We have not included any case whose post-operative period of follow up has not exceeded 3 months.



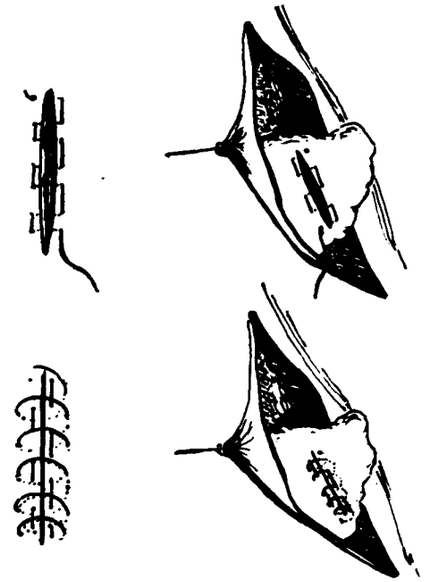

Fig. 1.
Method of suturing the auricular incision.

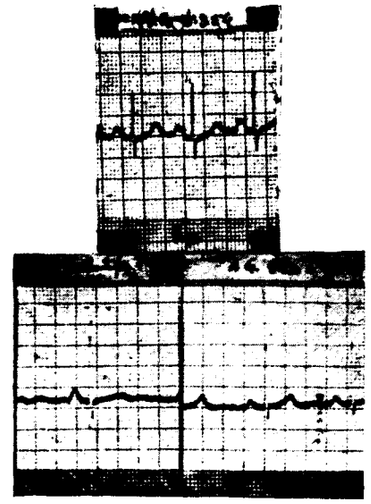

Fig. 2.
Pre and post operative E.C.G. showing change in the character of the 'P' waves in Lead II.

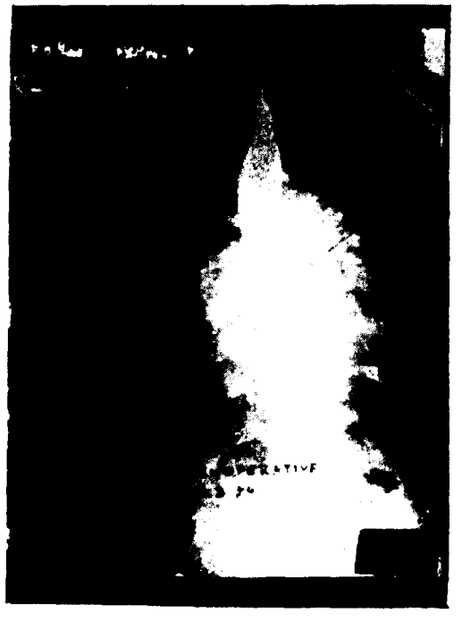

Fig. 3-a.

Fig. 3-b.

Fig. 3-a & 3-b. Pre and post operative skiagrams showing reduction in the size of the heart and alteration in the pattern of the pulmonary conus.

Fig. 4.
Big heart with marked hypertrophy of left ventricles in a case of aorto-pulmonary septal defect.

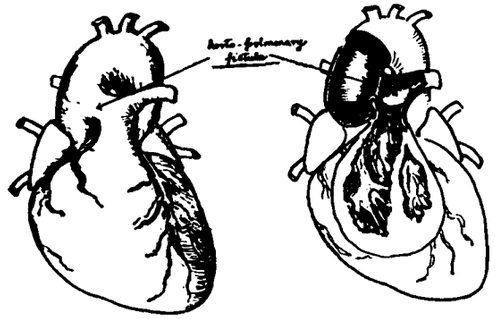

Fig. 5.
Aorto-pulmonary septal defect.

### Patent Ductus Arteriosus

We have had only 3 cases of clinically diagnosed P.D.A. referred to us for surgical closure. Two of these cases have been successfully tackled and the 8 year girl and the 6 year boy are doing well and their follow up periods have exceeded 18 & 14 months respectively. The 3rd case, a boy of 16 years, was very interesting. Clinically he showed signs of a large ductus. He had complained of marked dyspnoea and had an overactive heart pounding forcibly against the chest wall. There was an extra loud continuous machinery murmur at the base particular prominent over the pulmonary area. The pulse pressure was very wide and the heart particularly the left ventricle was big in size (Fig. 4). The E.C.G. showed left ventricular hypertrophy. Angiocardiography and cardiac catheterisation studies were done but were inconclusive. At operation, the ductus was absent at the usual site and instead a direct large sized connection between the trunk of the pulmonary artery and the ascending aorta was found with the blood rushing forcibly into the pulmonary artery from the aorta and producing a markedly palpable thrill (Fig. 5). It was not deemed feasible to tackle this defect and the chest was closed. After an immediate stormy post-operative period, the boy settled down and was discharged. At the present time, about 20 months since the operation, he says that he is doing somewhat better than his pre-operative state.

It should be noted that this condition of direct aorto-pulmonary defect although extremely rare has been reported a number of times in the world's literature. Gross (1952) reported 8 cases and was able to close the defect in only one of these cases by direct preplanned attack. Varco (1952), Scott & Sabiston (1953) and Bailey (1955) have also reported a few successful cases. The differentiation from a large P.D.A. is almost impossible clinically or by other methods and the diagnosis is usually made at operation.

We closed the ductus in the other 2 cases by first ligating with silk at the two ends and then transfixing with another silk suture at the middle. In the average sized ductus, this seems to us safe, satisfactory and reliable. The chances of recanalization are extremely small. In a wide ductus, we would, if possible, certainly consider dividing the ductus and suturing the ends. This procedure is particularly indicated in this type of case.




Fig. 6.
Right sided aortic arch in a case of Fallot's tetralogy.

Fig. 7.
Course of subclavian artery in a case of right sided aortic arch with Fallot's tetralogy.

### Fallot's Tetralogy

6 cases of this congenital cyanotic type of heart disease have so far been operated on. All 6 survived the operation and in 5 cases it was possible to do a satisfactory Blalock-Taussig shunt of the sub-clavian pulmonary artery type, end to side. All the latter 5 cases are doing well and show progressive improvement. One case, a boy aged 6 years, was recently reviewed about 11 months after operation. He has grown considerably in stature and his marked cyanosis and clubbing of the fingers have nearly completely disappeared. Concomitantly his poly-cythaemia has considerably abated and the boy is able to take part in games and is going to school. Another girl of 16 years showed striking improvement within 2 months after the operation.

We have found several interesting features in these cyanotic group of cases which are worth reporting. In the case of the boy mentioned previously, there was a right-sided aortic arch and the left subclavian artery after taking its origin on the right side coursed to the left between the trachea and the oesophagus and then reached to the left thoracic apex (Figs. 6 & 7). It had been possible to diagnose the aortic abnormality prior to the operation and the shunt was performed deliberately through the left hemithorax.

In another case, a boy of 5 years with intense cyanosis, the expected systolic murmur at the base of the heart (3rd intercostal space) was absent and the preoperative presumptive diagnosis of relative pulmonary atresia was confirmed at operation by the finding of a very stunted and short pulmonary artery and its left branch. It was possible, however, to do a fairly satisfactory end to side shunt procedure using the largest and upper most branch of the left pulmonary artery (Fig. 8).

Fig. 8.
End to side anastomosis of subclavian artery with the uppermost branch of the left pulmonary artery.

Fig. 9.
Post stenotic dilatation in a case of Fallot's tetralogy.

In another case, a boy of 28 years, an interesting and complicating feature of the cardiac abnormality was pulmonary tuberculosis affecting the right upper lobe. His sputum was also initially positive. This complication of congenital pulmonary stenosis is well known and obviously results from relative pulmonary ischaemia. In this particular case, the pulmonary condition was at first controlled by antibiotics and 6 months after antibiotic treatment a satisfactory Blalock shunt was later performed. This case showed another interesting feature. In the pre-operative angiocardiogram there was evidence of marked post-stenotic dilatation of the pulmonary artery (Fig. 9). At operation, it was noticed that the stenosis was of the coarctation type involving the trunk of the pulmonary artery instead of being valvular stenosis (Fig. 10). This type of abnormality is very rare and has been reported by Bailey (1955).

An important point regarding the operative technique in this particular abnormality may be mentioned. The great difficulty in this procedure is the isolation and clearing of the pulmonary artery from its massive envelope of thick, tortuous and varicose blood channels (Fig. 11). It helps matters considerably, if dissection is started in the relatively avascular area over the arch of the aorta and after finding the proper cleavage plane, the vascular overlapping membrane is gradually divided downwards between clamps and ligated.

One other difficulty often times met with is the stunted length of the left subclavian trunk with its early division into branches. It would be dangerous or impossible in such cases to try to anastomose the trunk of the main artery to the left pulmonary branch. All the branches of the subclavian trunk should be cleaned as far and as high as possible and the biggest branch of the arterial trunk should be utilized to gain additional length and to make the anastomosis. In our series, we have used this procedure on 3 occasions—using the vertebral artery once and the real subclavian branch in the other 2 cases.

### Coarctation of Aorta

Our experience in this particular abnormality is unique though unfortunate. We have had 2 cases referred to us—diagnosed convincingly by expert clinicians and in both cases on exploration, instead of the



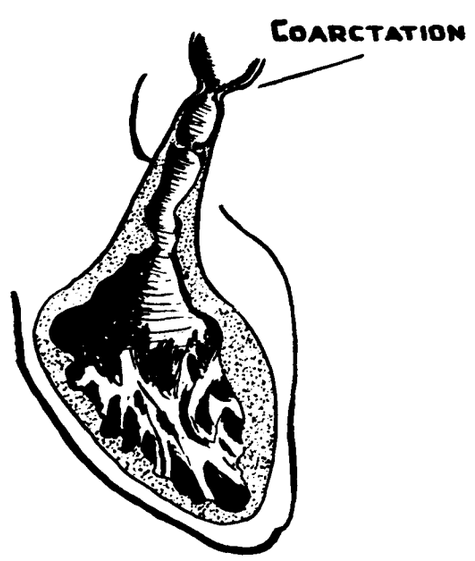


Fig. 10.
Coarctation of trunk of pulmonary artery.

Fig. 11.
Varicose veins lying over the pulmonary artery in cases of Fallot's tetralogy.

Fig. 12.
Gradual narrowing involving the whole of descending thoracic aorta.

typical annular type of coarctation at the usual site, we found tubular narrowing of the descending thoracic aorta starting beyond the take off of the subclavian artery and progressing beyond the aortic orifice in the diaphragm (Fig. 12). It would not have been possible to resect and bridge this large defect even with a large vascular graft. In the 1st case, which died some-days after operation, autopsy was performed and showed marked intimal and medial thickening of the aorta—as compared to normal aorta (Fig. 13).

This type of linear and tubular coarctation affecting the descending thoracic aorta and also other portions of the aorta is a very rare abnormality but has been reported with increasing frequency in recent years. It is not possible to help these patients with the resources available at present (including vascular grafts). The knowledge of the frequency of this type of abnormality calls for more caution in the diagnosis of the

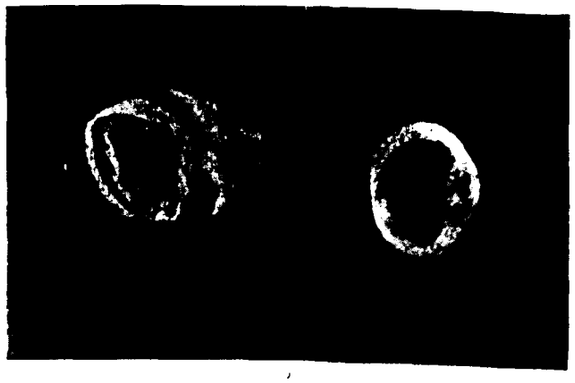

Fig. 13.

Transverse section of the involved descending thoracic aorta showing marked intimal and medial thickening — compared to a normal aorta.

usual type of aortic coarctation based only on clinical signs and symptoms and signifies the usefulness of good aortograms to establish such diagnosis.

### Constrictive Pericarditis

It has been reported elsewhere that constrictive pericarditis of tuberculous origin is a fairly common and increasing cardiac complication in this country. That is possibly true but we have had only 4 cases referred to us for operation and 3 of these were operated on. 2 of these cases were successful and have been followed up—one for nearly 4 years and another for 2 years. Both these women continue to do well. The latter case has been investigated recently in detail. The cardiac movement and silhouette, the auscultatory and the E.C.G. findings are relatively normal and the venous pressure has come down from 26 cm. to 11 cm. There has been no accumulation of ascitic fluid in the abdomen and the liver which was 4 fingers below the costal margin before the operation is now only just palpable.

We decorticated the heart through the standard left sided approach and have used either the longitudinal sternal splitting approach of Holman or the transverse sternum cutting approach, opening both pleural cavities, which Bailey uses. It is surprising what a large exposure of the right heart is obtained in the standard approach if one excises the whole length of the costal cartilage together with the 5th rib and in all the 3 cases, we were satisfied with this approach.

### Aortic Embolectomy

We have had one unique experience of being able to successfully remove a massive saddle embolus—from within the aorta at the level of its bifurcation (Basu & Das 1955). This was a lady of 30 years who had a combined lesion of mitral stenosis associated with insufficiency and was being investigated for consideration of commissurotomy. We did a cardiac catheterisation procedure in the morning and the 2 days later, about 10 p.m., she had severe agonising pain in the loin with numbness in the lower extremities and absence of femoral pulsation on both sides. At operation at 3 a.m., 5 hours later, a large saddle shaped embolus (Fig. 14) was found sitting astride the fork of the bifurcation and was successfully removed through an incision over the right common iliac artery extending slightly over the termination of the abdominal aorta. The circulation to the lower extremities was at once fully restored and the patient was rehabilitated without trouble.



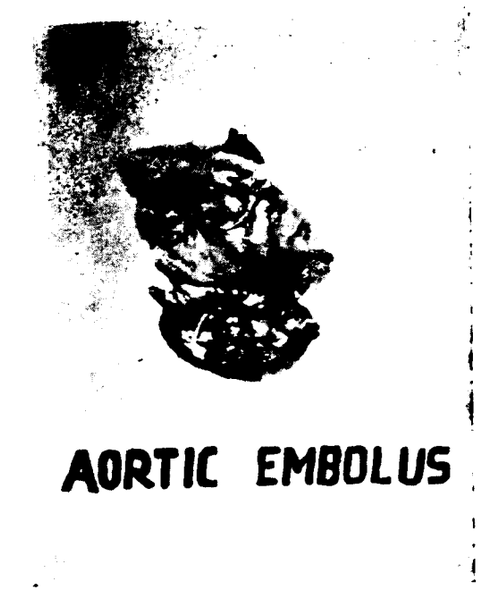


Fig. 14.

Saddle embolus removed from the bifurcation of aorta.

Fig. 15.

Splenoportal venogram in a case of portal hypertension showing many collaterals (case of cirrhosis liver).

It is not likely that the catheterisation procedure had anything to do with the embolic episode except the factor of coincidence. In the literature, only about 25 of these cases have uptil now been successfully dealt with by operation. Without operation, many of these cases are fatal. Their successful management depends primarily upon the time factor. The maximum allowable interval before embolus should be removed is about 6 hours.

### Splenorenal Anastomosis for Portal Hypertension with repeated Haematemesis (Fig. 15)

We have deliberately included a discussion of this procedure in this paper because it brings in many problems of vascular surgery and because we have had experience of 7 of these cases. The anastomosis was successfully done in each case. 6 cases have done very well. 3 of them have been followed more than a year and one for 18 months and have not had recurrence of haematemesis. We are convinced that in suitable cases this is a thoroughly worthwhile procedure and can produce lasting benefit. The difficulties in this operation are many. The massive large spleen with extensive vascular adhesions with the diaphragm, the large sized splenic vein of the size of one's thumb with its numerous fine pancreatic tributaries make dissection hazardous and time consuming. Transthoraco-abdominal approach with division of the diaphragm—which we now routinely use, gives excellent exposure and minimises blood loss considerably. The anastomosis if of the end to side type and the opening in the renal vein has to correspond with the size of the splenic vein. There is one other difficulty. Due to the change in the direction of the splenic vein in the per-

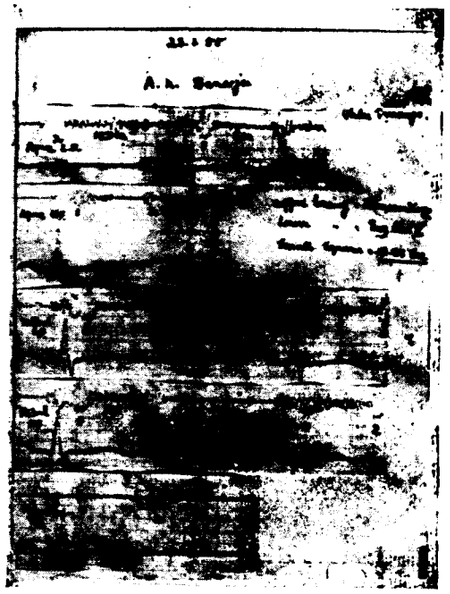

Fig. 16.
Phonocardiography in a case of mitral stenosis with presence of systolic murmur.

Fig. 17.
Cardiac catheterisation in a case of mitral stenosis.

formance of the anastomosis, one sometimes produces a twist in its longitudinal direction and in one case, because of this complication, we have had to undo the anastomosis at the end of a long and arduous operation and re-anastomose the vessels.

### Investigational procedures

Besides routine radiography, electroradiography and other investigational methods we have made considerable use of certain special procedures such as phonocardiography (Fig. 16), angio-cardiography and cardiac catheterisation studies. The latter two methods have helped us considerably. In angio-cardiography, we have hitherto relied on rapid manual method of changing cassettes and in many cases have obtained excellent and informative skiagrams. Similarly we have had excellent information from many catheterisation studies done with the saline manometer (Fig. 17). This is a relatively simple assembly and can be easily installed in any hospital.

### Summary

This paper gives an account of the different types of surgical procedures in diseases and abnormalities of the heart and great blood vessels performed at the Thoracic Surgical Service in Calcutta. The significant findings in each type of disease and the many lessons learned as our experience increased are briefly reviewed. It must finally be stressed that this is a field of surgery where co-operative endeavour between the Surgeon, the Physician, the Radiologist and the Anaesthesiologist is essential and no one can do without the others. In other words, a team spirit between all these specialists is essential for successful management of these cases.



### ACKNOWLEDGEMENT

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# THE SURGERY OF THE HEART AND GREAT BLOOD VESSELS WITH SPECIAL REFERENCE TO MITRAL STENOSIS *

*by S. S. ANAND and R. P. MALHOTRA, Amritsar.*

During the past few years there has been a spectacular advance in cardiovascular surgery following the pioneering work of Blalock, Taussig, Gross, Crafoord, and Potts. These workers made their great contributions in relieving the congenital abnormalities by "extra-cardiac" procedures which are now more or less standardized. Along with these advances, attempts were made to relieve congenital and acquired defects by "intra-cardiac" procedures. In this work Bailey, Harkins and Brock have made great contributions.

In our unit at the V. J. Hospital, Amritsar, cardiac surgery was started about two years ago and so far operations on the following diseases have been carried out:—

TABLE I

| | |
|---|---|
| Mitral stenosis | 15 cases |
| Constrictive pericarditis | 7 cases |
| Patent ductus | 2 cases |

In this paper we would deal with the problem of mitral stenosis in greater detail. The importance of this disease becomes quite obvious when it is recalled that congenital heart lesions constitute only 2% of all cases of heart disease while 20—40% of the cases are due to rheumatic disease as reported by several Indian workers: (Malhotra (1951) 20.2%, Vakil (1949) 24.8%, Sanjive (1946) 46.8%, Devi Chand (1946) 27.68%). This means that mitral stenosis is a very common lesion. The surgical treatment for this condition was first suggested by Sir Lauder Brunton (1902), but it was in 1925 that Souttar performed a successful operation approaching the mitral valve through left auricular appendix and doing valvulotomy by using his finger. Elliot Cutler (1923) made several unsuccessful attempts through the left ventricular approach. But in spite of Souttar's successful operation not much progress was made till Bailey (1949) and Harkins (1948) made it a routine and safe procedure.

In the present report we will give our experience with 15 cases of this disease which were operated on during the last eighteen months.

*Material and Methods:*

Of the 15 patients with mitral stenosis 9 were males and 6 were females. The ages varied between 14 and 40 years.

TABLE II

| Agegroups | Sex | | Total |
|---|---|---|---|
| | Male | Female | |
| 0 — 15 years | 1 | — | 1 |
| 16 — 20 „ | 3 | 4 | 7 |
| 21 — 30 „ | 4 | 2 | 6 |
| 31 — 40 „ | 1 | — | 1 |
| Above 40 years | — | — | — |
| Total | 9 | 6 | 15 |

The youngest patient was 14 years old and the oldest was 35 years old.

*Clinical assessment:*

This was based mainly on the history, a careful physical examination, X-rays and E.C.G. examination. Cardiac catheterization was not attempted in any case.

*Symptoms:*

Dyspnoea on exertion was graded as:—
Grade I
—Dyspnoea on severe exertion.
Grade II
—Dyspnoea on moderate exertion.
Grade III
—Dyspnoea on minimal exertion.
Grade IV
—Dyspnoea even at rest.

A careful assessment of dyspnoea along with exercise tolerance test was done in every case. Note was made about orthopnoea, cough, haemoptysis, anginal pain, embolic phenomenon and congestive heart failure.

* Paper read at the XVII Annual Conference of the Association of Surgeons of India at Amritsar, Dec. 1955.



*Physical signs:*

Careful attention was paid to the following:— Character of the arterial pulse, apical pre-systolic murmur or rumbling diastolic murmur, apical first sound and apical systolic murmur with an opening snap of mitral valve. Sellors et al (1953) have emphasised that the presence of a mitral first sound with an opening snap is indicative of a mobile mitral valve. These signs were present in ten of our cases. A soft first sound and an absent opening snap indicate a rigid valve and significant mitral incompetence. A soft localised murmur is not a contra-indication to valvotomy but a loud systolic murmur with wide propagation is suspicious of mitral incompetence and the latter type of case should first be thoroughly assessed for a dominant mitral leak.

*Investigations:*

Radiographs in the postero-anterior view and right anterior oblique view with barium swallow were taken in every case. The enlargement of the left auricle was assessed in every case. In one case there was aneurysmal dilatation of left auricle. Lung studies were made for the following:

(a) Chronic venous congestion: 10 cases.

(b) Presence of pulmonary oedema was not detected in any case.

(c) Evidence of fresh or old pulmonary infarction was present in three cases.

(d) Hydrothorax was present in two cases.

(e) Haemosiderosis was not seen in any case.

*Electro-cardiography:*

A complete 12 leads electrocardiogram was taken in every case. Repeated graphs were taken later on in majority of the cases. Only cases with evidence of right ventricular hypertrophy or normal electrocardiogram were selected for surgery. Patients showing any evidence of left ventricular hypertrophy or combined hypertrophy were rigidly excluded. In some cases interesting arrhythmias during the operation and in the post-operative phase were observed.

*Discussion:*

Diagnosis of mitral stenosis can be made on clinical grounds by the presence of:—

1. Diastolic thrill and snapping accentuation of the first sound at the apex and of the second sound in the pulmonary area.

2. Mid-diastolic or late diastolic rumbling murmur.

3. E.C.G. showing P 'mitrale' or and right ventricular hypertrophy.

4. X-rays showing enlargement of the pulmonary artery and pulmonary conus and left atrial impression on a barium-filled oesophagus.

*Criteria of selection and indications for operation:*

1. Symptoms and signs of pulmonary engorgement.

2. Dyspnoea: limiting patients' activity, associated with cough, paroxysmal nocturnal dyspnoea.

3. Attacks of pulmonary oedema after excitation or at rest.

4. Recurrent haemoptysis.

TABLE III

*Showing Indications for Mitral Valvotomy in our cases.*

| *S. No.* | *Indications.* | *No. of cases.* |
|---|---|---|
| 1. | Various grades of dyspnoea: | |
| | (a) Exertional dyspnoea | 15 |
| | (b) Dyspnoea at rest | 7 |
| | (c) Paroxysmal cardiac dyspnoea | 1 |
| 2. | Embolism: | |
| | (a) Pulmonary infarction | 1 |
| | (b) Systemic (Hemiplegia) | 2 |
| 3. | History of right-sided heart failure | 6 |
| 4. | Recurrent haemoptysis | 4 |
| 5. | Pregnancy with mitral stenosis | 1 |

Fig. 1.

Fig. 2.

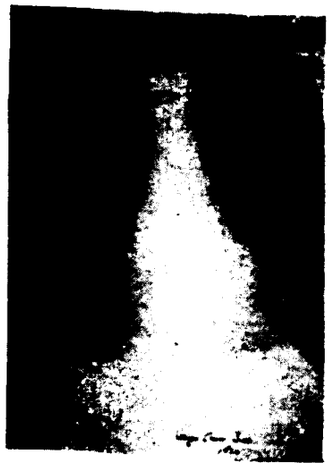

Fig. 3.

Fig. 1. Pre-operative X-ray showing old healed infarct right lung.

Fig. 2. Post-operative X-ray showing development of pulmonary oedema.

Fig. 3. X-ray chest showing disappearance of pulmonary oedema following treatment.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4. Pre-operative X-ray.

Fig. 5. X-ray at the time of being discharged after valvotomy. Heart is a little reduced in size.

Fig. 6. X-ray on follow up. Heart a little smaller. He had an excellent result. Could walk for 10—15 miles and even run without getting dyspnoea.



Fig. 7.

Fig. 8.

Fig. 9.

Fig. 7. Pre-operative X-ray.

Fig. 8. X-ray at the time of being discharged from hospital after valvotomy. Heart is reduced in size— Pulmonary artery is less prominent.

Fig. 9. Follow up X-ray. Heart reduced markedly — Pulmonary artery is less prominent. He had an excellent result. Could walk 9—10 miles and even run without getting dyspnoea.

Of these indications the less favourable types are :—

(a) Cases with embolism.
(b) Cases with bouts of haemoptysis.
(c) Cases with auricular fibrillation.

*Contra-indications :*

1. Age : Few cases below 20 and above 50 years.

2. Bacterial endocarditis.

3. Frank aortic regurgitation.

4. Mitral incompetence as a dominant abnormality shown by blurred first sound with a loud well marked systolic murmur and presence of left ventricle hypertrophy judged radiologically and electro-cardiographically.

5. Intractable right-sided heart failure. Mortality in such cases is high and the operation does not produce good results.

6. Presence of any activity of rheumatic infection.

*Optimum time for operation :*

The best time for the operation would appear to be before the development of third grade of dyspnoea and after the congestive heart failure or auricular fibrillation has been controlled. In some cases the operation had to be undertaken even in the presence of arrhythmias. In one case in spite of pregnancy a mitral valvotomy was undertaken : the patient went to full term with a normal delivery and the result was good.

*Operative technique and findings :*

In all our cases we performed an antero-lateral thoracotomy through the bed of the 5th rib, without excising it. 10 c.c. of 2% novocaine was injected into the pericardial cavity before incising it parallel to the

phrenic nerve. The auricular appendix was palpated to find any clot in it. A purse-string suture was passed round the base of the appendix and an auricular clamp was applied before excising the tip of the appendix. The clamp was then removed and the right index finger introduced into the auricle and the purse-string suture was tightened. The antero-medial or aortic cusp and the postero-lateral cusps were felt during the ventricular systole to notice their mobility. This was found mobile in 14 of our cases. The mouth of mitral opening was then felt for its size, its surface was felt for any roughness or calcification. Heavy calcification was noticed in two cases. Next, the presence of any regurgitation was noticed. The commissures are then split — first posteriorly and then anteriorly. This was possible by the use of finger alone in 14 cases but needed the help of a valvotome in one case. For a satisfactory valvotomy the commissures should split as far as the a-v ring antero-laterally and postero-medially. The finger is then passed into the ventricle to feel the chordae tendenae and the pupillary muscles for any crossfusion and lastly the size of the resultant mitral opening and any regurgitation is noticed. Bailey advises the use of intermittent clamping of the vessels arising from the aorta during valvotomy to decrease the chances of cerebral embolism. We have depended upon the anaesthetist pressing the carotids in the neck during the manoeuvre of valvotomy. After removing the finger the auricle is closed by tying the purse-string suture and a layer of 00000 silk suture on the cut end.

In most of the cases the size of mitral opening of two fingers or 1½ fingers was obtained.

*Anaesthesia :*

Most of our cases were slowly induced with pentothal and maintained with Pethidine, Ether, Gas and oxygen. Curare was used in about 50% of our cases. All the cases except one or two started moving about and responding to questions soon after the operation.

*Operative findings :*

1. Size of the opening varied from 0.5 to 1.00 cm. in our cases.

2. The diaphragmatic type of the mobile valve (which is most suitable for this operation) was found in 14 cases.

3. Calcification of valve was found in five cases.

4. Funnel-shaped valve was found in one case.

5. Regurgitation of a mild degree was found in one case.

6. Thickening of the pericardium was seen in one case.

*Complications :*

Chart IV showing the operative complications.

| S. No. | Complications. | No. of cases. |
|---|---|---|
| 1. | Arrhythmias : | |
| | (a) Auricular fibrillations | 4 |
| | (b) Bundle branch block | 1 |
| | (c) Multiple extra-systoles | 1 |
| 2. | Lung complications : | |
| | (a) Collapse lower lobe | 1 |
| | (b) Pulmonary oedema | 1 |
| | (c) Pulmonary embolism | 1 |
| | (d) Pyo-pneumothorax | 1 |
| 3. | Pericardial effusion | 1 |
| 4. | Uraemia | 1 |
| 5. | Serum jaundice | 1 |

Three patients developed cardiac arrest during the operation but this was successfully treated by the use of cardiac massage and the intra-cardiac injection of 10 c.c. of 5% calcium chloride in two cases but one case failed to revive after the use of these measures.

*Post-operative care :*

Antibiotics in the form of penicillin and streptomycin or broad spectrum antibiotics were used in every case.



Every case was put on digitalis before the operation and this was continued in the post-operative period.

For relief of pain, we relied mostly on Pethidine hydrochloride in 100 mgm. doses. Cases in which pulmonary oedema was either threatening or had developed were put on morphia ¼ gr. 8 hourly along with Mersalyl 1.5—2 c.c. intramuscularly once daily or on alternate days for 3—4 days.

Quinidine was not used as a routine in the pre-operative period but only after the operation when indicated.

Oxygen, 4 litres per minute was administered for the first 48 hours as a routine and later on if indicated.

*Operative mortality :*

1. K.K. Developed auricular fibrillation and bundle branch block leading to congestive heart failure and death on the 10th day.

2. S.K. Went into shock and could not resuscitated. Expired 8 hours after the operation.

3. G.L. Developed shock — recovered temporarily with Noradrenaline but expired next morning.

4. A.K. Oeveloped coma following anaesthesia and did not recover.

5. L.W. Developed cardiac arrest during operation and could not be revived.

*Results of Valvotomy :*

These were judged by the improvement in the patient's general condition, his dyspnoea, his exercise tolerance test and the results were classified as excellent, good, fair and poor. Four cases have been followed for more than one and a half years, four cases for 9—12 months and only two cases have been followed for less than three months. The results were classified :

(a) Excellent : If the patient gets relief of all his symptoms — paroxysmal dyspnoea, orthopnoea, haemoptysis — and has an increased capacity for work.

(b) Good : If a bed-ridden patient whose activities were markedly restricted can walk about without dyspnoea and returns to his work.

(c) Fair : Improvement of disability but falling short of optimum improvement.

(d) Poor : Slight or doubtful benefit.

Only six cases could be followed upto December 1955. Out of ten survivors — (one is still in the hospital).

Chart showing results following valvotomy.

TABLE V

| No. | Name of patient | Follow up interval | Results | | | |
|---|---|---|---|---|---|---|
| | | | Excellent | Good | Fair | Poor |
| 1 | K.S. | 1 year & 9 months | 1 | | | |
| 2 | G. | 1 2/3 years | | 1 | | |
| 3 | D.S. | 1½ years | | 1 | | |
| 4 | J.S. | 1 year | 1 | | | |
| 5 | I.W. | 9 months | 1 | | | |
| 6 | D.S. | 8 months | | 1 | | |
| 7 | C.S. | 8 months | | 1 | | |
| 8 | T.R. | 7 months | | | | 1 |
| 9 | K.S. | 2 months | | 1 | | |
| 10 | G.C.S. | 1 month | | | | 1 |
| | Total No. of cases | | 3 | 5 | | 2 |

## SUMMARY AND CONCLUSIONS

1. 15 cases of mitral stenosis treated surgically have been reviewed.

2. Stress has been laid on the pre-operative assessment of the cases clinically to find out the type of valve we are dealing with — best results being achieved if the valve is pliable or diaphragmatic.

3. A successful operation produced a good result in most of the cases.

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We wish to acknowledge the help which we received from our Anaesthetists Dr. S. K. Bakhshi

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# ADENOMA OF THE BRONCHUS *

*by ERNEST BHASKER SUNDARAM and REEVE H. BETTS, Vellore.*

Tumours of broncho-pulmonary origin are, apparently, comparatively rare in India. From 1948 through 1955, only 107 cases of cancer of the lung, one case of fibroma of the trachea, and three (proved) cases of adenoma of the bronchus were investigated in the Thoracic Surgical Unit of the Christian Medical College Hospital. Adenomas of the bronchus are infrequent in comparison with carcinomas. Leibow[3] found an incidence of 5—6 per cent of all primary lung tumours, while Thomas[4] reported of only 2 per cent. Naclerio and Langer[1] recorded 305 pulmonary cancers and 15 bronchial adenomas. Souttar et al[2] have reported 56 carcinoid and four cylindromas seen in the period 1909—1954.

The first description of an adenoma of the bronchus was by Reisner[5] who in 1926, described a benign epithelial tumour of the bronchus, and drew attention to other possible cases in the German literature, but it was Kramer[6] in 1930, who first brought to notice this clinical entity. However, the Westminster Hospital Museum has a specimen placed there in the last decade of the last century, and described by Hebbs[4] as a benign glandular tumour of the bronchus, the patient having died from concomitant pulmonary suppuration. Brunn and Goldman[7] have divided the evolution of this entity into three phases: (1) 1882—1932, mostly a postmortem recognition; (2) 1932—1938, clinical recognition and treatment, during which period several important papers appeared and (3) from 1938 till the present, a period of development of rational therapy based upon new knowledge of the natural and therapeutic life histories of these tumours.

The purpose of this paper is to reiterate some facts regarding these tumours and to present three proved cases of adenoma of the bronchus from our service. We wish to stress three points; (1) even though a rare tumour it should be thought of in cases of chronic, recurrent pneumonitis or intractable lung suppuration of long duration, (2) its potentially malignant characteristics, but satisfactory end results if treated adequately, and (3) the importance of a proper understanding of its histopathological classification.

* From the Dept. of Thoracic Surgery, Christian Medical College and Hospital, Vellore, S. India.

## *Natural History of the Disease*

According to most reports there is no marked sex predilection in these tumours like there is in bronchogenic carcinoma where males are affected five or six times more frequently than females. However, Thomas[4] found the male to female ratio to be 1:4 which is in contrast to the findings of others. Womack and Graham[8] considered that the sexes are equally affected. In our series, there are two males and one female.

These tumours usually occur before the age of 40, but are very rare in children, although Ward et al[9] have collected eight cases in children under fourteen years, and reported one case of their own, the youngest to date, who was only seven years old.

Symptoms depend on the site of the tumour, the degree of bronchial obstruction and the amount of infection distal to the lesion. Good et al[10] have stressed the frequency of asymptomatic bronchial adenomas. Due to the vascularity of the tumour haemoptysis is a cardinal symptom. Sharp, short bouts of haemoptysis often bring the patient to the physician. Alternatively, the sputum may merely be streaked with blood, in which there may be many old clots. This is usually found when there is distal pulmonary suppuration, and the origin of the blood is postulated to have come from the pulmonary circulation. Fresh, abrupt bleeding, with no streaking of the sputum is supposed to

be from the bronchial vessels. Concomitant haemoptysis at the time of menstruation suggests a hormonal factor.

Dyspnoea on change of posture, or a sonorous sound and a unilateral wheeze suggest a ball-valve mechanical obstruction. Cough is an irritative phenomenon but may be postural also, and increased by assuming certain positions. In the presence of distal suppuration the cough becomes productive and the sputum may have an offensive odour.

Bronchial adenomas are notorious for masquerading as some other disease. Due to the sluggish growth and the long time they take to metastasize, when they do, and the indefinite X-ray findings at the beginning, the symptoms may be attributed to pnuemonia, pleurisy, pneumonitis, tuberculosis, bronchiectasis or cancer. Souttar et al[2] surveyed cases in a general hospital and found that from the onset of illness to the time of definite surgery the time period was six years and seven months. In Brunn and Goldman's[11] series six cases were treated as pulmonary tuberculosis, three as tuberculosis and cancer, and two as pulmonary suppuration. In our series the cases were treated as pneumonia, and later as tuberculosis. One case had a phrenic crush, and two cases had pneumoperitoneum. All of them had symptoms for three to four years before a definite diagnosis was made. In one of our cases (Case 2, I.R.M.) even though a bronchogram showed an obstructive lesion the tumour was not recognised until the specimen was sectioned. It was not seen bronchoscopically due to the excessive amount of purulent secretion.

Rarely peripheral adenomas are found in the smaller bronchi and may give no symptoms or signs until picked up by a routine examination. When bronchial obstruction is present, a wheeze or moist sounds, diminished air entry or signs of areas of compensatory emphysema may be elicited. If there is a complete block, dullness is present with the other signs of atelectasis. Atelectasis and bronchiectasis are the presenting features in most of the cases. All our cases had diminished air entry in the affected lobe. Cases of intractable, recurrent pneumonitis, with chronic cough, wheezing or localised emphysema should make one think of adenoma as a possible cause. Death is usually not due to the tumour itself, unless there has been a large bout of bleeding. Souttar et al[2] report one fatal case due to haemorrhage after bronchoscopic biopsy.

### *Diagnostic Measures*

*Roentgenological Investigation*: Plain P-A X-rays of the chest may show deflation of the lung beyond the obstruction, and a shift of the mediastinum to the affected side or a shift of an interlobar fissure when a lobar branch is involved. On fluoroscopy the area will not lighten and darken during respiration. Small segmental atelectasis or small extra-bronchial masses may pass unnoticed if the shadows fuse with mediastinal shadows. Here tomograms can effectively localise the occult atelectasis or extra-bronchial mass. If there is distal bronchial dilatation, cystic areas with fluid levels may be seen, or there may be areas of pneumonitis if infection is added. Case 1, (F.M.) showed these findings. Segmental emphysema or segmental atelectasis is difficult to detect, unless good skiagrams in various projections are available. Circumscribed shadows in the lung parenchyma the so called 'coin lesions' are not apt to be adenomas, as only 2—4 per cent of such lesions have been so reported.

*Bronchoscopy*: Since most of these tumours are centrally located endoscopic examination will often reveal the tumour. Bronchoscopic biopsy is an essential supplementary measure to prove beyond doubt the nature of the mass, but one has to remember the vascular nature of the tumour. Bronchography can be done if the tumour is more peripheral and to investigate any accompanying pulmonary changes. In one of our cases a bronchogram revealed the site of obstruction, even though the adenoma could not be seen bronchoscopically. The Papanicolaou technique is usually not helpful since the intact mucosal covering prevents the shedding of the adenoma cells.



### *Differential Diagnosis*

Some benign tumours of the bronchus such as fibroma, ecchondroma and myoma are rare and usually can be distinguished, easily, histologically.

Among the slow growing, polypoid malignant tumours are angioendothelio-sarcomas and myosarcomas which are very uncommon. Of the primary malignant tumours, some epidermoid carcinomas have a striking resemblance to adenomas especially bronchoscopically. One of our malignant cases was treated as an adenoma as the lesion was very slow growing and bronchoscopically resembled an adenoma. A frozen section of the tumour at the time of operation suggested an adenoma with malignant changes. A right middle and lower lobectomy was done. The permanent sections showed it to be malignant and now the patient has signs of recurrence.

Although there is no unanimous opinion regarding the histological nature of the adenomas, the definite clinical syndrome they produce is definitely different from either the purely benign or frankly malignant growths of bronchial origin.

Various theories have been postulated as to the origin of bronchial adenomas. (a) The most commonly accepted theory is that they arise from bronchial glands, since bronchial glands are found in great numbers in the larger bronchi, and seldom found in bronchi more than 2 mm. in diameter. (b) Secondly, their origin may be from persistent embryonal bronchial buds. In 1938, Womack and Graham[8] created much interest in the subject by asserting that these tumours arise from lung anlages and behave in a similar way to 'mixed tumours' of the parotid. They claimed that the cartilage that was seen in these tumours, and the mucin produced in them gave added proof to the behaviour resembling mixed tumours. In one case they found anatomical anomalies and this added weight to their embryonic origin theory, since histologically it resembled a foetal lung. This theory has not been widely accepted. Leibow[3] believes that they came from either the bronchial glands or their ducts. He further claims that the oncocytic cell type is compatible with an origin from the mucus glands. These tumours do not resemble the salivary gland type of mixed tumours in that there are no myomatous tissue, no chondroid transformation of epithelium, no stellate elements, and no myoepithelial proliferation. Cartilage appears to be engulfed or invaded rather than formed by the tumour and such bone as has been found may have occurred either from metaplasia of pre-existing cartilage or within the septa or capsule of the tumour.

Moersch et al[12] have classified bronchial adenomas into (1) carcinoid, which comprise about 90% and (2) cylindromas, the remaining 10%. Carcinoids have long thin pedicles, and are the more amenable to treatment. They usually occur in the larger bronchi. Cylindromas have a tendency to be sessile, infiltrating and are quite commonly found in the trachea. Leibow[3] uses the same classification with a variant in each group, that is carcinoid with a variant, oncocytic type and cylindromas with a variant, mucoepidermoid type. The latter is very rare.

Even though classified as benign tumours, the potential malignant characters of bronchial adenomas must be considered. The modern trend supports the view that even though essentially benign these tumours have shown on occasion both macroscopic and microscopic malignant changes, and recurrences have been noted especially after bronchoscopic removal. In certain instances metastasis have been found in the lymph nodes, liver, and a few other organs. Umiker et al[14] report with convincing certainty a case of adenocarcinoma in a bronchial adenoma.

Hock[15] in 1926, was the first to describe metastasis in lymph nodes from a bronchial adenoma. Probably the incidence of metastasis is not over 10%. But secondary deposits often show more malignant changes histologically than the primary. However, patients may have a prolonged life in contrast to metastatic bronchogenic carcinoma.

It has been found, that the cylindroid form has a geater tendency to metastasize than the carcinoid variety.

### Treatment

Either lobectomy or pneumonectomy is the preferred treatment for most cases of bronchial adenoma. The five year results are excellent. Any regional lymph nodes should be excised with this lesion. If there is no irreparable lung damage from prolonged bronchial stenosis, it is sometimes possible to resect the tumour locally with a small margin of normal bronchus. In some cases this can be done by excising the growth longitudinally and closing the bronchus transversely. In other locations such as the orifice of the right upper lobe the main bronchus may be divided and anastomosed after excision of the tumour, with or without accompanying lobectomy. It is appreciated that any procedure that conserves lung parenchyma is advisable. In those instances where it is necessary, a wire-reinforced dermal graft has been found useful. If the growth is very peripheral then a simple local excision is possible.

Endoscopic removal even in these days of comparatively safe thoracotomy may be indicated under certain special conditions, such as the tumour being located very central (especially near the main carina) with a long, thin pedicle and not very vascular; or the patient not a suitable subject for exploration, but with the tumour entirely intraluminal, and tomograms having determined no definite intramural or extrabronchial growth. One of Jackson's[16] cases is without recurrence 35 years after endoscopic removal. If the tumour recurs after bronchoscopic removal an exploratory thoracotomy is indicated. Endoscopic removal can be done by fulguration, piecemeal removal, or the use of a snare.

Radiation therapy is unsuitable for bronchial adenomas as they are resistant to this form of treatment.

CASE 1.

F.M. C.M.C.H. 129696. This 32 year old woman was admitted on 30th March 1953 because of repeated attacks of fever of 5 years' duration. She was first diagnosed as pleurisy with effusion, and aspiration was attempted. An X-ray of the chest was taken at that time and it was thought that there was a patch of unresolved pneumonia on the right side. An evening rise of temperature and dry cough ensued, and a diagnosis of pulmonary tuberculosis was made. She was given streptomycin and the the fever subsided. After another attack of fever, a few months later, X-rays taken at that time showed the right upper lobe opaque with areas that were thought to be cystic. Streptomycin was given for five days and she improved. A week later, after another episode of fever, a bronchoscopy done elsewhere detected the adenoma and the patient was referred to our hospital.

On physical examination the patient was well developed. The trachea was shifted to the right. There was dullness in the right infraclavicular and infrascapular areas. The breath sounds were diminished on the right side with occasional posttussic rales in the infraclavicular areas. Examination of the other systems showed no abnormalities. The routine laboratory tests revealed a slight anaemia and an E.S.R. of 29 and 63 mm.

Posterio-anterior and right lateral skiagrams of the chest showed shifting of the mediastinum to the right side, and what appeared to be cystic disease with pneumonitis and fibrosis of the right upper lobe. The left lung was clear (Fig. 1-a).

On tomographic examination a mass was seen in the right bronchus, which was 0.75 cm. diameter and extended up into the trachea. Two and one half centimeters below the mass the bronchus appeared narrowed.

On bronchoscopy, the mass was seen in the right main bronchus pushing the main carina to the left. There was marked bleeding, and on introducing the bronchoscope further the mass was seen to come from the right upper lobe bronchus. A biopsy was taken and the histological appearance was that of a bronchial adenoma. After controlling the secondary infection by appropriate chemotherapy, operation was performed.

A pneumonectomy was found necessary because the lung distal to the bronchus seemed irreversibly damaged. On dividing the bronchus it was found that the adenoma came from the anterior wall of the bronchus and projected almost into the main carina. The postoperative course was essentially uneventful.

The pathological report was as follows: "The specimen is that of a right lung with slight pleural thickening especially in the region of the upper lobe. The upper lobe feels indurated. On cut section most of the upper lobe shows evidence of pneumonitis with cystic areas and there is an abscess cavity in the central area of the pneumonitis. The middle and lower lobe bronchi are congested but the lung parenchyma is fairly normal with minimal pneumonitis. In the main stem



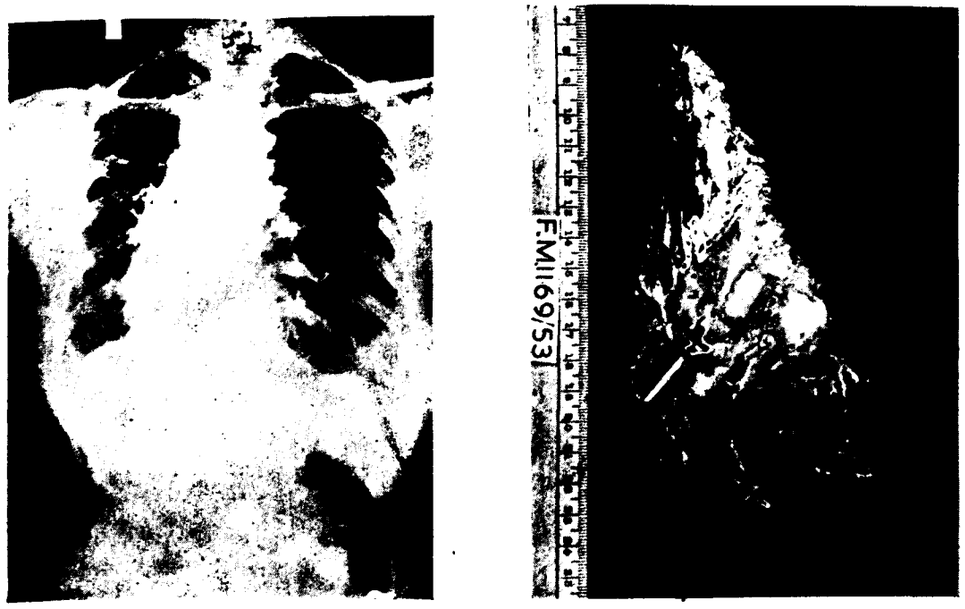


Fig. 1-a. Fig. 1-b.

Fig. 1. (a) P.A. X-ray of the chest showing marked retraction of the mediastinum to the right and changes in the lung interpreted as cystic disease.

(b) Right lung showing the intrabronchial tumour, and also the accompanying abscess and bronchiectasis.

bronchus and extending from the orifice of the right upper lobe is a nodular, firm growth which has a sessile pedicle and intact mucosa over it. It is 2 x 1 cm. in diameter and arises mainly from the anterior wall (Fig. 1-b).

Microscopic: The essential feature of the section is clumps and sheets of cells with dark staining, large, fairly uniform nuclei. There is an acinar arrangement in some areas. The acini or ducts contain eosin staining mucoid secretion. No mitosis is seen. The picture is typical of a cylindroma or a mixed type of bronchial adenoma" (Fig. 1-c).

This case is an example of an adenoma masquerading as some other disease due to suppuration distal to the obstruction. The changes on X-ray were consistent with congenital cystic disease and atelectasis. The clinical picture was mistaken for pulmonary tuberculosis and was treated as such until a bronchoscopy revealed the true difficulty. This illustrates the importance of a routine bronchoscopic examination in the investigation of cough. A pneumonectomy was justified in this instance as the lung distal to the lesion contained an abscess and was irreversibly damaged. Also in this instance the tumour was so near the main carina that we did not believe there was enough room for local resection and an end to end anastomosis.

CASE 2.

I.R.M. C.M.C.H. 115074. Male. Age 25 years. This 25 year old man was admitted on 16th October 1951 with a chief complaint of copious sputum of three years' duration. There had been a gradual onset of cough and expectoration. In June 1949 he developed fever with chills. At that time a diagnosis of pneumonia at the left base was made and 20 injections of penicillin were given. The fever abated, but the cough and sputum persisted. The amount of sputum was 8—10 cups a day. He later developed vague pain in the left chest, and was X-rayed and was told that he had pleurisy at the left base. For the next four months he had fever intermittently and was given 70

Fig. 1-c.

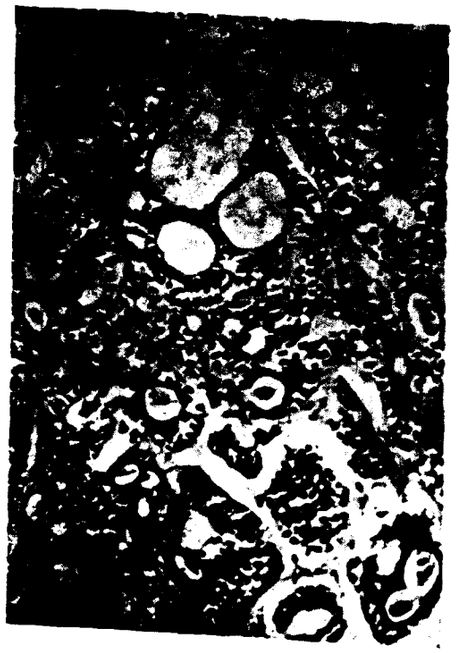

Fig. 1-d.

(c) Lower power photomicrograph.

(d) High power photomicrograph showing cylindromatous type of adenoma.

grams of streptomycin. In October 1949, artificial pneumothorax was tried on the left side but had to be abandoned. He rapidly developed fluid which had to be aspirated repeatedly. Next pneumoperitoneum was started and the fever, sputum and cough decreased, and the weight increased. This improvement lasted for a year, with occasional bouts of low fever. In February 1951, a left phrenic crush was done. Sputum was always negative for A.F.B. but he was treated in a sanatorium as a case of pulmonary tuberculosis. At the time of admission he was raising 3—4 cups a day of sputum which was foul smelling, and occasionally blood-streaked.

Physical examination of the chest revealed the left side of the chest to move less than the right. There was dullness on percussion throughout the left side with diminished breath sounds and vocal fremitus. The breath sounds posteriorly at the apex were bronchial in character. There were no adventitious sounds heard. The right lung was clear. Laboratory examinations revealed no significant abnormality. A plain skiagram of the chest showed a dense haziness on the left side, the findings being consistent with tuberculous infiltration and atelectasis (Fig. 2-a).

Bronchoscopy was done three times and each time the adenoma was missed. Once it was suggested that there was a stricture of the left lower lobe bronchus. At another time the bronchoscope could not be passed into the lower lobe bronchus and the basal segments were never visualised. Every time large amounts of pus were aspirated. A bronchogram showed the lipiodol completely obstructed in the left main bronchus.

At operation the left lung could be easily mobilized but was solid on palpation. A pneumonectomy was carried out. The post-operative period was uneventful.

The pathological report was: "The specimen is that of a left lung with only slight pleural reaction. The lung is solid, except for cystic feeling areas. On looking into the bronchus one can see what appears to be a tumour mass filling the left lower lobe bronchus. On section, this is found to be papillary in type with a comparatively small stalk. The wall of the bronchus is destroyed at that point and the growth is continuous with a lymph node. The lower lobe shows marked cystic bronchiectasis with multiple small cavities, the largest measuring 2 cm. in diameter. The rest of



Fig. 2-a.


Fig. 2-b.

Fig. 2. (a) P.A. X-ray of the chest showing dense opacity of the lower zone due to collapse of the lung with added infection and fibrosis.

(b) Gross appearance of the left lung showing the tumour in the left lower lobe and cystic bronchiectasis in the lower lobe.

the lung shows purulent pneumonitis. No normal lung tissue is seen (Fig. 2-b).

Microscopically the tumour consists of cords of cells, some arranged with a glandular pattern. The cells have pink cytoplasm and uniform dark nuclei, some pyknotic and others containing clumps of chromatin. There are occasional mitoses. The stroma is very scanty. The picture is consistent with a carcinoid type of adenoma. The lymph node is not infiltrated but shows anthracosis. The surrounding lung shows marked infection with frank abscess formation and macrophages in the alveoli. The greatly thickened fibrous tissue, and the collections of lymphocytes in the respiratory bronchioles suggest bronchiectasis. The surrounding lung shows edema fluid, consolidation and congestion, and pigmented macrophages. At one point the tumour cells are seen in the submucus layer" (Fig. 2-c).

This case was treated as pneumonia, pleurisy and pulmonary tuberculosis, and even had a left phrenic crush. Even after three bronchoscopic examinations the adenoma was not detected due to the large amount of pus. The bronchogram showing a blocked left main bronchus should have suggested the probability of an adenoma in the bronchus. The correct diagnosis was made only on sectioning the specimen.

CASE 3.

H.S. C.M.C.H. 124051. Male. Age 23 years. This man was admitted on 28th August 1952 with cough and blood stained sputum of four years' duration. The patient stated, that he had had a dry cough ever since he was a small child. Also he had had a history of the glands of the neck. The sputum was frequently blood-stained in the mornings. Three years previously the cough became very severe and for nine days he had severe blood spitting. Then he was given 19 grains of streptomycin. The sputum before and after chemotherapy was negative for acid fast bacilli. An X-ray of the chest showed increased vascular markings with some suggestion of bronchiectasis

Fig. 2-c.
Photomicrograph showing the characteristics of the carcinoid type of adenoma.

of the right lower lobe. He felt better after chemotherapy and went back to work. While playing badminton, he felt a severe pain in the right chest. High fever ensued and he was diagnosed as a case of malaria, and later as dry pleurisy. Three months afterwards he went to a sanatorium where he was given pneumoperitoneum and 500 grams of P.A.S. Pneumoperitoneum was given for 8 months. After 6 months in the sanatorium a bronchoscopy was done and a tumour, seven millimeters in diameter, was seen in the right lower lobe bronchus.

On physical examination the general condition of the patient was found to be good. There were a few rales in the right lower lobe, and the breath sounds in that area were diminished. There was questionable dulness to percussion at the right base. The routine examination of the other systems was negative. P.A. and right lateral skiagrams showed evidence of pneumonitis in the right lower lobe. No area of atelectasis was seen (Fig. 3-a). The bronchogram showed obstruction at the level of the right lower lobe bronchus (Fig. 3-b). A Papanicolaou smear of sputum was negative for malignant cells.

At bronchoscopy, 1 cm. beyond the orifice of the right superior segmental bronchus at the level of the medial basal bronchus (which was patent), there was a reddish, slightly lobulated tumour almost obstructing the bronchi to the remaining basal segments. The tumour appeared fairly vascular and after biopsy there was moderate bleeding.

Fig. 3-a.

Fig. 3-b.

Fig. 3. (a) Plain skiagram of the chest showing infiltration of the right lower zone.
(b) Bronchogram showing obstruction at the level of the right intermediate bronchus.



Fig. 3-c.

Fig. 3-d.

(c) Right lower lobe showing the intrabronchial tumour, and the distal dilatation of the bronchus.
(d) Photomicrograph showing the atypical characters of a carcinoid type of adenoma.

Histological examination showed psuedostratified respiratory epithelium covering fibrous tissue, containing alveolar spaces lined by cells with small, dark, round to oval nuclei. There was a glandular pattern in places giving an impression of bronchial adenoma.

A right lower lobectomy was done. The lower lobe was consolidated and there were many adhesions between the lobe and the diaphragm.

The pathologist reported: "The specimen is that of a right lower lobe with moderate thickening of the pleura. On section the adenoma is just visible at the basal segmental bronchial opening that is just beyond the orifice of the superior segment. The adenoma is sessile and measures 2 x 1.5 cm., situated mainly in the upper part of the posterior segmental bronchus which in that part is dilated to accommodate the growth. The growth is fixed to the anterior wall of the bronchus and is free on all other sides. The bronchus beyond is marked dilated. The lung parenchyma around it is firm, but more or less normal (Fig. 3-c).

Histologically the tumour shows sheets and cords of darkly staining epithelial cells with small oval to round nuclei arranged in an alveolar pattern. Dilated respiratory epithelium is seen covering the tumour for the most part. The bronchus beyond the tumour shows patchy desquamation of the epithelium and fibrosis. At one point the tumour cells are seen in the submucous layer. The appearance is consistent with that of a carcinoid type of bronchial adenoma" (Fig. 3-d).

## Follow-up

The first two cases have been followed and they have no significant symptoms. The last case was from Nepal and attempts to get in touch with him have been unsuccessful.

## Summary

(1) A brief review of the etiology, diagnosis and treatment of bronchial adenomas has been discussed.

(2) Three cases treated in the Thoracic Unit of the Christian Medical College and Hospital have been reported in some detail.


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# A CASE OF MIXED EMPYEMA SECONDARY TO AN AMOEBIC LIVER ABSCESS

*by BINDRA BAN, Delhi.*

Master Narinder, Case No. 3459 Mc of 1954, aged 12 years came under the observation of this clinic on 7th December 1954 with a history of three and a half months fever, pain in the right side of chest and non-productive cough of six weeks duration.

The fever started on 24th August 1954 (103°F—100°F) which settled to 99°F after a week's indigenous treatment. On 22nd September, patient got another attack of pyrexia 104°F—100°F with profuse sweating and occasional rigors and this persisted with minor variations till the day of observation. On 24th August he had an acute attack of pain in the right side of the chest and right hypochondrium which radiated to the right shoulder and this subsided to a mild continuous pain after about ten days. He had two similar episodes of acute pain on 1st October and 30th November 1954 with the difference that the patient felt as if something is rising up in the right chest from the hypochondriac region. Paroxysmal non-productive cough started on 24th October 1954. During these three months he had Homeopathic, Ayurvedic and Allopathic treatment. He was given ten gms. of Combiotic, Ambistryn 15 gms. Procaine penicilin 5,200,000 units (400,000 units daily), Achromycin 5 gms. (0.25 gm. twice a day) and Cibazol 25 gms. But all this treatment did not alter the course of the disease. On 11th November, aspiration of the fluid was tried at three different places in the right chest posteriorly which resulted in dry aspiration.

*Past history:*

For the last two years patient was having diarrhoea with blood and mucus D 8 N 6, lasting for ten days every three to four weeks for which he had indigenous treatment.

Fig. 1-A.
Skiagram of the chest. P.A. view (5-11-1954). Homogenous opacity occupying whole of the right chest with shifting of mediastinum to the left. Maximum density is present medially and in the centre of the radio opaque area.

Fig. 1.
Skiagram of the chest. P.A. view (13-12-1954). (Hard picture) Hydro Pneumothorax right side.

Fig. 2.

Skiagram of the chest. P.A. view (30-12-1954). Hydro Pneumothorax right side and the catheter is seen in the middle of the opaque area.

Fig. 3.

Skiagram of the chest. Right lateral view (3-12-1954). A fluid level seen in the posterior part of the chest. The eye of the catheter is below. the right dome of the diaphragm as marked by arrows.

*On examination :*

Patient was ill, toxic and emaciated. Pea size glands were palpable in the neck and axilla. Clubbing of fingers third degree was present. Pulse 126 P.M. Respirations 23 P.M. thoracic type. Temp. 102.6°F. There was empyema necessitans on the right side of the chest just above the right nipple. Right side of the chest was full, movements absent, vocal fremitus and resonance absent. Breath sounds were absent. Left chest nothing abnormal detected. Apex beat in the fifth space 1½ inch outside the midclavicular line. Abdomen was full, restricted movements on breathing, marked tenderness and rigidity in the right hypochondrium. Liver was firm, tender and was palpable three inches below the costal margin.

*Laboratory examination :*

22-11-1954 : Stool and urine—N.A.D.

7-12-1954 : (1) Mantoux test—negative. (2) Sputum smear—negative for acid fast bacilli. (3) Total white blood cells—17,880 per cmm.

Polys. 84%, Lmpho. 10%, Mono. 4% and Eosino. 2%.

9-12-1954 : Pus from the pleural cavity was thick gelatinous chocolate coloured. No entamoeba histolyica, vegetative or cystic forms were seen on wet smear. Culture. Staphylococcus Aureus.

Sensitivity tests : Streptomycin + + + +. Penicillin + +. Aureomycin and Terramycin +.

*Roentgenographic examination :*

5-11-1954 : Postero-anterior view. Homogenous opacity occupying whole of the right chest with shifting of the mediastinum to the left (Fig. 1-a).

13-12-1954 : P.A. and right lateral (Hard pictures). Hydropneumothorax right side (Fig. 1).

30-12-1954 : P.A. and right lateral (Hard picture). A fluid level seen in the posterior part of the right chest. The eye of the catheter can be seen in the liver below the right dome of the diaphragm (Figs. 2 & 3).



Figs. 4 & 5.

Skiagram of the chest. P.A. and lateral views (10-1-1955). (Hard picture) thickened pleura with Pneumothorax right side. The right dome of the diaphragm is raised.

10-1-1955 : Pneumothorax on the right side with thickened pleura. The right dome of the diaphragm is raised (Fig. 4).

*Progress Report :*

On 9-12-1954 thick chocolate coloured pus was aspirated. He was given Nivaquine .2 gm. three times a day for two days and then 0.2 gm. twice a day for 15 days along with crystalline penicillin one million units twice a day. In addition he had multi-vitamins, iron and high protein diet. Fever came down to 99°F. on 13-12-1954 and remained so till 28-12-1954. The general condition improved and the toxaemia disappeared. He was aspirated four times till 28-12-1954 and 750 c.c. pus was aspirated. On reviewing the case at this stage it was evident that the pyrexia has settled to 99°F, the general condition had improved but the empyema necessitans was persisting and signs of sloughing of the subcutaneous tissue were appearing. On 28-12-1954 a catheter was passed through the eighth space in the anterior axillary line and 2½ pints of chocolate coloured pus was drained. Patient was given Emetine hydrochloride grain one daily for six days and Combiotic one gram daily for ten days. Temperature became normal on 30-12-1954. On 2nd January 1955, 150 c.c. of reddish coloured fluid was aspirated posteriorly from the right chest. The catheter was taken out on the 5th January 1955. For twenty days, patient had no complaints and was moving about freely, till on 25th January, suddenly at about 5 P.M. he got severe pain in the epigastric region with a feeling that something has given way. Patient was in profound shock having profuse sweating with rapid thready pulse without any dyspnoea or cyanosis. There was marked rigidty and tenderness of the right hypochondrium. Patient expired at about 8 P.M. No autopsy was allowed.

## Discussion

The patient had a liver abscess which communicated through the diaphragm anteriorly to produce a loculated empyema anteriorly. (No fluid could be aspirated on 11-11-1954 in the posterior axillary line.)

This finally resulted in empyema necessitans from which staphylo-coccus aureus was cultured and was most sensitive to streptomycin. There was no response to streptomycin or pencillin till Nivaquine or emetine was exhibited. It appeared to be a mixed empyema primarily due to amoebic liver abscess and secondarily infected with staphylo-coccus aureus. The sequlae were unexpandable lung with marked pleural thickening and pneumothorax. The tragic end came when probably a small liver abscess perforated into the peritoneal cavity leading to peritonitis, shock and death.

Manson Bahr[4] is of the opinion that empyema is a rare complication as the pleural sac is shut off by thick adhesions, though lung abscess is not uncommon. Dormer et al[1] did not find any empyema as a complication of amoebic liver abscess. Harley[2] and Ochsner et al[3] have come across empyema as a complication of amoebic liver abscess. Nivaquine failed to prevent the formation or help in the absorption of the pus. The reason is obvious as the concentration is highest in the liver and not in the pleural cavity. Further the course is different from an amoebic lung abscess in which the pus may find its way out through the bronchi. It appears the rational therapy in a mixed empyema due to liver abscess is the specific therapy like Nivaquine or Emetine along with proper antibiotics. But drainage must be carried out at the earliest time not only to drain the pleural cavity but to prevent complications like thickened pleura and unexpandable lung which may require major surgery at a later stage.


## Summary

A case of mixed empyema secondary to liver abscess has been described. The necessity of early drainage has been stressed.


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# THE CAUSE OF INJURY TO THE ABDUCENT NERVE IN INTRACRANIAL LESIONS

*by K. GOVINDA MENON, Madras.*

The involvement of the sixth nerve in cases of cerebral tumours and lesions has been noticed since a very long time but the cause of the involvement of this nerve more than any other has not been explained properly. Paralysis of the lateral rectus muscle of the eyeball occurs very commonly in intracranial tumours, in cases where there are inflammatory conditions in the brain, and in other cases of increase in intracranial tension. Not only has the paralysis in many cases no relation to the position of the tumour, if any, but it has been noticed to be contralateral[6] in some cases so that it is practically of no localising value in cerebral tumours.

Sixth nerve palsy is seen mostly in cases where there is an increase in intracranial pressure, though it sometimes starts very early before other signs of increased tension manifest themselves[2]. Murray[3] challenges the view that 6th nerve palsies are due to increase in intracranial tension but his arguments are not very convincing. Nobody denies that in cases where there is direct involvement of the nerve either by tumour or as the result of trauma, the muscle is paralysed even in the absence of increased tension. His argument that if it is increased intracranial pressure, there would have been more palsies, is not convincing. The evidence at present available shows that the abducent is the nerve that is involved most, and in most cases it has no relation to the tumour if present. Even without a tumour paralysis sets in, in many cases of intracranial lesions[6]. Another argument of Murray is that the abducent nerve is protected from pressure as more than half of its course is extradural, but if there is pressure, the fact that a nerve is outside the dura will only increase the possibility of injury as there is no cerebrospinal fluid to protect it. His third argument is that in three cases of medulloblastoma the palsy began after decompression. This may have been due to dislocation of the brain-stem or to direct involvement of the nerve as a later phenomenon and no conclusion is possible before the cause is investigated. He also mentions that ocular nerve palsies occur early whereas increased tension occurs later, but this is not always so[2, 4]. So also his statement that in cases of Pontine tumours of one side, the abducent paralysis is on the same side is not borne out by observations. In some cases it is contralateral[6].

The evidence therefore is in favour of the view that sixth nerve palsies are mainly due to increase in intracranial tension for it occurs in most cases of increased tension[2] and that only in few cases it is the result of direct pressure on or injury to the nerve. The question is what is the cause of paralysis in the former cases.

Collier, cited by Wolff[6], is of the opinion that it is due to the anteroposterior stretching of the nerve in its long intracranial course but Cushing[1] points out that in cases of some other nerves like the facial, stretching to twice the length does not produce paralysis. Cushing is of opinion that it is due to arterial pressure on the nerve in certain conditions and Stopford[5] agrees with him. Wolff[6] however points out that the structure producing the pressure must be of a firmer consistency than the compressible arteries. His contention is that when the abducent nerve crosses the superior border of the petrous temporal there is a bend of the nerve "very nearly at right angles" to its course in the posterior cranial fossa. According to him, it is the pressure of the stretching nerve on the superior border of the petrous temporal that is responsible for the injury to the nerve, in cases where there is a posterior pull. This pull exists in conditions of increased intracranial tension with the consequent tendency of the pons and medulla to be jammed towards the foramen magnum.

This investigation was started by the author with the idea of verifying the above statement of Wolff that the nerve turns very nearly at right angles at the superior border of the petrous temporal. The angle was measured in 30 cadavers on both sides. Copies of the case sheets were got from the wards and all the relevant facts noted. The nerve was carefully dissected without disturbing its position. Flexible wires were put along the nerve and bent so that they were in the same position as the nerve and the angle between the two limbs measured carefully. This angle named L in the succeeding description was found to be more than a right angle in all cases. In one case on the right side (Venkata Reddy aged 45) it was 94° and in another case on the left side (Manikam aged 55) it was 95°. In all other cases it was higher as shown in Table II.

Table I showing maximum, and minimum range, arithmetic mean, standard deviation and coefficient of variation of the angle L.

| | ANGLE IN DEGREES. | |
|---|---|---|
| | Right side | Left side |
| Maximum | 149 | 143 |
| Minimum | 94 | 95 |
| Range | 55 | 48 |
| Arithmetic mean | 120.4 | 122.4 |
| Standard deviation | 10.52 | 12.65 |
| Coefficient of variation | 8.75% | 10.34% |

Table II shows that the values for the right and left sides are different in all cases and there is a considerable range. The angle also varies widely among individuals. By applying the "t" test one finds that there is no significance in the difference between the two sides. This is only to be expected. In other words no importance can be attached to the difference between the averages of the values of the two sides and the whole can be taken as sixty different observations for purposes of calculating the angle taken by the abducent nerve at the superior border of the petrous temporal.

Table II showing age, sex, angle L in degrees on both sides and the difference.

| No. | Age | Sex | Age in Degrees | | |
|---|---|---|---|---|---|
| | | | Right side | Left side | Difference |
| 1 | 25 | M | 118 | 120 | — 2 |
| 2 | 55 | M | 110 | 95 | + 15 |
| 3 | 50 | M | 115 | 108 | + 7 |
| 4 | 45 | M | 94 | 100 | — 6 |
| 5 | ? | M | 112 | 110 | + 2 |
| 6 | 35 | M | 125 | 134 | — 9 |
| 7 | 50 | M | 120 | 126 | — 6 |
| 8 | 60 | M | 110 | 125 | — 15 |
| 9 | 60 | M | 116 | 128 | — 12 |
| 10 | 36 | F | 111 | 121 | — 10 |
| 11 | 68 | M | 122 | 135 | — 13 |
| 12 | 60 | M | 125 | 117 | + 8 |
| 13 | 25 | M | 104 | 115 | — 11 |
| 14 | 12 | F | 116 | 110 | + 6 |
| 15 | 30 | M | 132 | 134 | — 2 |
| 16 | 55 | M | 118 | 120 | — 2 |
| 17 | 65 | M | 118 | 114 | + 4 |
| 18 | 35 | M | 117 | 113 | + 4 |
| 19 | 57 | M | 128 | 130 | — 2 |
| 20 | 55 | M | 115 | 108 | + 7 |
| 21 | 40 | M | 128 | 118 | + 10 |
| 22 | 45 | M | 126 | 132 | — 6 |
| 23 | 64 | M | 125 | 140 | — 15 |
| 24 | 45 | M | 112 | 106 | + 6 |
| 25 | 53 | M | 135 | 135 | 0 |
| 26 | 50 | M | 134 | 130 | + 4 |
| 27 | 25 | M | 128 | 140 | — 12 |
| 28 | 20 | M | 127 | 143 | — 16 |
| 29 | 31 | M | 149 | 130 | + 19 |
| 30 | 45 | M | 122 | 135 | — 13 |

The facts noted during the course of this investigation are —

(1) That the angles are all obtuse and in some cases very obtuse.

(2) They vary widely and there is difference in the angle between the two sides of the same body.

(3) The superior border of the petrous temporal at the bend of the nerve is very



Fig. 1-a.
Right abducent nerve crossing below the petrosphenoid ligament and lateral to the internal carotid artery.

Fig. 2-a.
Section of the base of the skull at the point of crossing of the nerve over the petrous temporal with the nerve in situ.

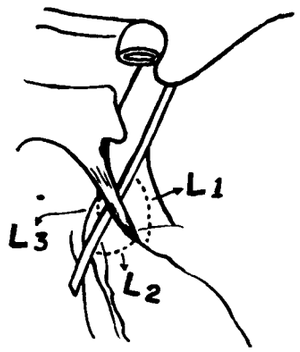


Fig. 1-b.
Diagram of the same area showing the angles.

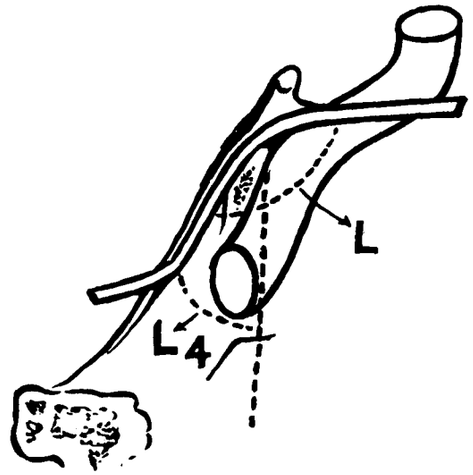


Fig. 2-b.
Diagram of the same area showing the angles.

smooth and rounded in all cases so that there is very little of friction possible there.

(4) Neither age nor sex seems to have any influence on the angle L.

(5) Owing to the obliquity of the fulcrum namely the superior border of the petrous temporal, the abducent nerve in the posterior cranial fossa subtends an obtuse angle in all cases with the medial part of the former. This angle is named $L_3$ in the figure.

Because the angle $L_3$ is always obtuse, only a fraction of the force acting on the nerve acts at right angles to the superior border of the petrous temporal. This fraction is further reduced because the angle L is also obtuse and only the vertical component of the fraction can exert a downward pressure on the fulcrum. As already pointed out the fulcrum is very smooth and rounded and there is not likely to be much friction there. It is doubtful therefore if the downward pressure by itself can be responsible for the injury to the nerve.

What then is the structure that causes the pressure on the nerve in case of increase of intracranial tension? If one traces the abducent nerve from its point of emergence between the pyramid and the pons to its termination, one finds that there is a definite lateral inclination. The distance between the two nerves at their origin is found to be 9.25 mm. with a maximum of 10 mm. and a minimum of 8.5 mm. The nerve crosses the superior border of the petrous temporal at an obtuse angle and continues forward in the cavernous sinus in a very nearly horizontal direction into the superior orbital fissure. At the point of crossing of the superior border of the petrous temporal it is just medial to the lateral attachment of the petrosphenoidal ligament of Gruber and under cover of it. The angle subtended by the ligament on the bone is very acute and there is only just space for the nerve to pass. So one can easily imagine that if there is a pressure on the nerve in a lateral direction or any pull on the nerve towards the lateral attachment of the ligament of Gruber the nerve is likely to be crushed against that angle and because of its acuteness, friction will be very much greater there.

With the idea of investigating if any such force comes into play in case of increased intracranial tension the two lateral angles subtended by the nerve at the superior border of the petrous temporal were measured in the first 22 of the 30 cases. The distance of the bend of the nerve from the posterior clinoid process was also measured with the idea of finding out if the difference in the angles has anything to do with the lateral or medial position of the nerve. The results are given in Table III. The angle between the anterior limb of the nerve and the lateral part of the superior border of the petrous temporal is named $L_1$ and that between the latter and the posterior limb of the nerve $L_2$ in the following Table. The distance between the bend of the nerve and the posterior clinoid process is named D.

Table III showing $L_1$, $L_2$, D and total of $L_1$ and $L_2$ :

The angle $L_2$ is less than a right angle in all cases measured due to the obliquity of the fulcrum. On the right side the average comes to 76.18° with a maximum of 86° and a minimum of 68° with a range of 18°. On the left side the average comes to 75.05°. The maximum is 83°, minimum 65° with a range of 18°.

When one looks at the angles, the result is misleading at first sight; instead of a lateral inclination of the nerve at the fulcrum one finds a slight medial bend, except in 5 cases on the left side and 3 cases on the right side. It is also noticed that the degree of this bend has no relation to its distance from the posterior clinoid process, i.e. it does not depend on the distance of the nerve from the posterior clinoid process. Neither age nor sex has any relation to the degree of the bend.

On closer scrutiny, one finds that the medial inclination is only slight and can easily be due to the fact that the internal carotid artery to which the nerve is closely bound in the cavernous sinus shrinks after death and injection, pulling the abducent



| No. | Age | Sex | Right Side | | | | Left Side | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $L_1$ | $L_2$ | Total | D | $L_1$ | $L_2$ | Total | D |
| 1 | 25 | M | 106 | 69 | 175 | 10 | 100 | 70 | 170 | 9 |
| 2 | 55 | M | 117 | 82 | 199 | 11 | 117 | 79 | 196 | 7 |
| 3 | 50 | M | 101 | 82 | 183 | 12 | 103 | 80 | 183 | 12 |
| 4 | 45 | M | 122 | 72 | 194 | 14 | 114 | 82 | 196 | 13 |
| 5 | ? | M | 92 | 74 | 166 | 13 | 100 | 73 | 173 | 13 |
| 6 | 35 | M | 107 | 83 | 190 | 11 | 110 | 79 | 189 | 11 |
| 7 | 50 | M | 114 | 80 | 194 | 10 | 106 | 74 | 180 | 11 |
| 8 | 60 | M | 118 | 86 | 204 | 11 | 117 | 83 | 200 | 10 |
| 9 | 60 | M | 117 | 76 | 193 | 8 | 117 | 81 | 198 | 7 |
| 10 | 36 | M | 110 | 68 | 178 | 10 | 94 | 66 | 160 | 9 |
| 11 | 68 | M | 121 | 75 | 196 | 15 | 120 | 70 | 190 | 18 |
| 12 | 60 | M | 126 | 77 | 203 | 11 | 124 | 72 | 196 | 12 |
| 13 | 25 | M | 128 | 72 | 200 | 9 | 118 | 75 | 193 | 10 |
| 14 | 12 | F | 190 | 74 | 194 | 11 | 109 | 68 | 177 | 10 |
| 15 | 30 | M | 120 | 78 | 198 | 15 | 102 | 75 | 177 | 11 |
| 16 | 55 | M | 128 | 73 | 201 | 10 | 110 | 74 | 184 | 8 |
| 17 | 65 | M | 118 | 78 | 196 | 13 | 110 | 80 | 190 | 9 |
| 18 | 35 | M | 121 | 78 | 199 | 11 | 120 | 74 | 194 | 7 |
| 19 | 57 | M | 122 | 75 | 197 | 9 | 118 | 76 | 194 | 10 |
| 20 | 55 | M | 122 | 74 | 196 | 14 | 116 | 65 | 181 | 12 |
| 21 | 40 | M | 132 | 78 | 210 | 10 | 117 | 75 | 192 | 9 |
| 22 | 45 | M | 127 | 72 | 199 | 8 | 126 | 80 | 206 | 10 |

nerve to the medial side. This however can only be a matter of conjecture as there is no easy possibility of measuring this during life. There is every probability however that in conditions where the artery is full and pulsating the abducent nerve in the cavernous sinus may be more laterally placed and the bend of the nerve lateral instead of medial even in normal conditions.

Whatever may be the change in the position of the nerve due to its adhesion to the artery, there can be no doubt that the anterior end of the nerve (i.e. at its entrance into the lateral rectus) is more lateral than at the superior border of the petrous temporal. In the course of some anthropological studies on South Indian skulls that is being done separately, it was found that the distance between the medial ends of the superior orbital fissure works to 29.09 m.m. whereas the distance between the lateral attachments of the petrosphenoidal ligaments is only 24.09 m.m. In all cases the former is greater than the latter. Moreover the nerve enters the superior orbital fissure more laterally. It has been mentioned already that at their posterior attachments the distance between the nerves is only 9.25 m.m. So the two nerves form a wedge-shaped figure. In

cases of increase in intracranial tension where the medulla with its attached nerve is pulled backwards towards the path of least resistance, a greater area of the wedge is engaged between the two petrosphenoidal attachments producing pressure in a lateral direction.

There is a second factor that comes into play in producing pressure in a lateral direction. Though the two nerves diverge from each other the angle $L_2$ is found to be less than a right angle owing to the obliquity of the fulcrum, i.e. the superior border of the petrous temporal. So a portion of the force F pulling on the nerve in the posterior cranial fossa, i.e. $F \cos L_2$ is directed laterally along the superior border of the petrous temporal. This force becomes greater, the lesser the angle $L_2$. In this lateral force the friction is much greater owing to the very acute angle subtended by the ligament of Gruber on the bone and the greater area of contact of the nerve (nearly thrice the area of contact) than in the pull in the downward direction.

A third factor may also come into play in case of increase in intracranial tension. The posterior ends of the nerves are fixed to the medulla and when the latter is pulled posteriorly there is a tendency for the former to be deflected outwards as shown in Fig. 3 thus reducing the angle $L_2$. It may be argued here that a part of the nerve in the posterior cranial fossa is between the two layers of dura mater and there is no possibility of the lateral movement of the nerve, but against this, one has to admit that the dura though tough is elastic and that the position of the nerve between the two layers of dura is mostly over the inferior petrosal sinus, which latter is crossed by the nerve from the medial to the lateral side. This might explain contralateral paralysis in some cases of cerebellopontine tumours, for if there is a lateral shifting of the nerve it will certainly decrease the angle $L_2$ and increase the pressure at the petrosphenoidal attachment. One cannot assert this however unless more work is done on the point.

If F is the force that pulls the nerve backwards, this F can be resolved in two directions, one along the superior border of the petrous temporal $F \cos L_2$ and another at right angles to it $F \sin L_2$. The latter is an oblique force and the pressure downwards on the superior border of the petrous temporal is only the vertical component of it, $F \sin L_2 \cos L_1$ (if we take $L_1$ as L -90).

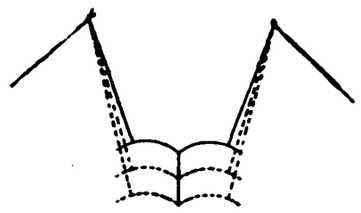

Fig. 3.
Diagram showing the posterior shifting of the medulla and the possible lateral tilting of the nerve.

So the force that acts on the petrosphenoidal attachment is $F \cos L_2$. The downward force is $F \sin L_2 \cos L_1$. $F \cos L_2$ increases with the reduction of the angle $L_2$. This reduces the $F \sin L_2$ and necessarily the vertical force $F \sin L_2 \cos L_1$, which is only a fraction of the former. The vertical force is still further reduced if $L_1$ becomes more, i.e. if the angle L becomes more obtuse. There is another factor that tends to reduce the vertical force namely a slight upward inclination of the medial end of the superior border of the petrous temporal.

If the posterior part of the abducent nerve is shifted laterally as shown in Fig. 3 there will be a gradual reduction of $L_2$ with a corresponding increase in the lateral force and a decrease of the vertical force. The lateral force is more injurious to the nerve than the vertical force owing to (1) the friction being much greater (for there is at least 3 times the area of contact) (2) the pressure of the greater area of the wedge getting jammed at the petrosphenoidal attachments, the force of this jamming being greater, the greater the intracranial pressure and wider the wedge. One has therefore to conclude that the lateral force is more potent in crushing the nerve.



This lateral force is dependent on (1) the force F which usually gradually increases in cases of intracranial tension (2) the angle $L_2$ which is seen to be less than a right angle in all cases measured (3) the nature of the wedge. These are not only different in different individuals but different on two sides of the same individual. The downward force depends mainly on the angle L and this angle also varies similarly. These differences can explain why the injury to the nerve is sometimes on one side, sometimes on the other even in centrally situated tumours and in uniform increase in pressure. These can also explain the fact that with the same degree of increase in tension different individuals react differently.

## Summary

The cause of the lateral rectus paralysis occurring in most cases of cerebral tumours, inflammation, etc. is the injury of the 6th nerve mainly due to increased intracranial pressure.

The views of different workers as to how the increased pressure affects the nerve are mentioned including that of Wolff, who thought that it was due to downward pressure of the nerve on the superior border of the petrous temporal.

The reasons why the downward force cannot be the sole cause of injury are given.

There is a lateral force on the nerve pressing it against the lateral attachment of the petrosphenoidal ligament where the angle subtended by the ligament is very acute and there is much greater friction. There is also the wedging action of the two nerves at the petrosphenoidal attachments when the former are pulled backwards. So it is pointed out that the lateral force may be more responsible for the injury.

There is considerable difference in the angles subtended by the nerve on the bone in different individuals and also on both sides of the same individual. This may explain the aberrant nature of the paralysis.

My thanks are due to Drs. Chengappa and Shetty, Demonstrators in Anatomy for help rendered during measurement of the angles.

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### THE XVIII ANNUAL CONFERENCE

The XVIII Annual Conference of the Association of Surgeons of India will be held at Indore during the last week of December 1956. Dr. B. B. Ohri, M.S., F.R.C.S., Professor of Surgery, M. G. M. Medical College, Indore, is the Local Secretary, and members will be hearing from him regarding the details and dates of the Conference sometime in September next.

At the Conference, the following subjects will be discussed :—

1. *Cancer of the Lung*—
   Opener : Dr. A. K. Basu, Calcutta. (Surgical aspect)
   Seconder : Dr. R. Dutt Chowdhuri, Calcutta. (Pathological aspect)
   Seconder : Dr. N. B. Roy, Calcutta. (Radiotherapeutic aspect)
2. *Hypospadias*—
   Opener : Dr. R. N. Sinha, Patna.
   Seconder : Dr. R. N. Sharma, Lucknow.
3. *Spinal Injuries particularly of the Cervical Spine*—
   Opener : Dr. H. K. Sarkar, Calcutta.
   Seconder : Dr. A. K. Saha, Calcutta.

Besides these, a few "Short Papers" will be read at the Conference. Members will get separate notice from the Hony. Secretary about this during September 1956.

**Subjects for discussion at future meetings**

19th Meeting :

1. *Non-malignant Stricture of Oesophagus* by Dr. Subrata Banerjee, Calcutta.
2. *Surgery of Intracranial Vascular Lesions* by Dr. B. Ramamurthi, Madras.
3. *Tumours of the Testis* by Dr. E. J. Borges, Bombay.

20th Meeting :

1. *Acquired Facial Defects* by Dr. M. Mukherji, Calcutta.
2. *Hydronephrosis—Experimental and Clinical Studies* by Dr. B. N. Balakrishna Rao, Gwalior and 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. P. K. Sen, Bombay.

## REVIEWS OF BOOKS

**Rontgenologische Differential Diagnose Der Knochenerkrankungen. (Rontgenological Differential Diagnosis of Diseases of Bones)** By Dr. HANS HELLNER, *Chief professor of Surgery and Director of the University Surgical Clinic* and Dr. HANNS POPPE, *Specialist in Rontgenology, and Director of the Rontgen Department of the University Surgical Clinic.* With efficient cooperation from Ilse Lohstoter, 1st technical assistant in the Clinic. (*All of University of Gottingen, Germany*).

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The text consisting of descriptive notes on "diseases of bones" from Congenital, Metabolic, Luetic, and Blood Dyscrasias, Traumatic, Tubercular, Rheumatoid and Gouty Involvements, Primary and Secondary Tumour Deposits etc., are in detail and excellently printed.

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Indexing and Bibliography is complete, and the volume should be in every University and Medical Library, and, in the library of the specialist. It is desirable this volume is translated into English, (but reproduced and published by the same George Theme Verlag) so that, the English knowing Colleagues may be benefitted.

P. R.

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1. Dr. Himdrikumar Sarkar, M.B., F.R.C.S., Surgeon, Calcutta Port Commissioner's Hospital, Calcutta-27 (3, Haji Mohsin Road, P. O. Kalighat, Calcutta-26).

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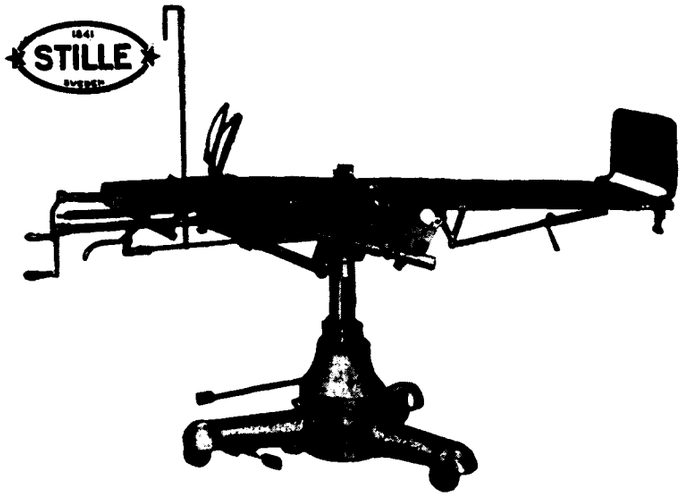


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## INDEX TO ADVERTISERS



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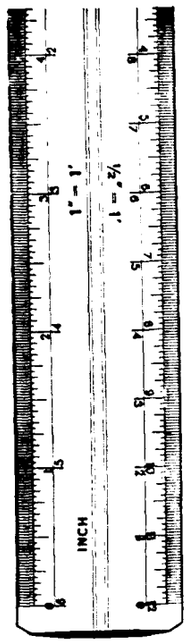
Vol. XVIII] AUGUST 1956 [No. 4

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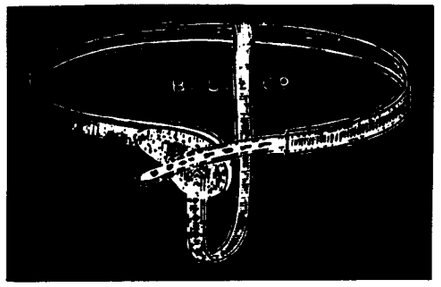

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*CONTENTS AUGUST 1956*

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THE
INDIAN JOURNAL OF SURGERY

Vol. XVIII AUGUST 1956 No. 4

# SOFT TISSUE SARCOMAS OF THE EXTREMITIES AND TRUNK *

## (A clinical and pathological study)

*by M. V. SIRSAT, Bombay.*

Sarcomas of the soft tissues are malignant mesenchymal tumours arising primarily in connection with the connective tissues of fasciae, aponeuroses, tendon sheaths, intermuscular septa, voluntary muscles, adipose tissue, synovial membrane and blood vessels. The present communication deals with the clinical and pathological aspects and the biological behaviour of 146 cases of soft tissue sarcomas of the extremities and trunk.

## MATERIAL AND METHODS

The material consists of 146 cases of soft tissue sarcomas of the extremities and trunk, documented in the Laboratories of the Tata Memorial Hospital, Bombay during the years 1941 to 1954. All the material was restudied and verified histologically. In 80 cases the diagnosis was made on the basis of sections of the tumour removed, and in 38 cases on biopsies performed at this hospital. In 28 cases the tumour was biopsied or removed in outside hospitals; in these cases the original slides or paraffin blocks were obtained and reviewed. In cases where the entire tumour mass was removed, at least three blocks from different portions of the mass were available for study. All the sections were stained with hematoxylin and eosin. In some cases, this was supplemented by differential fibre stains and silver impregnation stains. Twenty-six cases of soft tissue sarcomas of the extremities and trunk were deleted because either the material was insufficient for histological classification or the clinical data was meagre.

The following chart (Fig. 1) shows the histological classification of the cases studied. The individual varieties are discussed below.

* From the Dept. of Pathology, Tata Memorial Hospital, Bombay.

### 1. FIBROSARCOMA

There were 88 fibrosarcomas in this series. Fibrosarcoma thus ranked first in frequency and formed 60.3 per cent of the tumours. A survey of the literature shows that fibrosarcoma tops the list of soft tissue sarcomas. Pack and Ariel [21] encountered 39 cases of fibrosarcoma of the extremities and trunk during the years 1931 to 1948. In a series of 144 cases of fibrosarcomas reported by Stout [33], 66 were in the extremities. It is, however, difficult to judge the true incidence of fibrosarcoma of the extremities and the trunk, because, in reports on soft tissue sarcomas, fibrosarcomas occurring in viscera, retroperitoneal and mediastinal regions are also included and not always separately classified. Furthermore the term neurogenic sarcoma is a complicating factor in determining the true incidence of fibrosarcoma. Stout (loc cit) is against the indiscriminate use of this term, and has suggested that it be deleted. At the first National Cancer Congress [27] held in 1949, it was decided to accept Stout's suggestion and the term neurogenic sarcoma was dropped. Many tumours classified previously as neurogenic sarcoma in this laboratory were all reviewed and reclassified. The 88 cases of fibrosarcoma recorded in this series are in the light of this reclassification.

*Age and sex incidence*: Fibrosarcoma occurs in fairly young age groups. The average age of the patients in this series was 38.8 years. Pack and Ariel (loc cit) reported 39.4 years as the average age in their series. Seventy-five per cent of fibrosarcomas in this series occurred in

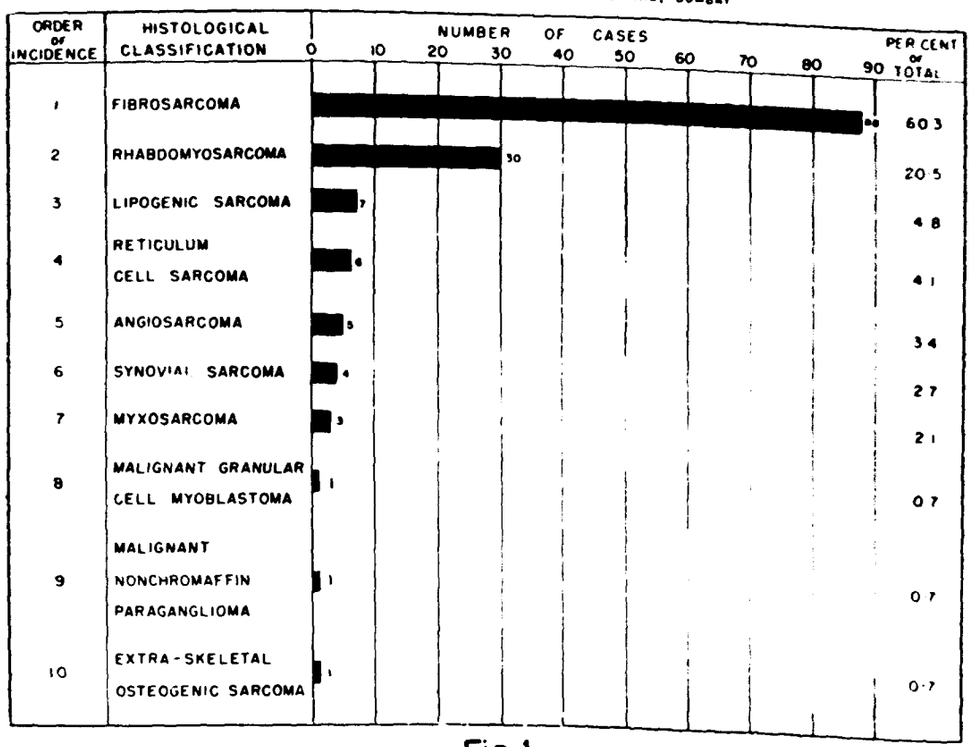


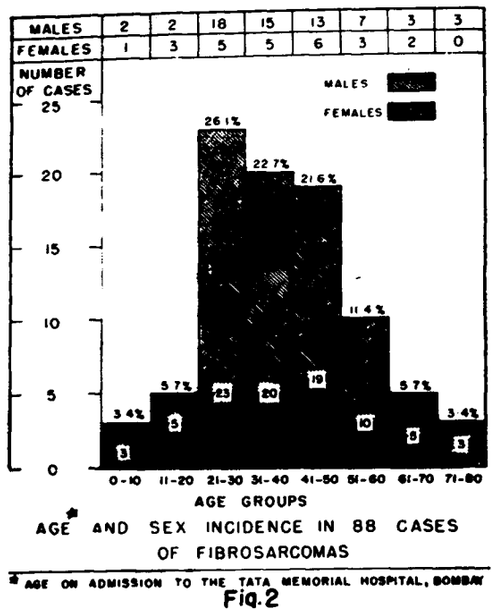

Fig. 1

patients between the ages of 30 and 50 years. The youngest patient was 9 months old (Fig. 5, A) and the oldest was 77 years of age.

There is a marked preponderance of males. In this series 63 patients were males and 25 females. Meyerding et al [15] and Wilson [45] reported a higher incidence of fibrosarcoma in males, whereas Pack and Ariel (loc cit) and Heller and Sieber [8] found a higher incidence of this tumour in women. The following histogram (Fig. 2) shows the age and sex incidence of fibrosarcoma in this series.

*Location*: In 45 cases (51.1) per cent) the site of the fibrosarcoma was the lower extremity. The upper extremity was involved in 19 cases (21.5 per cent) and the trunk (chest, back and abdominal wall) in 24 cases (27.2 per cent). The thigh was the most frequent location of fibrosarcoma, being involved in 19 cases (21.5 per cent). In the series reported by Pack and Ariel (loc cit) the upper extremity was the most frequent site (56.4 per cent). Attention may be drawn to the incidence of fibrosarcoma in the abdominal wall in this series. There were 6 cases. Pack and Ariel (loc cit) had reported only a single case of fibrosarcoma in the abdominal wall in their series. On the other hand Stout (loc cit) encountered 13 cases in a series of 144 fibrosarcomas of soft tissues. The per-






AGE* AND SEX INCIDENCE IN 88 CASES OF FIBROSARCOMAS

* AGE ON ADMISSION TO THE TATA MEMORIAL HOSPITAL, BOMBAY

Fig. 2

centage distribution in the various locations in the present series are given in Table I and compared with the distribution reported by Pack and Ariel (loc cit). Scattergram (Fig. 3) shows location of fibrosarcoma in each patient.

*Clinical findings*: There were no characteristic symptoms. It began as a painless mass and by and large was a slow growing tumour. In 44 cases (50 per cent) the patient came to the hospital with a painless swelling and in 25, (28.4 per cent) the swelling was painful. There was no mention regarding this symptom in 19 cases. In 18 cases (20.4 per cent) the tumour had ulcerated through the skin. The tumour was slow growing in 55 cases (62.5 per cent) and a history of rapid growth was obtained in 11 cases (12.5 per cent). The duration of the tumour varied from 2 months to 23 years. A long duration ranging from 10 years onwards was recorded in 8 cases. The average duration, from the onset of the first symptom until the patient came under observation, was 3.5 years. In the series reported by Pack and Ariel (loc cit) this interval was 32.7 months. Pack and Ariel (loc cit) stated that painlessness was the cause of this unfortunate delay. Fig. 4 illustrates a group of patients with fibrosarcoma.

*Recurrence*: A local recurrence was noted in 48 cases (54.5 per cent) in the follow up of patients treated at this hospital. Thirty-seven cases came to the hos-

TABLE I

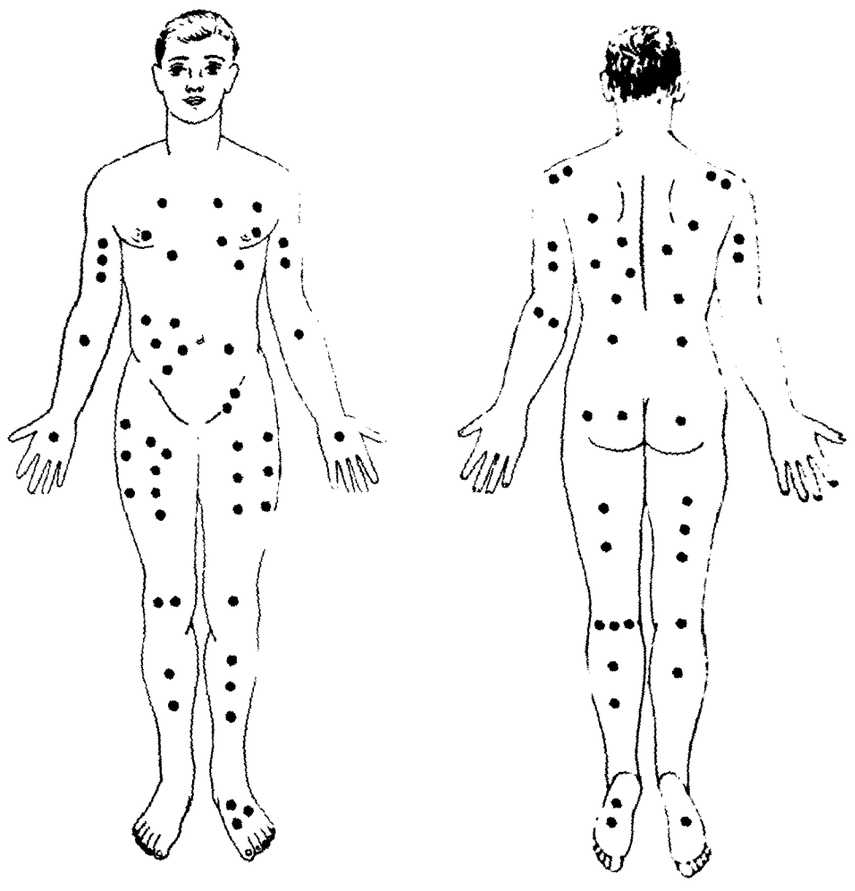
FIBROSARCOMAS: LOCATION

| Anatomic site | Number of cases: Pack and Ariel (1952) | Author's series |
|---|---|---|
| *Upper Extremity* | 22 (56.4) | 19 (21.5) |
| Shoulder | 10 | 4 |
| Arm | 3 | 9 |
| Elbow region | 5 | 2 |
| Forearm | 0 | 2 |
| Wrist | 1 | 0 |
| Hand | 3 | 2 |
| *Lower Extremity* | 10 (25.6) | 45 (50.1) |
| Groin | 0 | 2 |
| Thigh | 6 | 19 |
| Buttock | 0 | 3 |
| Knee region | 2 | 7 |
| Leg | 0 | 8 |
| Foot | 2 | 6 |
| Back | 4 (10.2) | 10 (11.4) |
| Chest wall | 2 (5.1) | 8 (10.0) |
| Abdominal wall | 1 (2.5) | 6 (7.0) |
| Total | 39 | 88 |

Figures in parenthesis represent percentage distribution.

pital with a tumour which had recurred after an excision. Not in all these cases did one have the opportunity to examine the slides of the previously operated tumour, but in those cases in which such an examination was possible, the recurred growth showed a higher grade of malignancy. The following histogram (Fig. 4) shows the number of recurrences.

*Metastases*: Metastasis is rather an infrequent occurrence in fibrosarcoma and at the time of admission was present in 17 cases: 7 pulmonary (3 bilateral), 8 in regional lymph nodes and 2 in the sub-




SCATTERGRAM TO ILLUSTRATE THE REGIONAL DISTRIBUTION OF FIBROSARCOMAS IN 88 CASES

Fig. 3

cutaneous tissues, a little away from the primary site.

*Pathologic features :*

(A) *Gross description* : Fifty-five specimens were available for gross inspection. Some of the tumours were well circumscribed and on histological examination these showed good differentiation of structure. The cut surface was greyish white and a whorled pattern was characteristic. Those fibrosarcomas which showed poor differentiation histologically were greyish in colour and seemed to merge with the surrounding tissues. These were homogeneous in appearance and showed areas of degeneration, necrosis and haemorrhage scattered throughout the mass.

(B) *Microscopic description* : The fibrosarcomas seen in this series were classified into two groups according to the degree of differentiation. A well differentiated fibrosarcoma was composed of fusiform cells with ovoid nuclei which showed moderate variability in size. There was abundant intercellular collagenous tissue and mitotic figures were few in number (Fig. 6, B), on the other hand, in a poorly differentiating tumour, there was increase in the cellularity of the neoplasm, the nuclei were hyperchromatic and showed variability in size and mitotic figures were frequent (Fig. 6, C). In some, the tumour was seen surrounding the transversely cut nerve bundle which did not mean that the tumour was a neurogenic sarcoma (Fig. 6, D). Figs. 6, E and F show a distribution of reticulum pattern in a well differentiated and undifferentiated fibrosarcoma respectively. The behaviour of fibrosarcoma according to histological differentiation is seen in Table II.

TABLE II

FIBROSARCOMAS: CORRELATION BETWEEN HISTOLOGICAL STRUCTURE AND CLINICAL BEHAVIOUR

| | No. of cases | No. of cases followed | Recurrences | Metastases | Died within years |
|---|---|---|---|---|---|
| Poor differentiation | 50 | 39 | 28 (71.8) | 11 (28.2) | 12 (30.8) |
| Good differentiation | 38 | 25 | 19 (76.0) | 3 (12.0) | 0 |
| Total | 88 | 64 | 47 (73.9) | 14 (21.9) | 12 (18.8) |

Figures in parenthesis represents percentage.

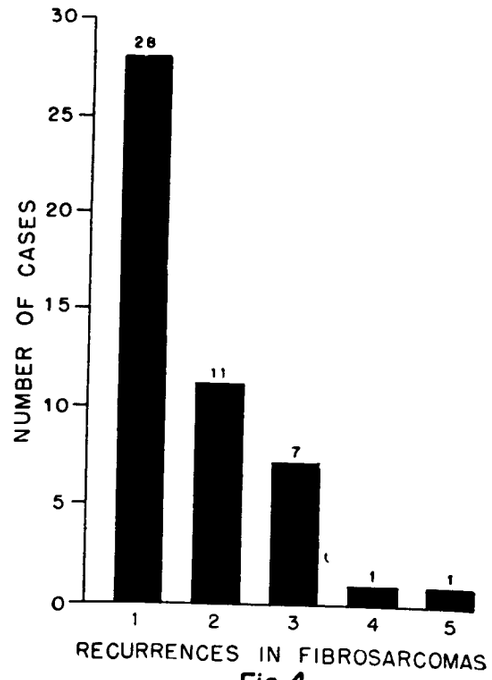


Fig. 4

## 2. RHABDOMYOSARCOMA

The incidence of rhabdomyosarcoma as reported in the literature, is low. Jonsson [11]

Fig. 5-A.

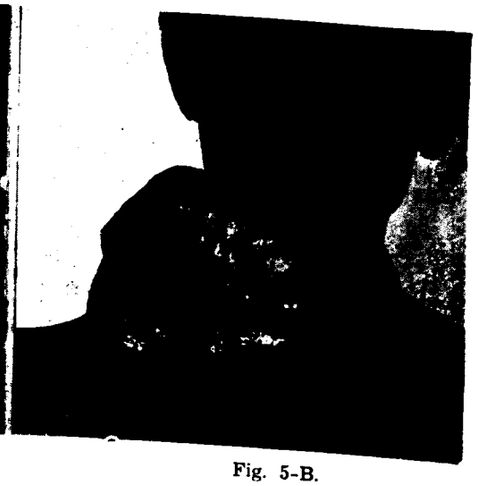


Fig. 5-B.


Fig. 5-C.

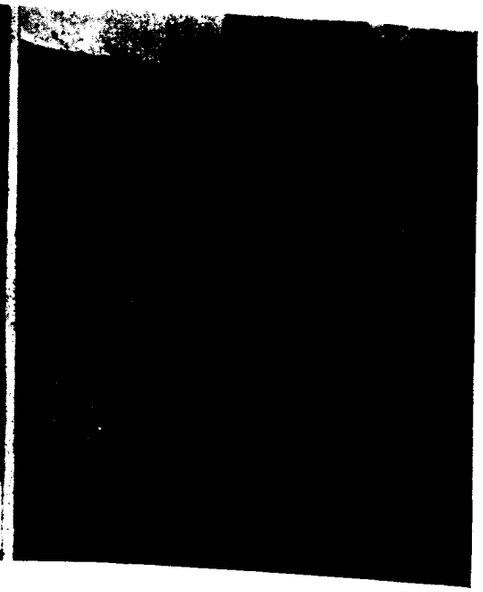


Fig. 5-D.

Fig. 5. A group of patients showing location of fibrosarcoma. Fibrosarcoma involving the right arm in a 9 month old child (A) (no. P. 134). Fibrosarcoma of the left shoulder region in a Hindu male aged 40 years (B) (no. P. 2649). Fibrosarcoma of the right arm in a Hindu woman aged 60 (no. 6226). History of two recurrences after excision (C). Fibrosarcoma involving medial aspect of the right thigh in a male aged 47. (no. 3848). In the series reported herein, thigh was the most frequent location being involved in 22.7 per cent of cases (D).




Fig. 5-E.

Fig. 5-F.

Fig. 5. A Hindu male aged 36. Fibrosarcoma of the planter aspect of the foot. History of 4 recurrences before admission to the Tata Memorial Hospital (E) (no. 1399). A bulky fibrosarcoma in a male aged 50. It has involved the lower abdomen (no. P. 5392). Six cases of fibrosarcoma of the abdominal wall were encountered in this series (F).

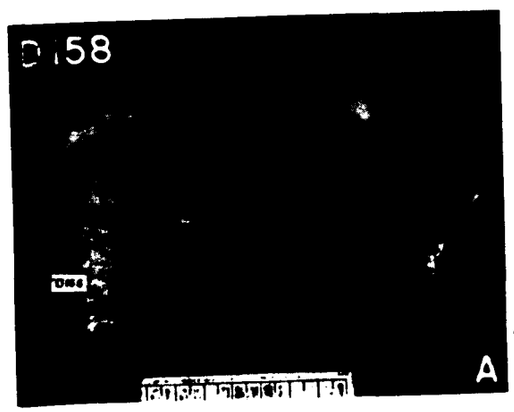



Fig. 6-A.

Fig. 6-B.

Fig. 6. Gross photograph of fibrosarcoma in a patient shown in (Fig. 5-C). Note the tumour extending into the muscles (A). Photomicrograph of a well differentiated fibrosarcoma showing excessive intercellular substance (B) (H & E stain x 250).


Fig. 6-C.

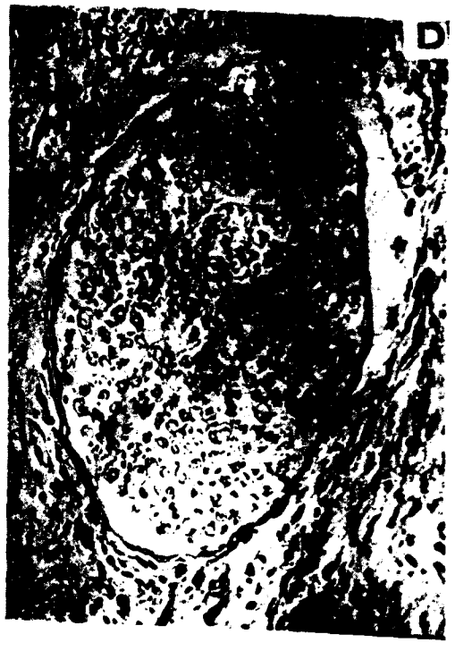



Fig. 6-D.

Fig. 6. Photomicrograph of an undifferentiated fibrosarcoma showing cellular structure of the tumour and scanty intercellular substance (C) (H & E stain x 250). Photomicrograph showing a transversely, cut nerve bundles, surrounded by fibrosarcoma (D) (H & E stain x 250).

recorded an incidence of 20 per cent, whereas Pack and Eberhart[22] found that rhabdomyosarcomas formed 13.9 per cent of soft tissue sarcomas in their material. In the present series there were 30 cases of rhabdomyosarcoma of the skeletal muscles of the extremities and trunk giving an incidence of 20.5 per cent. Nine cases included here have been previously described by Nanavati[20].

*Age and sex incidence*: Rhabdomyosarcomas occur at all ages. Stout[34] recorded a maximum incidence in the fifth and sixth decades. In this series the largest number of cases (40 per cent) occurred between the ages of 51 to 60 years. The oldest patient was 75 years of age while the youngest was 2 years old. Pack and Eberhard (loc cit) recorded an instance of a congenital rahbdomyosarcoma. Of 30 patients in this series there were 17 men and 13 women. The following histogram (Fig. 7) shows age and sex incidence of rhabdomyosarcomas of the extremities and trunk encountered in this series.

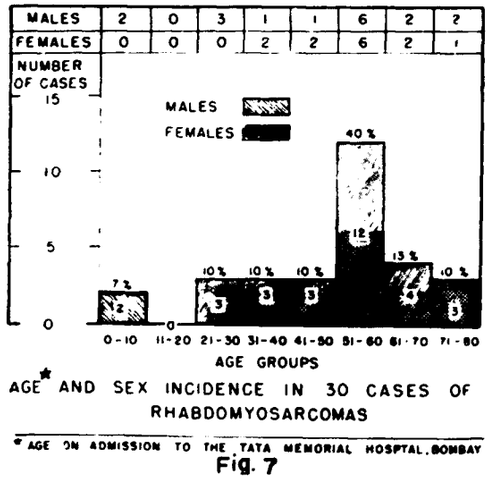
*Location*: The scattergram (Fig. 8) shows the location of rhabdomyosarcomas in each patient. The percentage distribution in the various locations is given in Table III and is compared with that reported by Pack and Eberhart (loc cit). In 100 cases of rhabdomyosarcomas reported by these authors, the upper extremity was involved in 34 per cent and the lower one in




Fig. 6-E.


Fig. 6-F.

Fig. 6. Photomicrograph showing the distribution of reticulum in fibrosarcoma, in a well differentiated tumour, reticulum seem to run parallel then branch off (E). In poorly differentiated fibrosarcoma reticulum is seen surrounding mostly the individual cells (F) (Gomori's silver impregnation x 250).




AGE* AND SEX INCIDENCE IN 30 CASES OF RHABDOMYOSARCOMAS

* AGE ON ADMISSION TO THE TATA MEMORIAL HOSPTAL, BOMBAY

Fig. 7

54 per cent of cases. In the present series rhabdomyosarcoma showed a definite predilection for the lower extremity (50 per cent) and the thigh muscles were the most frequent sites (30 per cent).

TABLE III

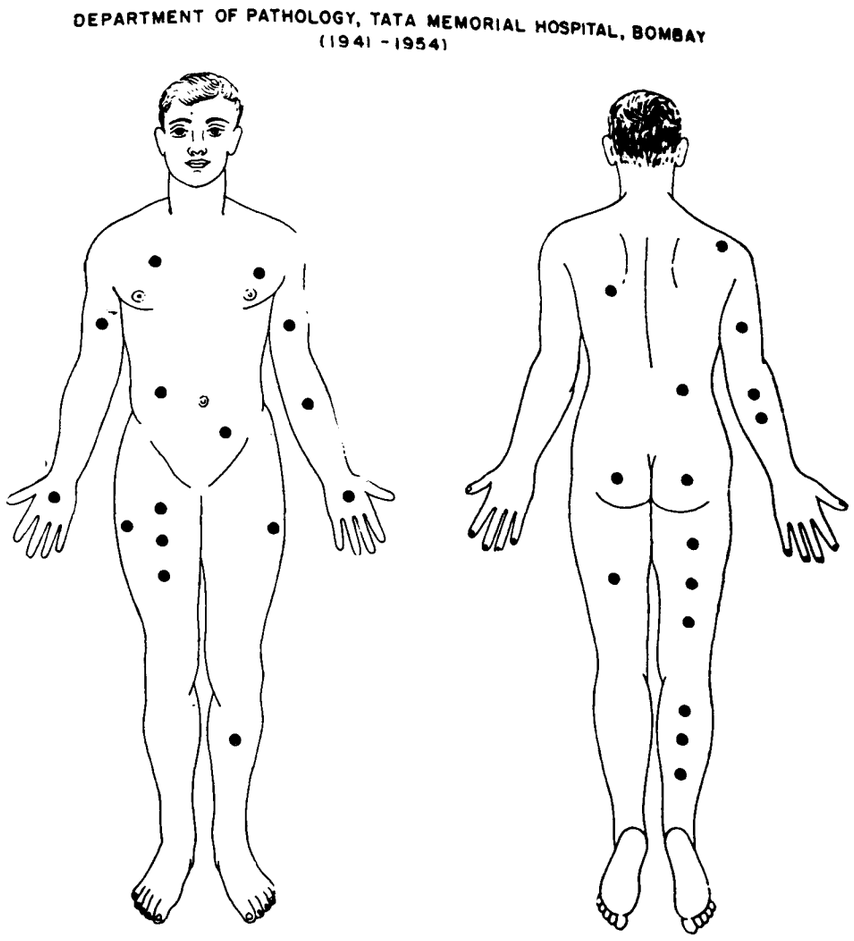
RHABDOMYOSARCOMA: LOCATION

| Anatomic site | Number of cases: Pack and Eberhart (1952) | Number of cases: Author's series |
|---|---|---|
| Hand | 1 (1.0) | 2 (6.7) |
| Arm | 27 (27.0) | 3 (10.0) |
| Forearm | 0 | 3 (10.0) |
| Shoulder | 6 (6.0) | 1 (3.3) |
| Leg | 9 (9.0) | 4 (13.3) |
| Thigh | 41 (41.0) | 9 (30.0) |
| Buttocks | 3 (3.0) | 2 (6.7) |
| Groin | 4 (4.0) | 0 |
| Chest back and abdominal wall | 9 (9.0) | 6 (20.0) |
| Total | 100 | 30 |

Figures in parenthesis represent percentage.

*Clinical findings*: All the patients came with a swelling which was slowly growing in size. In 15 cases there was no mention as to whether the swelling was painful or painless. Out of the remaining 15 cases, 10 (66.6 per cent) gave the history that the swelling was painful from the beginning; and in 5 cases (33.3 per cent) it was painless. The average duration from the onset of first symptom until the patient came under observation was 16 months. Ulceration of the tumour through the skin was recorded in 12 cases (40 per cent). Fig. 9, (A, C, D) shows a group of patients with rhabdomyosarcoma.

*Recurrence*: Recurrence was noted in 15 cases (50 per cent). Eight cases had a




SCATTERGRAM TO ILLUSTRATE THE REGIONAL DISTRIBUTION OF RHABDOMYOSARCOMAS IN 30 CASES
Fig. 8




Fig. 9-A. Fig. 9-B.

Fig. 9. A male aged 30 (no. 4504) rhabdomyosarcoma of the thigh. There were two recurrences before the patient came to the hospital (A). Roentgenogram of the lungs shows bilateral metastases due to rhabdomyosarcoma of the thigh (no. 3598) (B).

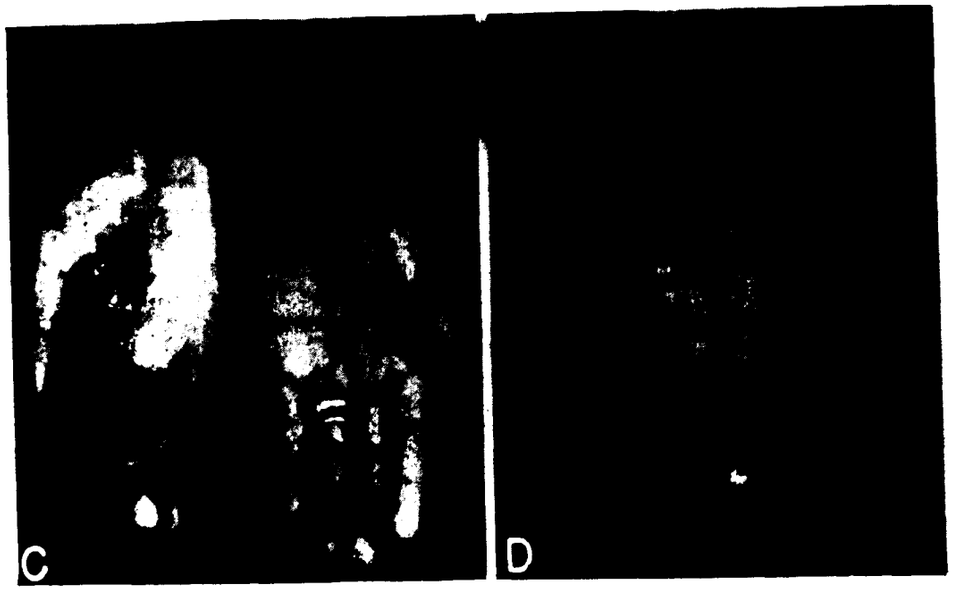



Fig. 9-C. Fig. 9-D.

Fig. 9. A male aged 22 years, hotel servant (no. 8691) with a history of using his right hand to hold the handle of the knife for cutting the bread. Developed this lesion which histologically was a rhabdomyosarcoma (C). Rhabdomyosarcoma of the abdominal wall in a Hindu male aged 55 (no. G. 3206). Histologically the tumour was an undifferentiated rhabdomyosarcoma and the patient died two years after admission to the hospital (D).


Fig. 10-A.

Fig. 10-B.

Fig. 10. Photograph of gross specimen of rhabdomyosarcoma. Note a single large size growth and discrete satellite nodules. A characteristic gross finding in rhabdomyosarcoma (A). Photomicrograph showing ribbon-like cells and spindle cells (B) (H & E stain x 250).

single recurrence, while in 7 cases the tumour had recurred twice. Compared with fibrosarcoma recurrences in rhabdomyosarcoma were few in number. This may be attributed to a more radical operation done in cases of rhabdomyosarcomas, because of the known lethal potentiality of the neoplasm.

*Metastases*: Ten cases (33.3 per cent) showed metastases at the time of admission. Rhabdomyosarcomas generally metastasize to the lungs (Fig. 9, B). In 5 cases roentgenograms showed pulmonary metastases, regional lymph node metastases was found in 4 cases, whereas one case showed widespread subcutaneous metastases.

*Pathologic features*:

(A) *Gross description*: Sixteen specimens were available for detailed examination. The tumour was seen either as a single mass, or as a large mass with several discrete satellite nodules around it (Fig. 10, A). The latter appearance was interpreted by Pack and Eberhart (loc cit) as suggestive of multicentric origin and these authors, on the basis of this observation advocated that radical resection should include the removal of the entire muscle. The tumour masses were either firm or soft to feel. The cut surface was reddish in appearances and scattered areas of haemorrhage and necrosis were frequently seen.

(B) *Microscopic description*: Rakov's[28] classic description of the histological characteristics of rhabdomyosarcoma is very helpful to pathologists in identifying this tumour. These characteristics are: marked pleomorphism, presence of giant cells, presence of longitudinal fibrils and occasional



Fig. 10-C.

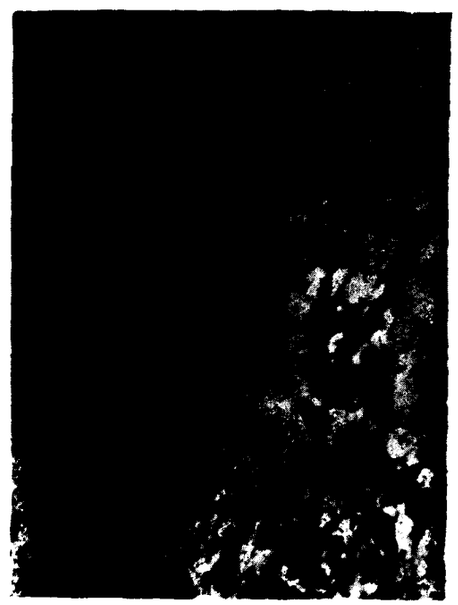


Fig. 10-D.

Fig. 10. Photomicrograph showing racquet and ribbon cells; characteristic of the tumour (C) (H & E stain x 920). Photomicrograph showing the plasmodial-like cell and a giant cell containing 8 to 10 nuclei (D) (H & E stain x 470).

detection of cross striations. Absence of striations however does not rule out a rhabdomyosarcoma. Stout (loc cit) described three types of cells as distinctive of this tumour: cell with granular eosinophilic cytoplasm; round or strap-shaped cells with two or more nuclei; and racquet-shaped cells with a single nucleus. All these structural variations were encountered in the group of rhabdomyosarcomas studied here (Fig. 10, B, C, D).

## 3. LIPOSARCOMA

Stout[35] gave an excellent review of liposarcoma and reported 39 cases seen by him during 37 years. Twenty-three of these were males and 16 females. Sixty per cent of the patients were past 40 years and the average age was 53 years. Thirty-five per cent of the total cases were tumours arising in the thigh, popliteal space and gluteal region. In a recent study of 105 cases of liposarcoma by Pack and Pierson[23] the tumour accounted for 14.6 per cent of all sarcomas of the soft somatic tissues seen at the Memorial Cancer Centre, New York. The lower extremity was the site in 62.7 per cent of the cases. The distribution between the sexes was: males 56.5 per cent and females 43.5 per cent. There were 7 cases (4.8 per cent) of liposarcoma in the present series and the relevant data concerning these is given in Table IV. Six cases were within the ages of 30 and 66 years. There were 6 males and 1 female. Four occurred on the lower extremity and one each on the back, axilla and shoulder. Three cases showed recurrence after operation. Two cases showed metastases in lymph nodes and in 1 there was roentgenologic evidence of pulmonary metastases.

TABLE IV
LIPOSARCOMA

| Serial No. | Case No. | Age (Years) Sex | Location | Duration | Symptoms | Recurrence after operation | Metastasis |
|---|---|---|---|---|---|---|---|
| 1 | 3741 | 20 M | Back | 1 year | Painless swelling Rapidly growing | Once | — |
| 2 | 4004 | 38 M | Right thigh | 5½ years | Painful swelling Rapidly growing | — | Rt. inguinal lymph nodes |
| 3 | 7171 | 30 F | Left axilla extending on to the front of the chest and neck. | 1 year | Painful swelling Slowly growing | — | — |
| 4 | M1718 | 55 M | Left popliteal fossa | 9 months | Painful swelling Slowly growing | Four times | Lt. inguinal lymph nodes |
| 5 | N197 | 48 M | Left shoulder extending lateral to the scapula | 11 years | Painless swelling Rapidly growing | Twice | — |
| 6 | N667 | 66 M | Popliteal fossa | 1 year | Painless swelling Slowly growing | — | Lungs |
| 7 | 298H | 31 M | Left leg (tendo achilles) | 1½ years | Painless swelling Slowly growing | — | — |

*Pathologic features :*

(A) *Gross description* : Four specimens were available for study. The tumours were encapsulated and were firm to feel. The cut surface showed variability in colour : pink, orange and red. The colour was probably because of haemorrhages which were a consistent feature observed in all the 4 specimens. The cut surface had an oily feel and in 2 normal yellow fat was seen interspersed between the tumour tissues (Fig. 11, B).

(B) *Microscopic description* : The microscopic picture of liposarcoma as seen in the present material was of two types : (i) well differentiated, (ii) undifferentiated. The differentiated liposarcoma was characterised by stellate lipoblasts with vacuoles in the cytoplasm (Fig. 11, C). The nuclei were ovoid in shape and pushed to one side, presenting the characteristic signet ring appearance. The undifferentiated liposarcoma showed cells with vacuolated cytoplasm due to the presence of lipoid. The nuclei were hyperchromatic and showed variability in size. These cells resembled the physalliferous cells of a chordoma (Fig. 11, D).

## 4. RETICULUM CELL SARCOMA

This is a rare malignant tumour of the soft tissues. Stout [40] recorded 9 cases of reticulum cell sarcoma of the soft tissues. The salient features of 6 cases of reticulum cell sarcoma encountered in this series are presented in Table V. The roentgenologic examination of the bone in these cases failed to reveal any change, indicating that the tumours were primarily in the soft tissues. There were 4 males and 2 females. All the patients belonged to the age group between 18 to 35. A recurrence of the tumour after removal was observed in 4 cases. One case showed pulmonary metastases.

*Microscopic description* : The microscopic characters in all were essentially similar. The tumour was composed of cells with round, ovoid, indented or lobulated nuclei, without any cytoplasmic outlines. The



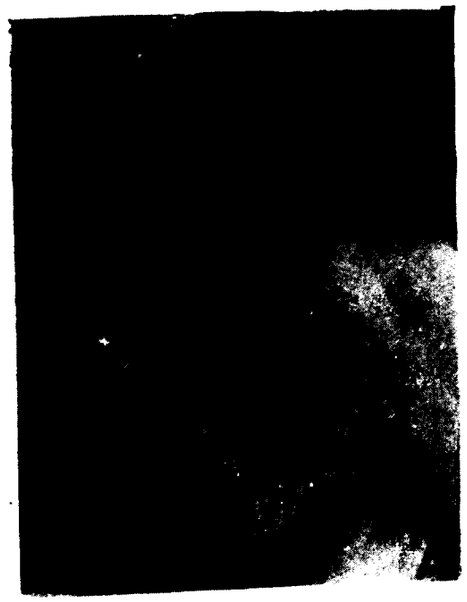


Fig. 11-A.

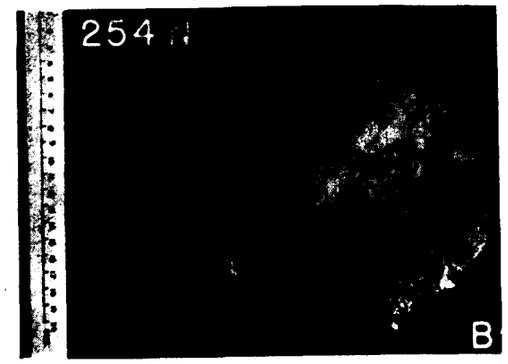



Fig. 11-B.

Fig. 11-C.


Fig. 11-D.

Fig. 11. A Hindu male aged 48 (no. N. 197) Liposarcoma of the left shoulder (A). Gross specimen photograph from the same patient. Note the characteristic lobulated appearance of the tumour (B). Photomicrograph of a well differentiated liposarcoma, showing compressed nuclei with cytoplasmic fat (C) (H & E stain x 100). Photomicrograph of an undifferentiated liposarcoma. A large size bizarre form of lipoblast with vacuolated cytoplasm is seen in the centre of the picture (D) (H & E stain x 470).

TABLE V
RETICULAM CELL SARCOMA

| Serial No. | Case No. | Age (Years) Sex | Location | Duration | Symptoms | Recurrence after operation | Metastasis |
|---|---|---|---|---|---|---|---|
| 1 | H3134 | 35 M | Right upper ⅓rd of the thigh | 2 months | Painless swelling Rapidly growing | Once | — |
| 2 | M2567 | 35 F | Medial aspect of left elbow | 2 years | Painful swelling Slowly growing | Once | — |
| 3 | N1480 | 21 F | Right lower chest wall in front of 7th intercostal space | 8 months | Painful swelling Slowly growing | Once | — |
| 4 | N5516 | 22 M | Left iliac region joint below the crest | — | Painful swelling Slowly growing | — | Lungs |
| 5 | J1678 | 35 M | Left chest wall, axillary region | 3 years | Painless swelling | Once | — |
| 6 | 602H | 18 M | Medial aspect of the left arm | — | Painful swelling Slowly growing | — | — |

TABLE VI
ANGIOSARCOMA

| Serial No. | Case No. | Age (Years) Sex | Location | Duration | Symptoms | Recurrence after operation | Metastasis |
|---|---|---|---|---|---|---|---|
| 1 | 4264 | 11 M | Left upper arm (Posterior surface) | 9 years | Painless swelling Slowly growing | Thrice | — |
| 2 | G1849 | 32 M | Abdominal wall | 4 years | Painless swelling Slowly growing | Twice | Left lung |
| 3 | J1906 | 17 M | Left forearm (Medial aspect) | 6 months | Painless swelling Slowly growing | Once | — |
| 4 | K1318 | 2 M | Gluteal region (left side) | 2 months | Painful swelling Slowly growing | — | Lymph nodes |
| 5 | L928 | 40 M | Back (left side) | 7 months | Painful swelling Slowly growing | Once | — |



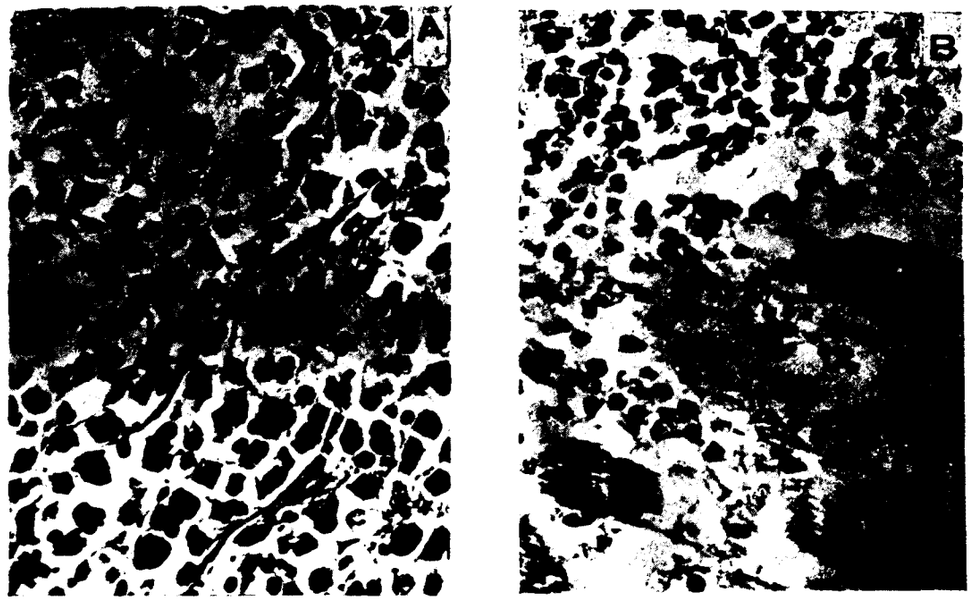


Fig. 12-A. Fig. 12-B.

Fig. 12. Photomicrograph showing clusters of ovoid and reniform cells, separated by thin connective tissue strands (A) (H & E stain x 470). The reticulum is seen as fine net work between the tumour cells (B) (Gomori's silver impregnation x 250).

chromatin material was coarse and a prominent nucleolus was seen, in the nucleus (Fig. 12, A). Infiltration of the tumour cells through the striated muscle bundles was seen (Fig. 12, B). The distribution of reticulum was mostly seen around individual tumour cells (Fig. 12, C).

## 5. ANGIOSARCOMA

Kinkade [10], McCarthy and Pack [14] and Stout [36, 41] have given an excellent account on angiosarcoma. Angiosarcoma is a malignant tumour of blood vessel origin and is a very rare neoplasm. Stout (loc cit) classified the malignant blood vessel tumours into three types: malignant haemangioendothelioma, malignant haemangiopericytoma and Kaposi's disease. The 5 cases in the present series were malignant haemangioendotheliomas. The data concerning these cases are given in Table VI.

*Microscopic description*: All 5 tumours showed essentially an identical histological picture. The most characteristic feature was the presence of capillaries lined by endothelioblasts. The tumour cells were either round or elongated in shape. The chromatin material was scanty. Mitoses were infrequent. Proliferation of endothelial cells and presence of blood capillaries lined by tumour cells characterise the microscopic appearance of a haemangioendothelioma (Fig. 13, B and C).

## 6. SYNOVIAL SARCOMA

Synovial sarcoma is a rare malignant tumour and arises in connection with tendons, tendon sheaths, bursal pouches and

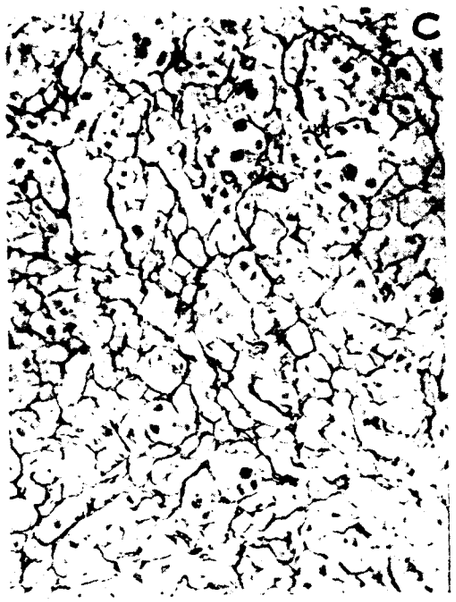



Fig. 12-C.

Fig. 12. Note infiltration of the tumour through the muscle bundles (C) (H & E stain x 470).

Fig. 13-A.

Fig. 13. A boy aged 11 (no. 4264) with a recurrent tumour on the left arm (A).

joint capsules. Comprehensive pathological and clinical accounts of this tumour are obtained from the writings of Bennet[3], Haagensen and Stout[6], and Pack and Ariel[24]. The clinical data concerning 4 cases in this series is given in Table VII. The following case is described in detail as a representative example of this tumour.

*Case report*: A child, aged 15 months (C. 430) had a swelling on the dorsum of the foot of 3 months' duration (Fig. 14, A). There was a palpable lymph node in the left groin, which was removed for examination in an outside hospital; the report was that the biopsy showed a 'sarcoma'. Roentgenogram showed pressure atrophy of the meta-tarsal bones, but there was no indication that the tumour was arising from the bones. Roentgenologic examination of the lungs did not show metastases.

*Gross description*: The specimen consisted of a part of the foot showing the talus, the calcaneous and the metatarsal bones. There were three digits seen including the great toe. The tumour was globular in shape and measured 6 x 6 x 4 cm. It was firm to feel and yellowish in appearance. The cut section presented irregular yellowish striations interspersed with greyish, firm tissue (Fig. 14, B).

*Microscopical description*: The microscopical features of this tumour as well as the other three were identical. The tumour was composed of two different types of tissues: (1) the synovioblastic element was made up of polygonal or cylindrical cells. (2) The other, which insinuated itself between the islets of synovioblastic tissue, was reminicent of fibrosarcoma (Fig. 14, C). These two features which were seen in all the four tumours are essential



Fig. 13-B.


Fig. 13-C.

Fig. 13. Photomicrograph of the tumour from the same patient showing blood capillaries lined by ovoid vesicular cells (endothelioblasts) (B) (H & E stain x 250). High power photomicrograph of haemangioendothelioma showing blood capillaries lined by tumour cells (C) (H & E stain x 470).

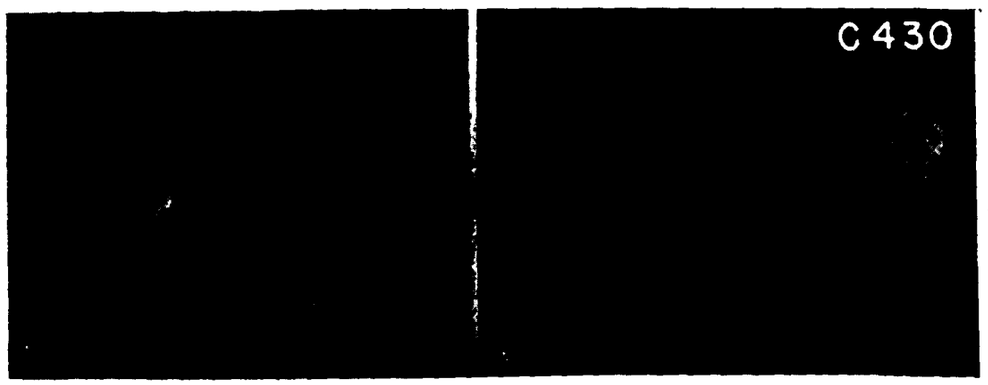



Fig. 14-A.

Fig. 14-B.

Fig. 14. A child aged 15 months (C. 430) with a synovial sarcoma on the dorsum of the left foot (A). (Photograph by courtesy of Dr. D. A. Anderson, Evangelene Booth Hospital, Ahmednagar). Gross specimen showing the globular appearance of the tumour (B).

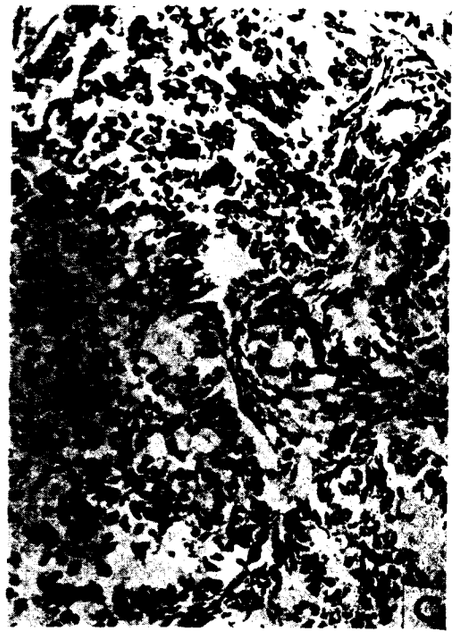


Fig. 14-C.

Fig. 14. Photomicrograph showing gland-like spaces with cylindrical cells (synovioblasts) and fibrosarcoma like tissue in between (C) (H & E stain x 250).

for establishing a diagnosis of synovial sarcoma. Haagensen and Stout, loc cit).

## 7. MYXOSARCOMA

This is a malignant tumour of the primitive mesenchyme. Myxosarcoma is known for local infiltration and recurrences but does not produce distant metastases. It is because of the last feature that Stout [37] has preferred to call these tumours myxomas. Sponsel et al [32] attempted to separate myxoma (benign) from myxosarcoma (malignant) on histological grounds. Because of the rarity of the neoplasm, 3 cases of myxosarcoma encountered in this series are described below.

*Case* 1: A Hindu farmer, aged 46, (no. 4698) was admitted to the Tata Memorial Hospital, Bombay in June 1943, for a swelling of the right thigh of 7 months' duration. There was no history of trauma. A roentgenogram did not show any evidence of involvement of the bone. A biopsy was taken from the tumour mass.

TABLE VII
SYNOVIAL SARCOMA

| Serial No. | Case No. | Age (Years) Sex | Location | Duration | Symptoms | Materials |
|---|---|---|---|---|---|---|
| 1 | 134G | 14 M | Medial aspect right | ? | Painless swelling<br>Slowly growing | Rt. inguinal nodes Lungs<br>- 8 months later |
| 2 | C430 | 1¼ M | Dorsum left foot | 6 months | Painful swelling<br>Rapidly growing | Rt. inguinal nodes |
| 3 | 456L | 26 M | Left lower thigh | ? | Painless swelling<br>Slowly growing | — |
| 4 | 2126M | 12 M | Medial aspect of thigh | 2 years | Slowly growing<br>Painless swelling | — |



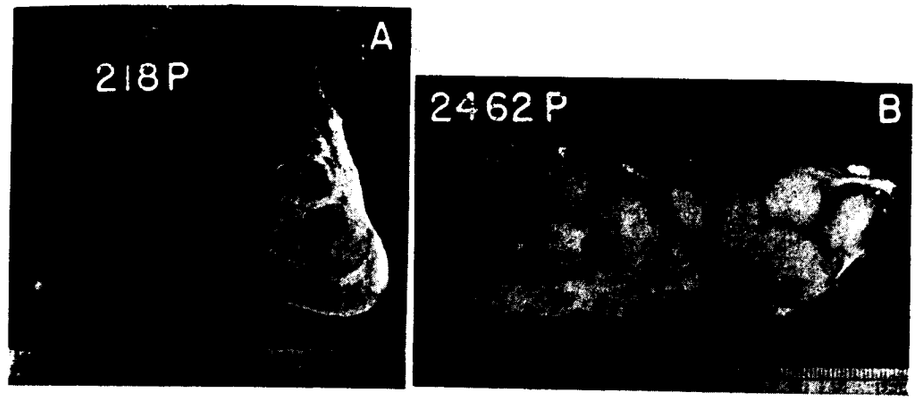



Fig. 15-A. Fig. 15-B.

Fig. 15. Gross specimen of myxosarcoma. An amputated leg. The sagittal section shows a homogeneous tumour on the plantor surface. The skin was not involved (A). Gross specimen of myxosarcoma of the thigh showing lobulated and translucent appearance of the tumour (B).

*Case* 2: A boy, aged 8 years, (no. 3064. N) was admitted in December, 1951, for a swelling of the right great toe. The clinical diagnosis was tubercular dactylitis and the distal phalynx was excised in an outside hospital and reported as 'myxoma'. After the operation there was a persistant sinus for a period of about 3 months. On September 24, 1953, the boy returned for a follow-up and a recurrence of the tumour was noticed. A roentgenogram taken at this time showed destruction of the head of the first metatarsal bone and reactive sclerosis around this area of destruction. A biopsy of the recurred growth revealed microscopical characters of myxosarcoma. On January 30, 1954 amputation of the leg was carried out.

The specimen consisted of an amputated leg. There was a greyish glistening tumour on the plantar surface of the foot superficial to the metatarsal bones. The tumour did not show any connection with either

Fig. 15-C.

Fig. 15. Photomicrograph showing the stellate cells lodged in mucoid matrix (C) (H & E stain x 220).


Fig. 16-A.


Fig. 16-B.

Fig. 16. Photomicrograph of benign granular cell myoblastoma of the tongue. Note the down-growth proliferation of surface epithelium. The tumour fills the subepithelial tissue (A) (H & E stain x 100). High power photomicrograph showing the characteristic cells of the myoblastoma. Note the granularity of the cytoplasm (B) (H & E stain x 920).

the bones or the skin and was situated in the subcutaneous tissue (Fig. 15, A).

*Case* 3 : A male aged 43, (2762. P) complained of a swelling of the lower part of the left leg. The duration was 3 years. Roentgenograms of the bone and the lungs were normal. The tumour was excised.

The specimen measured 10 x 6 x 4 cm. The surface was lobulated and reddish brown in colour. The cut surface had a translucent reddish appearance with scattered areas of haemorrhage (Fig. 15, B).

*Microscopical description* : Sections of all the three tumours showed an identical histological picture. The tumour was composed predominently of stellate cells lodged in a mucoid matrix. The nuclei were ovoid in shape, hyperchromatic and showed variability in size. An occasional mitotic figure could be discerned (Fig. 15, C). The blood capillaries showed an exudate of lymphocytes around them.

## 8. MALIGNANT GRANULAR CELL MYOBLASTOMA

Granular cell myoblastoma is a debatable tumour. Abrikossoff [1], first drew attention to this tumour. Fig. 16, (A and B) illustrates a benign type of granular cell myoblastoma. Willis [44] opined that myoblastomas were not tumours but degenerative or regenerative lesions of muscle fibres whereas Fust and Custer [5] contended that granular cell myoblastomas were tumours of Schwann cells. Stout (loc cit) affirmed that these tumours were myoblastic in origin, because in tissue culture studies by Murray [17] " granular cell myoblastoma cultures bear a greater resemblance to cultures of various forms of skeletal muscles, normal or neoplastic, than to cultures of other tissue types to which their origin has been attributed ". The malignant variety of the tumour is exceedingly rare. Ross, Miller and Foote [29], accepted only 4 previously reported instances of malignant granular cell myoblastoma. Thus with the three cases reported by them, the literature consists of only seven examples of malignant granular cell myoblastomas. In the present series there was only one instance of this tumour.


Fig. 16-C.


Fig. 16-D.

Fig. 16. Photomicrograph of malignant granular cell myoblastoma showing spindle shaped or ovoid cells with granular cytoplasm (C) (H & E stain x 470). Metastasis of the same tumour in the inguinal lymph node showed an identical structure (D) (E & E stain x 250).

*Case report* : A Hindu male, aged 56, (no. N. 1537) was admitted to the Tata Memorial Hospital, Bombay, on April 6, 1953. He gave the following history. About 2 years previously, he had noticed a swelling over the abdomen which extended from the xyphisternum to the umbilicus. He was operated on at an outside city hospital and a firm mass was excised from the anterior abdominal wall. This material was available for study and the histological findings are given later. At the time when the patient was seen at this hospital, there was a palpable lump (enlarged lymph node) in the inguinal region. It was excised and subjected to histology. There was no palpable mass in the region of the previous operation. The follow-up information stated that the patient died at home in November 1953. There was no autopsy.

*Microscopical description* : The sections from the primary tumour (anterior abdominal wall) showed sheets of spindle shaped or ovoid cells with granular cyto-


Fig. 17-A.


Fig. 17-B.

Fig. 17. Photomicrograph of malignant non-chromaffin paraganglioma showing alveolar or organoid arrangement of the tumour (H & E stain x 220). The reticulum stain has brought well the characteristic organoid pattern (B) (Gomori's silver impregnation x 110).

plasm. Nuclei were oval or reniform, with small nucleoli (Fig. 16, C). Metastatic tumour in the inguinal lymph nodes showed an identical structure (Fig. 16, D). The characteristic feature both in the primary and the metastatic tumour was the granular cytoplasm.

## 9. MALIGNANT NONCHROMAFFIN PARAGANGLIOMA

The tumour designated as malignant nonchromaffin paraganglioma of soft tissue has been previously reported in the literature as alveolar soft-part sarcoma, so called granular cell myoblastoma with organoid structure and as granular cell myoblastoma. Recently, Smetana and Scott [31] studied a series of 14 cases of soft tissue tumours with similar behaviour and a peculiar histologic structure. These authors noticed the structural resemblance of these tumours to the carotid body and other glomera and concluded that the type of tumour seen by them originated from paraganglia of the nonchromaffin variety. The case included in this series has already been reported in detail in another communication [30]. The histological appearance of the tumour revealed an organoid or alveolar arrangement of the tumour cells (Fig. 17, A). The tumour cells were either oval or polygonal in shape and the cell outlines were distinct. The cytoplasm was abundant and granular. The nuclei were either round or oval in shape and vesicular. Binucleated cells were seen occasionally. In sections stained with Gomori's silver impregnation method, the septa of reticulum were seen to separate individual alveolar groups very distinctly (Fig. 17, B). The capillaries separating the groups of tumour cells were limited by a single layer of endothelial cells. Some of the capillaries were seen to contain tumour emboli.




Fig. 18-A.

Fig. 18-B.

Fig. 18. Roentgenogram showing bilateral metastases in the lungs of an extraskeletal osteogenic sarcoma, located in the anterior abdominal wall (A). Photomicrograph showing pleomorphic tumour cells with osteoid stroma (B) (H & E stain x 470).

## 10. EXTRA-SKELETAL OSTEOGENIC SARCOMA

Extra-skeletal osteogenic sarcoma and chondrosarcoma, occurring in the soft tissues are very rare. Stout and Verner [38] have reported eight osteogenic sarcomas and five chondrosarcomas of the soft tissues. Extra-skeletal osteogenic sarcoma arising in irradiated tissue and in myositis ossificans has been described by Auerbach et al and Pack and Braund [25]. The following case encountered in this series is reported below.

*Case report*: A Hindu male, aged 62, (no. L. 1890) was admitted to the Tata Memorial Hospital, Bombay, on June 1951, for a swelling on the right lower abdomen. The duration was 2 years. The lump measured approximately 4 x 5 cms., and was situated in the right side of the hypogastric region. It was hard to feel and fixed to the deeper structures. A roentgenogram showed multiple, small discrete opacities scattered over both the lung ficlds (Fig. 18, A). The pelvic bones were normal in appearance. A biopsy from the mass was taken. There is no follow-up.

*Microscopical description*: Microscopical examination showed that the tumour was composed of large atypical spindle shaped cells. A few giant cells were seen. The stroma consisted of osseous and osteoid tissue (Fig. 18, B).

*Comment*: Normally the soft tissues of the human skeleton do not contain either bone or cartilage. Both of these, however, can be found in healing wounds and in myositis ossificans. This would mean that the cells of mesenchymal origin have differentiated as osteoblasts and the malignant tumour arising from these cells would be an osteogenic sarcoma. It is in this way that extra-skeletal osteogenic sarcomas arise.

## GENERAL DISCUSSION

1. *Histogenesis*: Soft tissue sarcomas are malignant tumours of mesenchymal origin. The mesenchyme is typically a loose soft tissue and its cells originate from the middle germ layer. The cells of the mesenchyme possess great potentiality and have a capacity to form different adult types of connective tissue. Maximow's [13] studies indicate the presence of undifferentiated mesenchymal cells in the connective tissues of the adult body. These retain the potencies of embryonic mesenchymal cells and may be capable of differentiating into any of the adult tissues derived from the mesenchyme. Willis (loc cit) has stated "It is quite probable that these cells may be the source of some of the mesenchymal tumours. It will be splitting hairs to debate whether or not these cells or the differentiated cells of the tissues are the usual origin of tumours." The knowledge about the potentiality of the mesenchymal cells and what they can do under various pathological conditions is important to histopathologists and those dealing with these tumours in tissue culture. Thus if one were familiar with their potentialities of growth, accurate classification of soft tissue sarcoma would be possible with sections stained with haematoxylin and eosin stain. This stain however will not do for all occasions and must be supplemented in some cases by differential fibre stains, silver impregnation and stains for special substances like lipoid, elastic tissue and nerve fibres. With the help of tissue culture soft tissue sarcomas with obscure structure have also been elucidated. Reference may be made to in vitro techniques, developed by Murray and Stout [16, 18, 19], Stout and Murray [42, 43] and Pogogeff and Murray [26] of growing tumours of soft tissues in culture media. This has proved an important method in ascertaining the histogenesis of various mesenchymal tumours.

2. *Biological behaviour of soft tissue sarcomas*: Table VIII shows certain aspects of the behaviour of different types of soft tissue sarcomas in the present series. The table shows that in 103 cases followed, despite the high rate of recurrences, the tumour killed the patient in only 29 instances (28.1 per cent), while the recurrence rate was 71 per cent for the entire group of soft tissue sarcomas of the extremities and trunk.

Table IX, compares the behaviour of soft tissue sarcomas in this series with that reported by Stout (loc cit).

It will be seen that in the latter series the death rate was in the vicinity of 30 per cent, on the other hand the recurrence rate was as high as 60 per cent. These figures compare very favourably with those of the present series. The low fatality rate despite the high recurrence rate suggests that with adequate therapy prognosis in soft tissue sarcomas of the extremities and trunk could be improved.

3. *Therapy*: Table X shows the treatment adopted at the Tata Memorial Hospital in dealing with the soft tissue sarcomas of the extremities and trunk.

In 91 cases (62.3 per cent) excision was the primary treatment. Obviously this was inadequate, as is indicated by the high recurrence rate of 71 per cent. A more radical treatment such as amputation or disarticulation of the limbs was carried out in 25 cases (17.1 per cent) which showed several recurrences of previously excised tumours. Radiation alone was given in 6 cases, mainly as a palliative measure for inoperable cases.

It is evident from the foregoing study that the microscopic pattern of soft tissue sarcoma gives an indication of its probable



TABLE VIII

BEHAVIOUR BY HISTOLOGICAL TYPE OF THE SOFT TISSUE SARCOMAS OF THE EXTREMITIES AND TRUNK

| | Total cases | Followed cases | Recurrence | Metastasis | Died of Tumor |
|---|---|---|---|---|---|
| 1. Fibrosarcoma ... | 88 | 64 | 47 (73.9) | 14 (21.9) | 12 (18.8) |
| 2. Rhabdomyosarcoma ... | 30 | 18 | 12 (66.6) | 8 (44.4) | 9 (50.0) |
| 3. Lipogenic sarcoma ... | 7 | 3 | 2 (66.6) | 2 (66.6) | 1 (33.3) |
| 4. Reticulum cell sarcoma ... | 6 | 5 | 4 (80.0) | 1 (20.0) | 0 |
| 5. Angiosarcoma ... | 5 | 5 | 4 (80.0) | 2 (40.0) | 1 (20.0) |
| 6. Synovial sarcoma ... | 4 | 3 | 0 | 2 (66.6) | 3 (100.0) |
| 7. Myxosarcoma ... | 3 | 2 | 2 (100.0) | 0 | 1 (50.0) |
| 8. Malignant granular cell Myoblastoma ... | 1 | 1 | 0 | 1 (100.0) | 1 (100.0) |
| 9. Malignant nonchromaffin Paraganglioma ... | 1 | 1 | 0 | 1 (100.0) | 1 (100.0) |
| 10. Extra skeletal osteogenic Sarcoma ... | 1 | 1 | 0 | 1 (100.0) | 0 |
| Total ... | 146 | 103 | 71 (68.9) | 32 (31.1) | 29 (28.1) |

Figures in parentheses represent percentage of followed cases.

biological evolution. For instance, rhabdomyosarcomas and synovial sarcomas run a rapid course (see table VIII) and even though radical treatment is carried out the ultimate prognosis is poor.

In planning therapy in cases of soft tissue sarcomas, one must begin with a biopsy. This is obligatory in order to plan the correct treatment and the decision as to the extent of surgery must necessarily depend on the histological structure. Stout[39] opined that for soft tissue sarcomas, if cure is the aim, the line of excision must pass at a distance of 3 cm. or more outside the palpable tumour limits at all points. It is beyond the scope of this paper to discuss in detail the treatment followed in cases of soft tissue sarcomas of the extremities and trunk. An excellent outline and discussion on the treatment of soft tissue sarcomas is

TABLE IX

BEHAVIOUR OF SOFT TISSUE SARCOMAS

| | Total Cases | Followed Cases | Recurrence | Metastases | Died of Tumor |
|---|---|---|---|---|---|
| Stout's series (1906-1948) | 432 | 259 | 158 (61) | 59 (22.8) | 79 (30.5) |
| Present series (1941-1954) | 146 | 103 | 71 (68.9) | 32 (31.1) | 29 (28.1) |

Figures in parentheses represent percentages of followed cases.

Stout's series include soft tissue sarcomas from all locations.

TABLE X

TREATMENT ADOPTED AT THE TATA MEMORIAL HOSPITAL, BOMBAY IN 146 CASES OF SOFT TISSUE SARCOMAS OF THE EXTREMITIES AND TRUNK

| Treatment | No. of Cases |
|---|---|
| Excision alone | 72 |
| Excision plus Radiation | 19 |
| Amputation alone | 12 |
| Amputation plus Radiation | 3 |
| Disarticulation of limb | 10 |
| Radiation alone | 6 |
| No treatment* | 24 |

* Twenty-four patients did not come back for treatment after the primary investigation.

given in the writings of Cade [4], Lieberman and Ackerman [12], and Pack et al (loc cit).

## SUMMARY AND CONCLUSIONS

1. Pathological and clinical features of 146 cases of soft tissue sarcomas of the extremities and trunk in Indians are analysed and presented.

2. In the present series fibrosarcoma ranked first in frequency and formed 60.3 per cent of the soft tissue sarcomas. Seventy-five per cent of fibrosarcomas in this series occurred in patients between the ages of 30 and 50 years. The average age was 38.8 years. Fibrosarcoma most frequently occurred in the lower extremity, and the thigh was the most frequent site. Metastases in fibrosarcoma were observed in 21.9 per cent of cases. Local recurrences were observed in 73.9 per cent. The high recurrences in the entire series (68.9 per cent) is attributed to inadequate initial surgical treatment.

3. Rhabdomyosarcomas of skeletal muscles, formed 20.5 per cent of soft tissue sarcomas of the extremities and trunk. The tumour was predominantly seen between the ages of 41 and 50 years. Like fibrosarcoma, rhabdomyosarcoma showed a definite predilection for the lower extremity, and thigh muscles were involved most frequently (30 per cent).

4. Microscopical structure gives an important clue as to the probable behaviour of soft tissue sarcomas. By and large rhabdomyosarcomas and synovial sarcomas have a poor prognosis. Undifferentiated sracomas have a rapid clinical course. In these pulmonary metastases are early and the tumour invariably kills the patient.

5. The clinical data concerning lipogenic sarcoma, reticulum cell sarcoma, angio-sarcoma and synovial sarcoma, encountered in this series, are summarised in tabulated forms.

6. Amongst the rare groups of soft tissue sarcomas of the extremities were myxosarcoma, malignant granular cell myoblastoma, malignant non-chromaffin paraganglioma and extraskeletal osteogenic sarcoma. Owing to the rarity of reports of these tumours in the literature, case histories of those encountered in this series are given.

7. Incisional biopsy, prior to institution of specific therapy, is obligatory, as it helps in planning accurate treatment. In a soft tissue sarcoma the line of surgical excision must pass at least 3 centimeters outside the palpable tumour limits at all points.



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# HISTOCHEMICAL DETECTION OF ALKALINE AND ACID PHOSPHATASE ACTIVITY IN NORMAL AND PATHOLOGICAL PROSTATES AS AN AID IN THE DIAGNOSIS

*by D. K. SEN, Calcutta.*

## Introduction

Researches on cancer problem are being continually appreciated in modern times with the increasing realisation of the virulence of the disease. The problem at present is attacked from different aspects and the synthesis of data has become necessary from the fields of Physiology, Cytology and Pathology for proper understanding of the subject. Vigorous researches are at present being carried out in a number of schools, and the publications of voluminous books (vide Homburger and Fishman, 1952) bear testimony to the wealth of data accumulated.

Of the different modes of attack involving this aspect of study, irradiation method, use of radio-active isotopes as well as histochemical, cytochemical and biochemical approaches need mention. It has rightly been pointed out by Gomori (1952) that 'the resolving power of histo-chemical methods, as a rule, is far superior to those used in biochemistry.'

Through biochemical researches, the activity of the enzyme phosphatases both acid and alkaline, have been detected in the serum and their increase has been recorded in osteoplastic bone diseases and in secondary metastases of the osteoplastic type in bones (Kay, 1930; Gutman and Gutman, 1938). As the Gomori method (Gomori, 1939, 1941, 1946, 1949) is considered a reliable means of detection of enzyme activity, this has been widely applied in such researches.

A search in the literature reveals that though so much of progress has been made on the application of this technique in determining the enzyme content of the serum, data regarding the degree of enzyme action is lacking, specially in the carcinomatous prostatic tissue.

As this aspect of study has been found to be quite promising, it was thought that a comparative study of enzyme action in normal, cancerous prostatic tissue, as well as in simple hypertrophy of the prostate might yield fruitful result. It was further hoped that the investigation might reveal some new means for the diagnosis of cancer through detection of enzyme activity. With this end in view the present investigation was undertaken. The text would reveal that promising data have been accumulated showing the possibility of this aspect of study, specially with alkaline phosphatase, in detecting cancer even at an initiation stage.

## Materials

The present investigation deals with the phosphatase activity, both acid and alkaline in the prostate glands of human beings. In all, twelve prostates have been examined. Out of these twelve cases, ten are pathological prostates and two are normal.

These ten patients with obvious disease of the prostate were treated in the surgical wards of the N. R. Sircar Medical College Hospital and in the surgical wards of the R. G. Kar Medical College Hospital during the period of ten months, between June, 1954 and March, 1955.

The specimens were collected after removal of the glands by operation. The age of the patients ranged between 55 and 75 years. Eight of them were admitted to the hospital with complete retention of urine and two with symptoms of frequency and intermittent retention on straining. The report on examination of blood, blood chemistry, urine, etc. are not mentioned here as those will be irrelevant in this paper. The specimens were examined macroscopically, as well as micro-

scopically (sections stained with Haematoxylin and Eosin) to determine the character of the tumours. On such examination it was found out that swo specimens exhibited carcinomatous changes and the rest showed evidence of benign pathological conditions of the prostate. Subsequent to this operation the phosphatase activity, both acid and alkaline were determined in each case.

Two normal prostates were kept as control. These prostate glands were collected from the Calcutta Police Morgue from normal persons who died immediately after accidents. One was 35 years and the other was 65 years old. In both the cases the prostate glands were normal as proved by macroscopical and microscopical examinations. The tissue in each case was also examined after staining with Haematoxylin and Eosin and subsequent to this both acid and alkaline phosphatase activities were determined.

The case histories are mentioned below briefly :—

(A) Sekh Arman, age—64 years. Muslim.

Date of operation : 9-6-54. Prostatectomy.

Macroscopical appearance : Prostate enlarged and was of the size of a small orange — simple hypertrophy of the prostate.

(B) Kunja Behari Sorkar, age — 56 years. Hindu.

Date of operation : 6-9-54. Prostatectomy.

Macroscopical appearance : gland slightly enlarged and very hard in places — carcinoma of the prostate.

(C) S. Bose, age — 59 years. Hindu.

Date of operation : 12-11-54. Prostatectomy.

Macroscopical appearance : simple hypertrophy of the prostate.

(D) Laburam, age — 60 years. Hindu.

Date of operation : 13-11-54. Prostatectomy.

Macroscopical appearance : simple hypertrophy of the prostate.

(E) Azman Ali, age — 60 years. Muslim.

Date of operation : 25-11-54. Prostatectomy.

Macroscopical appearance : small fibrous prostate with enlargement of the middle lobe.

(F) Banamali Acharya, age — 65 years. Hindu.

Date of operation : 29-11-54. Prostatectomy.

Macroscopical appearance : gland normal in size. The middle lobe is enlarged and hard.

(G) Panch Gouri Roy, age — 65 years. Hindu.

Date of operation : 7-12-54. Prostatectomy.

Macroscopical appearance : simple hypertrophy of the prostate.

(H) Basanta Kumar Roy, age — 55 years. Hindu.

Date of operation : 28-12-54. Prostatectomy.

Macroscopical appearance : simple hypertrophy of the prostate.

(I) Sekh Kurban, age — 35 years. Muslim.

Suicidal death by hanging on 10-2-55.

Macroscopical appearance of the prostate is normal.

(J) Abdul Kader, age — 60 years. Muslim.

Date of operation : 19-2-55. Prostatectomy.

Macroscopical appearance : simple hypertrophy of the prostate.



(K) Sashi Pandit, age — 75 years. Hindu.

Date of operation : 2-3-55. Prostatectomy.

Macroscopical appearance : simple hypertrophy of the prostate.

(L) Motilal Sorkar, age — 65 years. Hindu.

Suicidal death by opium poisoning on 3-3-55.

Macroscopical appearance of the prostate : normal.

## Methods

The prostates after removal were immediately fixed in a number of fixing fluids meant for the purpose. While selecting fixatives full attention was paid towards the choice of those chemicals having an established capacity of preserving the nuclear and cytoplasmic structures unchanged. It is well known that picric acid, formalin and acetic acid are all endowed with the same capacity. Nevertheless, the fact had also to be taken into account as to whether these chemicals had any inhibitory effect on the activity of the enzyme to be tested.

In this connection it is worthwhile to point out that chilled 80% alcohol has been recommended (vide Glick) as the fixative for the study of phosphatases. Fortunately however, a series of fixing chemicals involving both metallic and non-metallic salts have been tried in the Cytogenetics Laboratory of the University of Calcutta, where the suitabilities of each of the fixing agents in the study of phosphatases have been pointed out (Sharma and Roy, 1955). It has been noted that picric acid, formalin or acetic acid do not in any way interfere with the activity of these important enzymes of every organisms. With these results in view, a number of fixing chemicals were therefore, safely tried for the purpose of fixation.

The fixatives employed or more precisely involved in such attempts are the following :—

(1) Bouin's fluid :

Picric acid — 75 parts (saturated aquous solution)

Formalin — 25 parts

Clacial acetic acid — 5 parts

The formo-acetic solution and the solution of picric acid had to be kept separate and mixed just before use. Fixation in Bouin's fluid had to be performed for 12 hours before washing in water.

(2) 10% formalin for over night before subsequent washing in water for 4 hours.

(3) Acetic-alcohol for overnight before subsequent transference to 70% alcohol. This fixative consists of one part of glacial acetic acid and one part of absolute alcohol.

(4) Susa mixture of Heidenhein :

Sublimate — 4.5 G.
Common salt — .5 G.
Distilled water — 80 c.c.
Trichloracetic acid — 2 G.
Acetic acid — 4 c.c.
Formol — 20 c.c.

Fixation had to be performed for 24 hours before subsequent transference to 90% alcohol.

It is to be noted that trichloracetic acid forms a component of the recommended mixture. Recently the property of this acid of removing the nuclic acid from the nucleus has been demonstrated by a number of workers (Schneider, 1945 ; Sharma and Bhattacharya, 1952). Nucleus being a well known reservoir of phosphatase thus becomes to some extent artificially altered following this fixation — an alteration obviously disadvantageous for an accurate study of this enzyme activity. However, at the same time it should not escape one's notice that the demonstration of the property of the nucleic acid removal has been made through treatment in hot trichloracetic acid. The application of the same salt in cold temperature may not therefore cause any alteration in the nuclear consti-

tuent; but to be absolutely safe, the mixture had to be employed with certain reservations. An interpretation of the results noted following fixation in Susa fluid, always involved consideration of this specialized property of trichloracetic acid. The activity of enzyme could not be obtained in a sufficient degree which in the opinion of the author is possibly due to the removal of some amount of the nucleic acid from the tissue. In any case unless the capacity of nucleic acid removal through the application of the cold acid is demonstrated, it is better to reserve one's opinion regarding this issue. However, for the sake of obtaining tissues showing unquestionable phosphatase activity, and for a critical interpretation of the results, Susa fixed materials were therefore not included within the scope of the observation.

(5) Navashin's fluid (Belling's modification):—

Solution — A.

Chromic acid crystals — 5 G.
Clacial acetic acid — 50 c.c.
Distilled water — 320 c.c.

Solution — B.

Commercial formalin — 100 c.c.
Distilled water — 275 c.c.

The two mixtures are to be kept separate and mixed just before use. Fixation had to be performed overnight before subsequent washing in water overnight.

After a series of trials in all these fluids the best results were obtained following fixation in Bouin's fluid.

In all such cases dehydration through different grades of alcohol (e.g. 30%, 50%, 70%, 80%, 90%, 95% and absolute) were performed as usual keeping in each alcohol grades for 2 hours and in 70% and absolute alcohol overnight. The next usual step involved changes in alcohol-chloroform grades (3:1, 1:1, 1:3 and pure chloroform) keeping in each for 2 hours before infiltration in paraffin wax. In order to obtain perfect saturation with paraffin the tissues were kept in chloroform-paraffin mixture over the hot plate (at 35°C to 40°C) for at least 48 hours till a Scum of paraffin was found to remain over the fluid indicating super-saturation. Chloroform was used mainly because of the fact that this chemical has no injurious effect on phosphatases, both acid and alkaline (vide Glick).

After preparation of the paraffin blocks sections were cut (12 u in thickness) in a rotary microtome.

Removal of paraffin in the Xylol grades was done as usual and the slides containing the sections were brought down to water through usual down alcohol grades. The slides at this stage were ready for subsequent operations.

For a comparison of the representation of the tissue structures in both stained as well as incubated slides for phosphatase activation, haematoxylin and eosin staining was performed of each and every tissue. The purpose of this staining moreover was to determine the exact underlying pathological condition of the tissue concerned. For haematoxylin and eosin staining the usual schedule of Nickson was followed.

For the demonstration of the phosphatase activity of each and every tissue, tests for both acid and alkaline phosphatases were applied.

(A) Methods for the study of the alkaline phosphatase:—

Normal schedule as suggested by Gomori (1939) and Takamatsu (1939) as well as a number of its modifications were followed.

The usual incubation substrate, viz. Sodium-glycero-phosphate was substituted by a number of other phosphates, viz. Sodium-di-hydrogen phosphate, Potassium-di-hydrogen phosphate, etc. A comparison of the different sections revealed best preparations in Sodium-glycero-phosphate medium and as such this was kept in the standard solution. Potassium-di-hydrogen phosphate yielded to some extent comparable results.



In order to note whether the addition of magnesium is of absolute necessity for the preparation, materials were incubated in mixtures, both with and without magnesium. It is interesting to note that no difference could be noted confirming the report of Sharma et al (1953) on plant tissues. This is in contradiction to the report of Ross and Ely (1951) who claimed absolute disappearance of activity in the absence of magnesium.

The addition of chloroform however has been found to be fully necessary for the preparations of materials showing phosphatase activity.

The period of incubation was varied from 4 to 48 hours, best results being noted in 24 hours of treatment. The incubation mixture as recommended by Gomori and employed in the present investigation is constituted as follows:—

Sodium-glycero-phosphate (2% solution) — 25 c.c.
Sodium barbitol (2% solution) — 25 c.c.
Distilled water — 50 c.c.
Calcium chloride (2% solution) — 5 c.c.
Magnesium sulphate (2% solution) — 2 c.c.
Chloroform — a few drops.

The pH of the mixture was kept at 9.4 and the incubation was carried out strictly at 37°C. For prolonged incubation fresh mixtures were used at regular intervals. The materials were treated in citrate buffer to remove preformed calcium salts before incubation.

As recommended by Gomori the materials were rinsed in water and dipped subsequently in Cobalt chloride solution. Best result was however obtained by keeping the slides in the cobalt chloride solution for 15 minutes at 60°C. As usual the subsequent operations involving ammonium sulphide treatment, dehydration through alcohol grades, cleaning in xylol were followed before mounting in balsam. As the specificity of the technique in the localization of the alkaline phosphatase activity has recently been questioned by Novikoff a number of control methods were applied to test the specificity of the technique.

It is well known that the enzymes are generally killed by treatment in boiling water. Series of materials were first treated in boiling water and then incubated in the mixture. No precipitation could be obtained in such materials indicating the absence of precipitation as due to the killing of the enzymes concerned. This has been considered a proof that the formation of the calcium phosphate is not due to any other process but due to the activity of the enzymes concerned.

Another set of control involving incubation in room temperature was also followed. Here too, as expected no precipitate was formed due to the lack of the optimum temperature (37°C) necessary for enzyme activation. It is apparent that this is also clear evidence of the process being fully controlled by the enzymes present in the tissue.

In addition to the killing of the enzymes in boiling water a number of other chemical killers, e.g. Potassium cyanide, etc. were added in incubation mixtures and the results were subsequently observed. In such cases too, no activity could be recorded.

The question of non-specific absorption has recently been raised by Novikoff (1952). In order to have understanding of this issue, hydrogen peroxide was added to one set of incubation mixture. Materials before incubation were also treated in boiling water for inactivation of the enzymes concerned. In such cases no precipitation at specific areas could be recorded contrary to the findings of Novikoff.

All these control experiments obviously reveal that the test is specific for the demonstration of the alkaline phosphatase activity. In view of these results and only after a check of all the variables, interpretation of the materials showing phosphatase activity was made. As far as the author is aware, he has kept all the con-

trols necessary for the purpose as all the control sets indicated the specificity of the technique with a high degree of accuracy. The investigation was continued and the results interpreted with some amount of confidence.

(B) Methods for the detection of the acid phosphatase activity :—

With a view to obtain best possible reproducible results for the demonstration of activity of this particular enzyme, both the original method as suggested by Gomori as well as the same modified by Glick and Fisher were tried. A comparison of the data obtained after incubation in both the mixtures definitely indicates that so far as the prostatic tissue is concerned the latter method is best suited for the purpose. This was the reason why incubation in this mixture was followed in the present investigation. The formulae of the two incubation mixtures are as follows :—

(i) Gomori's original mixture (pH 5) :—
1 M Acetate buffer — 30 c.c.
Nitrate of lead (5%) — 10 c.c.
Distilled water — 60 c.c.
Sodium-glycero-phosphate (2%) — 30 c.c.

The mixture was shaken thoroughly, allowed to stand for a few hours, filtered and diluted with 2 to 3 parts of water.

(ii) Glick and Fisher's modification of Gomori's mixtures :—
1 M Acetate buffer — 4 c.c.
1 M Lead nitrate — 1 c.c.
Distilled water — 6 c.c.
Sodium-glycero-phosphate (3.2%) — 4 c.c.

The mixture was shaken thoroughly, centrifuged and the supernatant clear fluid was taken.

Caution was taken to keep the pH of the mixture strictly at 5.4. Here too the incubation was continued for 4 to 48 hours in different sets and the best results were obtained in 18 hours' incubation. Similar procedures involving cobalt chloride and ammonium sulphide applications were followed as recommended by its proponents.

Observations were made in a Zeiss microscope using an oil immersion lens (1.3NA) and an aplanatic condenser (1.4NA) and compensating eye pieces x 10 and x 20.

Photomicrographs are taken at a magnification of x 200 approximately.

## Observations

Material — A :

Material stained with haematoxylin and eosin shows this to be a case of benign hypertrophy of the prostate (Fig. 1).

Alkaline phosphatase activity : (Fig. 2). The most interesting feature of the section is a very high phosphatase activity throughout the glandular epithelium and the fibro-muscular tissue. Comparatively, the glandular epithelium shows a much higher activity than the fibro-muscular tissue. Within the glandular epithelium the activity is not uniform throughout but in certain places it shows higher activity than the rest of the glandular epithelium. Again, the epithelial cells lying near the basement membrane of the glands show a higher activity than those lining the lumen of the glands. The nuclei of the glandular epithelium are readily distinguished from the cytoplasm of the cells as they show higher activity than their cytoplasm. In most of the cases the nucleoli can be distinguished.

The activity in the fibro-muscular tissue is uniform throughout. The nuclei of the muscle fibres can be differentiated easily as they show higher activity in the nuclear wall than in the cytoplasm. The nucleoplasm however, shows much less activity. The nucleoli could be seen only on rare occasions.

Acid phosphatase activity : (Fig. 3). The activity is more or less uniform in the glandular epithelium and slightly higher in the fibro-muscular tissue. The cytoplasm of the epithelial cells is uniformly active throughout. Their nuclei can be easily seen due to a difference in precipitation.



Fig. 1.
Haematoxylin and eosin.

Fig. 2.
Alkaline phosphatase activity.

Fig. 3.
Acid phosphatase activity.

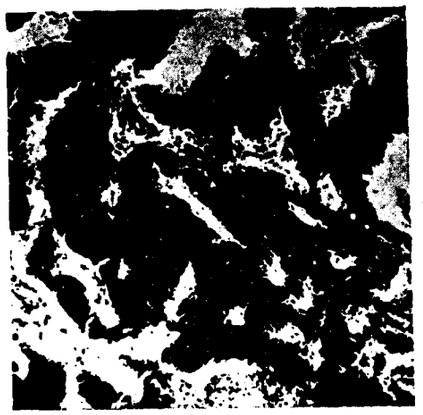

Fig. 4.
Haematoxylin and eosin.

The nucleoli can be differentiated with difficulty. In places the glandular epithelium shows higher activity than the rest of the tissue.

In the fibro-muscular tissue activity is present throughout and in places thick dark bands showing higher phosphatase activity could be seen. These dark bands run in a longitudinal direction and are along the direction of the fibro-muscular tissue. The nuclei are sharp and well defined and in places nucleoli can be differentiated.

Material — B :

Material stained with haematoxylin and eosin indicates the case to be of an adenocarcinoma of the prostate (Fig. 4).

Alkaline phosphatase activity : (Fig. 5). As will be noted in material F, the characteristic phosphatase activity of the carcinomatous tissue is apparent here too. The

Fig. 5.
Alkaline phosphatase activity.

Fig. 6.
Acid phosphatase activity.

Fig. 7.
Haematoxylin and eosin.

Fig. 8.
Alkaline phosphatase activity.

entire tissue including the glands as well as the fibro-muscular tissue shows moderate phosphatase content and no distinction between the two can be obtained as far as precipitation is concerned. In certain regions nuclei in the glandular epithelium can be differentiated from the cytoplasm but no distinction of the different nuclear parts is evident.

In the fibro-muscular tissue nothing characteristic can be mentioned and the activity is same as in the glands. Both nuclei and the cytoplasm are active and in rare cases nuclei can be differentiated from the cytoplasm.

Acid phosphatase activity: (Fig. 6). More or less similar to the picture obtained following alkaline phosphatase test, here also the precipitation is practically homogeneous in the glands as well as in the muscles. The term *homogeneous* has been used here to indicate similar degree of



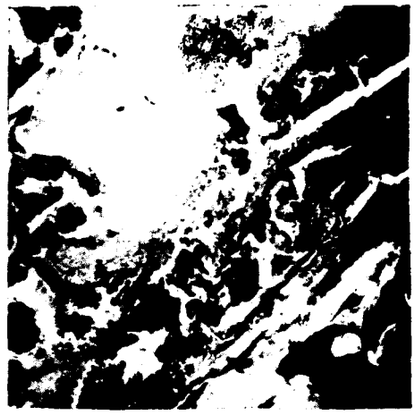

Fig. 9.
Acid phosphatase activity.

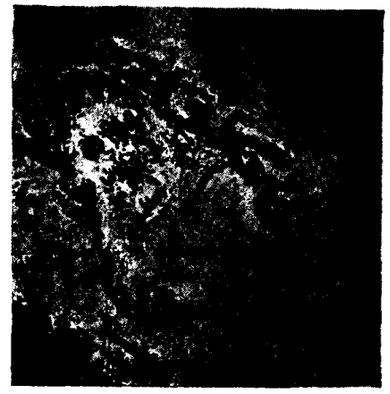

Fig. 10.
Haematoxylin and eosin.

precipitation in both types of tissues. Further, within the glands the activity is practically similar throughout all the cells, and nuclei can be distinguished from the cytoplasm only in certain cases. This distinction does not necessarily signify that the activity in the two is markedly different. Inspite of more or less same precipitation in both, the distinction is possible because of their gross difference in structural pattern.

Similar to the glands, in the fibro-muscular tissue the activity is uniform throughout. Nuclei however, in certain cases can be distinguished from the plasmatic mass because of the structural difference aforesaid.

Material — C :

Material stained with haematoxylin and eosin shows this to be a case of benign hypertrophy of the prostate (Fig. 7).

Alkaline phosphatase activity: (Fig. 8). In the tissue the activity is comparatively higher in the glands than in the fibro-muscular tissue. Curiously however, certain regions of the glands show more phosphatase content than other regions. Nucleus is differentiable and distinctly higher in phosphatase content than in the cytoplasm. Nucleolus is sharply positive and the nucleolar matter too is not insignificant.

In the fibro-muscular tissue the precipitation is not uniform and breaks are often found in certain regions. Nuclei are differentiable from the cytoplasm but the whole nuclear matter seems to show a uniform precipitation. The activity is less than that in the glands.

Acid phosphatase activity: (Fig. 9). The picture of the acid phosphatase activity as represented in the material reveals a number of interesting features. The precipitation offers a sharp contrast between that of the glands and the muscles. It is much higher in the glands as compared to that of the muscles. This appearance is lacking in the parallel slides incubated for the demonstration of alkaline phosphatase activity. In the glandular epithelium the nucleus as well as the nucleolus is sharp and the cytoplasm too shows quite a high amount of precipitation though less than that in the nucleus.

The fibro-muscular tissue as pointed out above is low in phosphatase content. The nucleus, in certain cases can be distinguish-

Fig. 11.
Alkaline phosphatase activity.

Fig. 12.
Acid phosphatase activity.

ed and both the cytoplasm and the nuclear structures show a faint reaction.

Material — D :

Material stained with haematoxylin and eosin shows this to be a case of benign hypertrophy of the prostate (Fig. 10).

Alkaline phosphate activity : (Fig. 11). The remarkable feature of the slide is comparatively more precipitation in the glandular epithelium than that of the fibro-muscular tissue. A constancy in the degree of activity in the different parts of the glandular epithelium is observable, specially in the cells lining the lumen, being present even at the contours of the lining epithelium. The nuclei of the lining cells are quite prominent showing high phosphatase activity, cytoplasm on the contrary indicating a comparatively negative result. Nuclear membrane too is highly positive. In addition to this specks of phosphatase positive substances are present in the cytoplasm. The distinction between intranucleolar matter and the perinucleolar zone is sharp due to the positive activity in the former and negative in the latter.

The fibro-muscular tissue shows activity to a lesser extent as compared to that of the glands, and the precipitation is not uniform throughout. But in this case too the nucleus shows a brightly positive nucleolus in its body.

Acid phosphatase activity : (Fig. 12). The tissue is characterized by having a precipitation more or less homogeneous in nature. The phosphatase activity of course is more in the glandular epithelium than in the fibro-muscular tissue. A diffuse appearance can be recorded throughout the glandular epithelium where the differentiation is not so sharp as in that of alkaline phosphatase. Here a uniform precipitation in the gland cells covering even the contours lining the lumen can be observed. The presence of differentiation in the different parts of the cells in the case of alkaline phosphatase activity and a comparative absence of the same in the acid phosphatase activity is accountable practically to the uniform activity in both nuclear and the cytoplasmic structures in the latter.

The fibro-muscular tissue however presents a strong contrast with the picture presented in parallel slides for a test of alkaline phosphatase activity. Though, in both, the fibro-muscular tissue is less positive than that of the glands in the present



Fig. 13.
Haematoxylin and eosin.

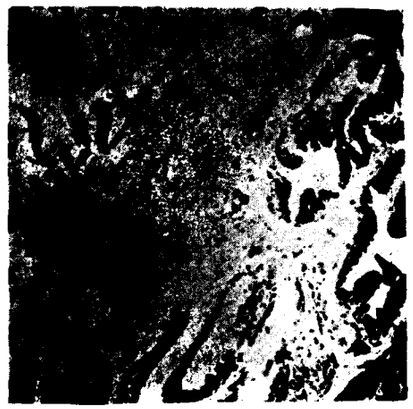

Fig. 14.
Alkaline phosphatase activity.

case the degree of difference is remarkable. Practically speaking, the fibro-muscular tissues are negative in enzyme content having occasional positive areas along their length. Nuclei within the muscle fibres cannot be differentiated.

Material — E :

Material stained with haematoxylin and eosin shows this to be a case of prostatic fibrosis (Fig. 13).

Alkaline phosphatase activity : (Fig. 14). In this case too as in the previous slide the activity in the glandular epithelium is more than in the fibro-muscular tissue, the activity of the latter however being in no way negligible. Within the glandular epithelium lining the lumen, the nucleus, nucleolus and the cytoplasm can be easily differentiated. Nuclei show better precipitation than the cytoplasm. Intranucleolar matter can be easily distinguished from the hyaline perinucleolar zone. In general, precipitation is quite uniform in all the glandular epithelial cells covering even the contours of the lumen.

The fibro-muscular tissues however are not uniform in their enzyme content along the entire length. Nuclei can be distinguished with slight differentiation of their parts.

Acid phosphatase activity : (Fig. 15). The precipitation in the glandular epithelium is more than in that in the fibro-muscular tissue. Inspite of a homogeneous precipitation in all the epithelial cells of the glands, nucleus, nucleolus and the cytoplasm can be differentiated. The activity in the nucleus is high as compared to that of the cytoplasm. In addition to the nucleus other phosphatase positive specks are present in the cytoplasm.

Not only the enzyme content is markedly less in the fibro-muscular tissue but at the same time a heterogeneity in the distributional pattern is to be noted. Some of the regions in the fibro-muscular tissue are faintly positive while other regions show a negative behaviour. Nucleus, only in rare cases can be distinguished. The most important point is, that there is no regularity in the distributional pattern of the enzymes in the fibro-muscular tissue.

Material — F :

Material stained with haematoxylin and eosin shows this to be a case of adeno-carcinoma of the prostate (Fig. 16).

Fig. 15.
Acid phosphatase activity.

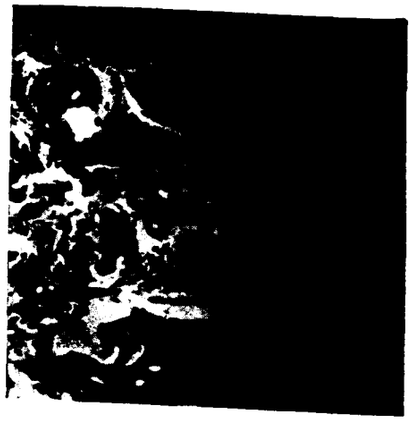

Fig. 16.
Haematoxylin and eosin.

Fig. 17.
Alkaline phosphatase activity.

Fig. 18.
Acid phosphatase activity.

Alkaline phosphatase activity : (Fig. 17). The outstanding feature in the section is the absence of any differential precipitation in the fibro-muscular tissue as well as in the glandular epithelium. It may be noted that in the case of benign pathological conditions of the prostate, activity is found to be very high in the glands and low in the muscles. That differential pattern as seen here is lost in cases of adeno-carcinoma. Further in the glandular epithelium no distinction can be made, at least in most cases, between the different cellular parts, i.e. the nucleus, nucleolus and the cytoplasm. In rare cases where the nucleus can at least be differentiated from the cytoplasm, there is no differential precipitation in various parts of the nucleus thus presenting a homogeneous picture.

About the fibro-muscular tissue the only fact that can be stated with certainty is a uniform precipitation just like that of the glands throughout their entire mass. No distinction into cellular parts is visible.



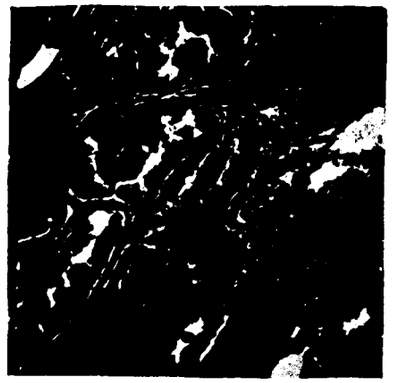

Fig. 19.
Haematoxylin and eosin.

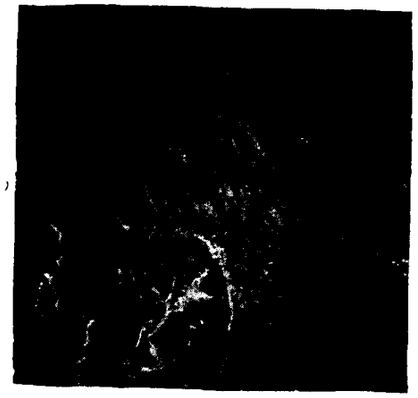

Fig. 20.
Alkaline phosphatase activity.

Acid phosphatase activity : (Fig. 18). The enzyme activity in the glandular epithelium shows practically no difference from that of the fibro-muscular tissue. This is a feature which finds strong contrast from that of cases of benign conditions. No doubt that the nucleus can be differentiated from the cytoplasm but that too only under dark field illumination indicating that it is not of much importance. The activity is homogeneous throughout all cellular parts.

Similar facts may be pointed out about the fibro-muscular tissue where the distributional pattern of the enzyme on the basis of precipitation is absolutely lost. No distinction can be noted in the enzyme content of different regions being a contrasting feature with that of the benign conditions of the prostate.

Material — G :

Material stained with haematoxylin and eosin shows this to be a case of benign hypertrophy of the prostate (Fig. 19).

Alkaline phosphatase activity : (Fig. 20). Normal phosphatase activity both in the glandular epithelium and in the fibro-muscular tissue is quite prominent. In the epithelial cells of the glands (practically in all the cells) the activity is more or less uniform with differentiation of cellular parts. Nucleolus can be differentiated within the nucleus in the epithelial cells of the glands. The activity in the nucleus is higher than that in the cytoplasm. Occasionally some of the nuclei show comparatively higher activity than the others. Though nuclei of different sizes are present no distinction in general can be recorded in the activity in the small and the large nuclei.

In the fibro-muscular tissue too clear differentiation of the nuclear and plasmatic activity is evident. Similar to the glandular epithelium here too more precipitation could be noted in the nucleus than in the cytoplasm.

Acid phosphatase activity: (Fig. 21) The tissue in the slide is characterised in having a faint precipitation practically throughout the tissue. Glandular epithelial cells are comparatively higher in phosphatase content than the fibro-muscular tissue. Only on careful study, the nucleus can be distinguished from the cytoplasm. The nucleolus within the nucleus shown more preci-

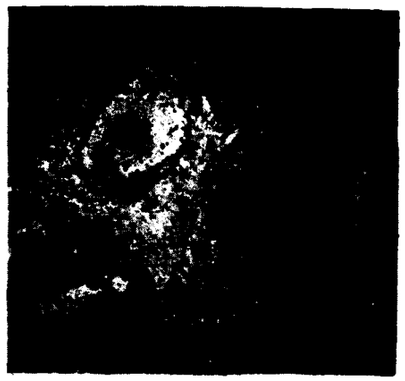

Fig. 21.
Acid phosphatase activity.

Fig. 22.
Haematoxylin and eosin.

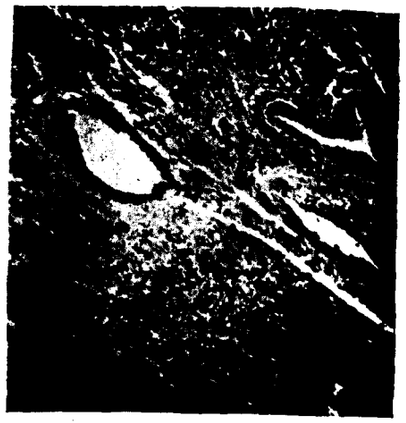

Fig. 23.
Alkaline phosphatase activity.

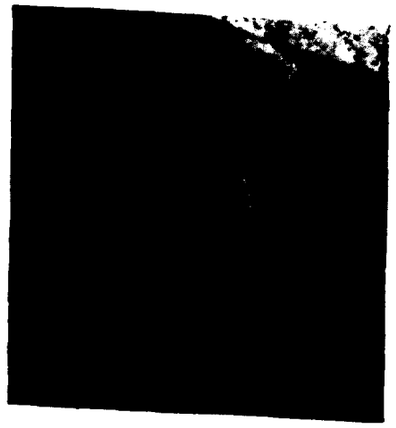

Fig. 24.
Acid phosphatase activity.

pitation than the other nuclear parts. The activity throughout the epithelial cells of the glands is more or less uniform in all the cells and no distinction can be recorded between the cells lining the lumen and those of the interior. In general the phosphatase activity is low as compared to that of the alkaline type.

In the fibro-muscular tissue, the reaction as pointed out earlier, is less as compared to that of the glandular epithelium. Only in rare cases the nuclei can be differentiated from the surrounding cellular structures. Uniform precipitation in the fibro-muscular tissue is present, covering the cells lining the glands as well as those away from the same.

Material — H :

Material stained with haematoxylin and eosin shows this to be a case of benign hypertrophy of the prostate (Fig. 22).



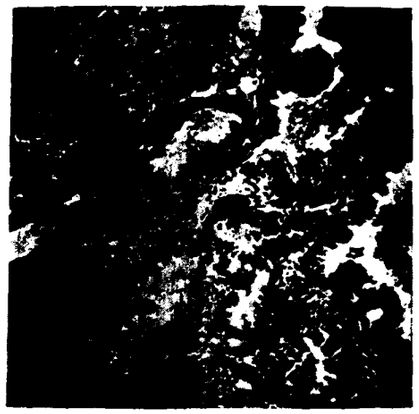

Fig. 25.
Haematoxylin and eosin.

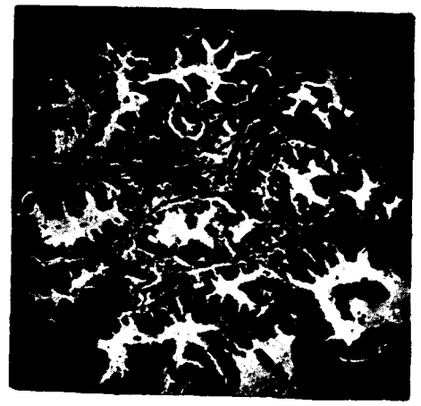

Fig. 26.
Alkaline phosphatase activity.

Alkaline phosphatase activity : (Fig. 23) The precipitation in the tissue is not uniform as the glandular epithelial cells are higher in enzyme content as compared to that of the fibro-muscular tissue. Within the glands, cells lining the lumen are more active and show better precipitation than the cells of the interior. Nucleus can be distinguished from the surrounding plasmatic mass, though of course the latter is also quite high in enzyme activity. Nucleolus within the nucleus is easily differentiable from the nucleoplasm.

The fibro-muscular tissue as compared to the glandular one is less active ; but the precipitation is more or less uniform in practically all the cells. The nucleus is distinct from the cytoplasm and small nucleolar matter within the nucleus is also sharp. Of the nucleolus, the intranucleolar substance and the perinucleolar zone cannot be differentiated.

Acid phosphatase activity : (Fig. 24). A contrasting picture is obtained as compared with the previous one, in that the precipitation here is much less than in the other. The glandular epithelial cells are however more active than the fibro-muscular tissue. No distinction in the activity of the enzyme in the different regions of the glandular epithelium can be demonstrated. It is more or less uniform throughout. Nucleus is differentiable from the rest and in rare cases the nucleoli can be distinguished.

A very faint picture of the phosphatase reaction is obtained in the fibro-muscular tissue. The reaction is however uniform and slightly less than that of the glandular epithelium. In certain regions nucleus can be differentiated from the cytoplasm and the same is true of the nucleolus. In both the fibro-muscular tissue and the epithelial cells of the glands the activity of the acid phosphatase is much less when compared with the alkaline type.

Material — I :

Material stained with haematoxylin and eosin shows this to be a case of a normal prostate (Fig. 25).

Alkaline phosphatase activity : (Fig. 26) The activity is uniform in general throughout the section but in places the glandular epithelium shows greater activity than the rest of the tissue. The alkaline phosphatase activity is seen throughout the cells of the glands. The nuclei of the glandular epithelium stand out prominently and show

Fig. 27.
Acid phosphatase activity.

Fig. 28.
Haematoxylin and eosin.

much greater activity than their cytoplasm. The nucleoli can be distinguished as sharp rounded areas within the nuclei and they show even higher activity than the nuclei.

The fibro-muscular tissues are uniform in their activity. Their nuclei can be differentiated due to the higher alkaline phosphatase content within them. Only in places nucleoli can be seen.

Acid phosphatase activity: (Fig. 27). The glandular epithelium shows a much higher activity in general as compared with that of the fibro-muscular tissue. The distribution of the activity is not uniform throughout the glandular epithelium and shows variations in the activity in the different places. The nuclei of the epithelial cells stand out as distinct masses and show higher activity than the cytoplasms. Where the activity is higher in the nucleus, nucleolus can be distinguished within the nucleus. But where the activity is less marked within the nucleus, nucleolus could be rarely seen. In addition to the nucleus a number of other phosphatase positive bodies are present in the cytoplasm.

Material — J:

Material stained with haematoxylin and eosin shows this to be a case of chronic interstitial prostatitis (Fig. 28).

Alkaline phosphatase activity: (Fig. 29) At a glance it is evident that alkaline phosphatase activity is enormous but uniform, both in the glandular epithelium and in the fibro-muscular tissue. The cytoplasm of the epithelial cells shows uniform activity throughout. The nuclei of the cells show a much higher activity than the cytoplasm and stand out as distinctly clear dark areas. The activity is more marked towards the periphery of the nucleus. The nucleoli can be easily distinguished. In the cytoplasm small specks of phosphatase positive bodies can be seen here and there.

The fibro-muscular tissue also shows a uniform distribution. The nuclei show higher activity than the cytoplasm. The nucleoli can be easily made out within the nuclei.

Acid phosphatase activity: (Fig. 30) The activity is more or less uniform throughout the tissue. But in places the activity is more marked in the epithelial cells of the



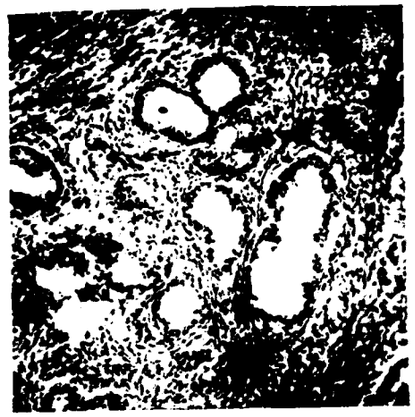

Fig. 29.
Alkaline phosphatase activity.

Fig. 30.
Acid phosphatase activity.

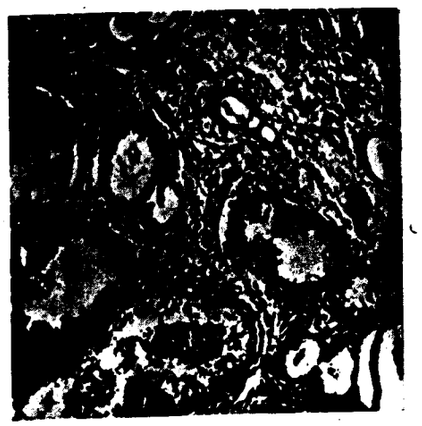

Fig. 31.
Haematoxylin and eosin.

Fig. 32.
Alkaline phosphatase activity.

glands as compared with that of the musculo-fibrous tissue. The cytoplasms of the epithelial cells is uniformly active and the nuclei can be seen as dark areas of higher activity within the cytoplasm. In most cases the nucleoli can be seen.

The fibro-muscular tissue shows uniform activity throughout the section. The nuclei can be identified as dark areas of higher phosphatase activity. The nucleoli stand out as dark dots within each nucleus.

Material — K:

Material stained with haematoxylin and eosin shows this to be a case of benign hypertrophy of the prostate (Fig. 31).

Alkaline phosphatase activity: (Fig. 32) Activity is present throughout the material; but the glandular epithelium shows higher activity than the fibro-muscular tissue. The nuclei of the glandular epithelium can be easily differentiated from their cytoplasm as the former shows higher activity

Fig. 33.
Acid phosphatase activity.

Fig. 34.
Haematoxylin and eosin.

Fig. 35.
Alkaline phosphatase activity.

Fig. 36.
Acid phosphatase activity.

than the latter. In most of the cases the nucleoli can be detected within the nuclei. The cytoplasm of the epithelial cells show a very uniform activity throughout.

High phosphatase activity is present throughout the fibro-muscular tissue and the nuclei of the muscle fibres stand out as dark circular areas showing higher activity than their cytoplasm. In most of the cases the nucleoli could be seen within the nucleus.

Acid phosphatase activity : (Fig. 33) The activity is high throughout the material and the glandular epithelium and the fibro-muscular tissue show a more or less similar degree of activity.

Uniform activity is seen within the glandular epithelium. Their nuclei could be differentiated within the cytoplasm only on rare occasions as both the nuclei and the cytoplasm show a similar degree of activity. It is practically impossible to differentiate the nucleoli.

The fibro-muscular tissue is active throughout and in places long streaks of phosphatase positive areas could be seen running along the fibro-muscular bundles. Nuclei can be differentiated only in places. The activity in the cytoplasm is much higher than in the nuclei.

Material — L :

Section stained with haematoxylin and eosin shows the material to be a normal one but in places there is some degree of hypertrophy of the glandular epithelium (Fig. 34).

Alkaline phosphatase activity : (Fig. 35) Throughout the material the activity is very high. Comparatively, the glandular epithelium shows higher activity than the fibro-muscular tissue. The nuclei of the glandular epithelium show a greater precipitation than their cytoplasm. Within the nuclei the nucleoli could be differentiated.

The fibro-muscular tissue shows uniform activity throughout and the nuclei of the muscle fibres can be differentiated as they exhibit higher precipitation than the cytoplasm.

Acid phosphatase activity : (Fig. 36). Here too, in most of the places, the glandular epithelium shows higher activity than the fibro-muscular tissue. In most cases the nuclei and the nucleoli can be differentiated.

The fibro-muscular tissue shows activity throughout and bands of phosphatase positive areas run along the direction of the fibro-muscular bundles. Their nuclei could be differentiated only on rare cases.

## Discussion

In recent years the progress of cytochemical research has been enormous and even the subtle activities of the cells, whose mechanism was formerly regarded to be an impossible work for the cytochemists is now not considered to be so. A number of histochemical and cytochemical methods are at present on record which have solved to a great deal the problems of cellular metabolism. No doubt it must be admitted that none of the techniques are free from limitations and a great deal is yet to be done to bring them to absolute perfection. Even with due consideration of this fact one cannot ignore the value of the wealth of data that have been accumulated in recent years. It is indeed far from negligible.

The data so far presented from different schools engaged in cytochemical researches are conflicting to a certain extent. This is quite apparent at a glance at any of the text books or critical reviews dealing with researches on cytochemistry. This in no way under-rates the labour, patience and at the same time the capabilities of our research colleagues of different schools, but simply serves to emphasize the need of a more and more understanding into the paths of cellular metabolism. The mechanism and means of each and every biochemical step concerned with the development of an individual is possibly the most subtle and critical method that one can conceive of. All these steps, though they apparently seem to be independent, are interrelated to some extent — a relationship responsible for the harmonious development of the entire individual. Even with so much of advance made in different aspects of cytochemical research, it is really deplorable to state that an understanding of this relationship has not yet been achieved. Whatever might be the results of the efforts which are in no way underestimable, workers engaged in cytochemical research are quite confident that an insight would soon be attained with so much of theoretical and technical back-ground already at hand. It needs no emphasis that no worker is unaware of the limitations of the techniques he follows and attempts are always forthcoming for their refinements.

TABLE I

| | Material & Diagnosis | | Alkaline Phosphatase Activity | | Acid Phosphatase Activity | |
|---|---|---|---|---|---|---|
| | | | Glands | Fibro-muscular tissue | Glands | Fibro-muscular tissue |
| A | Benign hypertrophy | Nucleus | ++ | ++ | ++ | ++ |
| | | Cytoplasm | + | + | + | +++ |
| B | Adenocarcinoma | Nucleus | ++ | ++ | ++ | ++ |
| | | Cytoplasm | ++ | ++ | ++ | ++ |
| C | Benign hypertrophy | Nucleus | ++ | ++ | ++ | + |
| | | Cytoplasm | + | + | + | + |
| D | Benign hypertrophy | Nucleus | +++ | ++ | + | + |
| | | Cytoplasm | ++ | + | + | + |
| E | Fibrosis of the prostate | Nucleus | +++ | ++ | ++ | + |
| | | Cytoplasm | + | + | + | + |
| F | Adenocarcinoma | Nucleus | ++ | ++ | ++ | ++ |
| | | Cytoplasm | ++ | ++ | ++ | ++ |
| G | Benign hypertrophy | Nucleus | +++ | ++ | ++ | + |
| | | Cytoplasm | + | + | + | + |
| H | Benign hypertrophy | Nucleus | +++ | ++ | ++ | + |
| | | Cytoplasm | + | + | + | + |
| I | Normal prostate | Nucleus | +++ | ++ | ++ | ++ |
| | | Cytoplasm | + | + | + | + |
| J | Fibrosis of the prostate | Nucleus | +++ | ++ | ++ | ++ |
| | | Cytoplasm | + | + | + | + |
| K | Benign hypertrophy | Nucleus | ++ | ++ | + | + |
| | | Cytoplasm | + | + | + | +++ |
| L | Normal prostate | Nucleus | ++ | ++ | ++ | + |
| | | Cytoplasm | + | + | + | ++ |



The phosphatase metabolism is possibly the most important step in cellular reactions and which is concerned directly or indirectly with a number of metabolic steps. The energy concerned with the reaction involved is of tremendous importance to every biochemical step necessary for cell growth. This is the step which may be considered as manoeuvring a number of strands represented by various cellular activities being itself located at the junction. It is the common point where convergence of results of different biochemical researches is noted. Recently this aspect of study has rightly attracted the attention of innumerable schools of cytochemistry, the outcome being a considerable advance of our knowledge of intracellular activity.

The researches on enzyme studies can conveniently be grouped under two different categories. One aspect of the research deals with a study of the *in situ* activity whereas the other involves an investigation of their behaviour following extraction. The latter category of the research, though it seems to be quite attractive has been condemned by a number of workers (Danielli, 1947; Sharma, 1952). It has been mainly criticised on the basis that the product during extraction may undergo a series of changes, at present undetectable to the cytochemists. Furthermore our knowledge is absolutely nebulous regarding the pattern of factors controlling enzyme activities within the cells. Various inhibiting and accelerating mechanisms are there, without an understanding of which the exact environment cannot be supplied *in vitro*. Moreover the cytoplasmic back-ground whose exact constitution has yet to be determined, controls to a large extent the activity of the enzymes concerned. These are the factors which need serious consideration before undertaking any research involving enzyme activity. That is the reason why the study of determining *in situ* activity has been much preferred to researches following extraction procedures. Thanks to the efforts of Gomori (l.c.) and Takamatsu (l.c.) who independently published their novel methods of detecting the activity of alkaline phosphatase *in situ*. The method that has been followed by them is absolutely novel an ingenuous, the principle being fully unknown to previous workers.

The technique, in principle, involves the detection of enzyme activity through precipitation test. The tissue containing the enzyme is to be incubated in a medium containing some phosphate salts as one of its constituents. Incubation at the optimum temperature (37°C) for enzyme activity and at a favourable pH (9.4) results in the liberation of phosphoric groups from the phosphate salts which is precipitated as calcium phosphate through reaction with a calcium salt at the site of enzyme activity. The calcium phosphate on the other hand being indistinguishable under the microscope is converted into cobalt phosphate through treatment with cobalt chloride solution. The cobalt phosphate is again further transformed into a black precipitate of cobalt sulphide following ammonium sulphide application. The final result is thus the occurrence of black precipitate at the site of enzyme activity, easily detactable under the microscope. Since the demonstration of its capability in localising the phosphatase activity, the method has been tried in various plant and animal tissues with remarkable success. Manheimer and Saligman (1948) suggested a modified method in which instead of precipitating the phosphoric groups, the other radicle is precipitated. In such cases naphthyl-phosphate has been used as the medium of incubation and precipitation of naphthyl salt is performed.

The specificity of the Gomori technique in determining *in situ* phosphatase activity has been seriously questioned by Novikoff (l.c.) as well as by Jacoby and Martin, etc. It has been claimed that a non-specific precipitation may result out of diffusion of either the enzyme or the enzyme reaction products. Novikoff has further claimed to have shown that in control sets where enzymes have been killed and hydrogen-peroxide added to the medium, precipita-

tion results on the tissue surface showing the invalidity of the test.

It is fortunate that all these criticisms have been well met by a number of workers working in different centres. Sharma et al (l.c.) carried out a number of experiments under strictly controlled conditions meeting all the requirements for a check of the specificity and concluded that the validity of the test is unquestionable. The objections raised by Novikoff were given serious attention to by Sharma and others and their methods of study included similar set of experiments as planned by Novikoff. In so far as plant chromosomes are concerned, they have shown dubiousness of Novikoff's claims and strongly recommended the method for a study of in situ activity in the chromosomes of plants. Danielli and Catcheside (1945) too suggest the importance of the test in the salivary gland chromosomes of *Brosophilla.*

While undertaking the present investigation, as has already been pointed out in the text, check of the specificity of the method was thought highly desirable, specially in view of the discrepancies noted by different authors. As such, control experiments of different types had to be planned before undergoing trials with tissues meant to be tested. Such a cautious approach seemed to be absolutely imperative in view of the far reaching significance of the interpretation to be given.

The text has revealed that none of the control methods tried here could give any indication of the non-specificity of the test. Materials treated in boiling water to effect killing of enzymes did not result in any precipitation whatsoever. In cases where hydrogen-peroxide was added to the medium containing materials treated in boiling water, a precipitation no doubt was there but it was absolutely non-specific and diffuse. Furthermore, incubation at room temperature too yielded no precipitate. A consideration of all these data distinctly show the fallacies of all the criticisms and emphasised once more the validity of the test. The author has kept all the controls necessary for the purpose of investigation and the experiments are undertaken whose results have been recorded above and whose significance will be discussed later.

In so far as acid phosphatase is concerned Gomori's method as modified by Glick and Fisher has been found to be useful in the present case. The distribution of the acid phosphatase has been tested till now by a number of workers in different organs of plants and animals most of which have yielded quite successful results. As their distribution is quite high in the animal tissues and as their importance in metabolism is immense, a study of their activity specially in comparison with that of the alkaline one was desired and carried out. It has been emphasised before that the purpose of the investigation was to detect the difference in the phosphatase activity, if any, in true carcinomatous conditions of the prostate so that it might be of help in the diagnosis of cancer. The author may state that the results so far obtained are quite hopeful and indicate the potentialities of this type of investigation to find out a more reliable and critical means in diagnosis of carcinoma.

Before interpreting the results obtained in the present series of experiments, the paper would remain incomplete if mention is not made of the excellent work of previous authors relevant to the present scheme of study. The phosphatase activity, both the alkaline and the acid types have been investigated by a number of workers in different organs of the individual including the prostate, breast, etc.

Franseen and McLean (1935) reported high level of the enzymes in the blood plasma and tumour tissues in the cases of secondary bony metastases from primary carcinoma of the prostate. They further concluded that the enzyme alkaline phosphatase was the product of the neoplastic cells. It is significant here to record that no doubt that the enzyme activity was found to be more in the tumour tissues, no definite pattern of their distribution was



detected. The present work has brought-forth a differential pattern of distribution of the enzyme phosphatase in the normal as well as in the pathological prostatic tissue hither-to unrecorded.

Kutscher and Wolbergs (1935) were the pioneer workers to record extraordinarily rich acid phosphatase activity in the normal prostate and the high level of the serum acid phosphatase during the osteoplastic skeletal metastases with carcinoma of the prostate.

Similar are the observations of Gutman and others (1936) who however reported a marked acid phosphatase activity in the bony metastases secondary to carcinoma of the prostate gland.

A highly significant observation reported by Greenstein and Eschenbrenner (1947) who used transplanted hepatomas for the study of the distribution of the enzymes. According to Greenstein, the tumours which go through generations of transplants have their enzyme patterns radically changed. It has been proved by them that with successive generations there is a loss in the alkaline phosphatase activity in the tissues.

Lemon and Wissemann (1949) reported certain cases which in the opinion of the author needs serious criticism. The tissues examined by them exhibited the presence of enzymes, both in the nuclei and in the cytoplasm of the normal prostatic epithelium. In the case of neoplastic cells, the localization was found to be exclusively in the nuclei. Furthermore, the inability of the enzyme acid phosphatase of non-prostatic tumours to move into the blood stream was attributed absolutely to the location of the enzyme within the nuclei of the cancer cells. This particular interpretation in regard to the failure of acid phosphatase of the non-prostatic tumours seems to the present author not a very tangible one specially due to the reasons outlined below.

It is well known that in the cancerous tissue cell division proceeds at an extremely rapid rate specially when compared with that of the normal tissue. The tremendous speed of cell divisions outruns the cell wall formation, the consequence of which is the origin of a mass of undifferentiated tissue. It needs no emphasis that the dissolution of the nuclear membrane forms an essential step during nuclear division (prior to metaphase). Even in cases where the phosphatase could be located in the nucleus, no difficulty could be encountered by the enzymes to have an easy passage into the cytoplasm during this phase of the nuclear cycle. Subsequently it would be quite easy for the enzymes to escape into the blood stream. On the basis of this known fact, the interpretation put forward Lemon and Wissemann can be questioned and as such some other suggestion needs to be put forward to account for such behaviour.

Moreover, the distributional pattern of phosphatases in normal prostatic epithelium and in a carcinoma of the same as suggested by the above mentioned authors do not find support in the present investigation. The significance of the data gathered during the present scheme of work would be discussed later.

Another important report was made by Kay (1930) who noted the high level of serum alkaline phosphatase in individuals suffering from bone diseases. That an artificial removal of osteogenic sarcoma causes a decrease in the level of serum alkaline phosphatase is also well known (Franseen and McLean, 1935).

It is worthy of note and it is quite significant in relation of this aspect of research that a high phosphatase activity is always noticeable even in cases of normal ossification.

Lievere (1952), Gutman and Gutman (1938) and Barringer and Woodard (1938) have shown that the acid phosphatase in carcinomatous prostate with bony metastases passes into the blood stream and thus an assay of the serum in regard to acid phosphatase may provide a means of diagnosis.

In addition to this type of investigation, studies on the effects of different salts have also been carried out by a number of workers. Kutscher and Wolbergs (1935) failed to get any activation of enzyme action by magnesium salts. In the present investigation it has been found that an addition of magnesium causes no change in the alkaline phosphatase activity.

Bodanskey (1949) recorded similar reactions of human osteogenic sarcoma phosphatase and that of the normal rat bone to the amino-acid inhibitors in the presence and absence of magnesium, etc.

The above references, as is known to the reader, are far from complete. Only the most relevant ones have been mentioned and the number of others have been elaborately dealt with by Homburger and Fishman in the excellent treatise on the physiopathology of cancer (1952).

The present series of investigations with prostate glands of different individuals indicate the presence of alkaline and acid phosphatase activity in all of them. But a precipitation in different parts of the normal and non-cancerous prostatic tissue has never been found to be uniform in all the cases. This is true of both acid and alkaline phosphatases. Even then, so far as benign and normal prostates are concerned there is a certain amount of regularity in their behaviour. But the acid phosphatase activity does not show such regularity. This would be clear in a resume of the results obtained in both sets of experiments.

Leaving aside the cases of carcinoma, the alkaline phosphatase activity in other normal and non-cancerous prostatic tissue shows a certain degree of constancy. For instance *in the glands* the precipitation in the nucleus is more than that in the cytoplasm in all the cases. The degree of precipitation and thus the difference represented between the same, in the nucleus and the cytoplasm is however different. It may be noted from the table that the comparative precipitation in the nucleus and the cytoplasm in materials A, C, K and L is much lower than that of materials E, C, H, I and J. Though a higher precipitation is observed in the glandular epithelium of material D, the approximate ratio as far as could be detected from the visual methods between the two (nucleus and cytoplasm) is less than that in materials A, C, K and L. Similarly, in the fibro-muscular tissue in general tested for alkaline phosphatase activity (excepting the cases of carcinoma) we find that the precipitation in all the cases is higher in the nucleus than in the cytoplasm.

It may be stated further that in majority of the cases the general activity of the enzyme is comparatively higher in the glandular epithelium than in the fibro-muscular tissue. The most significant point which is of universal application in the glandular epithelium and the fibro-muscular tissue tested for alkaline phosphatase activity (excepting the cases of carcinoma), that the activity of the enzyme in the nucleus is always high as compared to that in the cytoplasm. *In no case the cytoplasmic enzyme content has ever been found to be higher than that of the nucleus.*

A completely different picture of phosphatase activity is observable in cases of carcinoma diagnosed following haematoxylin and eosin stain. The most significant feature is the uniform formation of precipitate throughout the tissue. This uniformity in appearance is due to similar degree of precipitation in both the nucleus and the cytoplasm. The reaction is so homogeneous that no differentiation of the tissues can be made. It has been noted that the activity in the nucleus is very high in the normal tissues as well as in tissues showing benign pathological conditions. This uniformity in appearance (in the carcinomatous tissues) due to heavy precipitation in both the nucleus and the cytoplasm is therefore accountable to the increased activity in the cytoplasm. In cancerous condition therefore, the author suggests that there is a heavy increase in the alkaline phosphatase content of the cytoplasm. The question may be raised as to why there is such an abrupt increase in the phosphatase content of the cytoplasm. An explanation however may be offered to account for this behaviour which has been outlined in the following paragraph.



It is well known that in cancerous tissue there is a rapid rate of multiplication of nuclei. Nuclear multiplication involves unessential chromosome duplication. Chromosome duplication on the other hand is fully dependent on the nucleo-protein supply in the nucleus. For a proper functioning of a mitotic process involving gene reduplication, the inter-dependence of the nucleus and cytoplasm is also an established fact. Both act in a co-ordinated way for a smooth running of the process. The nucleo-protein supply necessary for chromonima duplication is supplied indirectly from the cytoplasm. Thus in order to meet the growing demand of nucleo-protein in cancerous tissue, its synthesis is to be accelerated in the cytoplasm. The significant role of phosphatase in this synthesis needs no introduction. It may be assumed that the high phosphatase content of the cytoplasm of the cancerous tissue is merely an adaptation, meeting the factors necessary for the nucleo-protein supply to the nucleus.

This homogeneous precipitation, thus differentiating the cases of carcinoma from that of normal tissues and tissues showing benign pathological conditions can possibly be considered as a reliable means of diagnosis of a carcinomatous condition. In cancerous prostates, where even in portions of tissues where carcinomatous condition is not detectable through normal staining procedure, such homogeneous precipitation of alkaline phosphatase can be obtained throughout. This fact, the author assumes would be of utmost importance in the diagnosis.

So far as the activity of the acid phosphatase is concerned in normal and in non-cancerous tissues no regularity in the behaviour could be noted. It would be evident from the table that in certain cases the activity is quite high in the nucleus when compared with the activity in the cytoplasm; whereas in others the opposite is the case. This is specially true of the fibro-muscular tissue.

In the glandular epithelium, though in no case of normal tissues and tissues showing benign pathological conditions, cytoplasmic activity has been found to be higher than that of the nucleus, a similar precipitation in both these cellular parts is on record (material D and K).

One particular feature that is constant for the cancerous tissues is an enzyme activity which is similar in its degree in both the nucleus and the cytoplasm of the fibro-muscular tissue and the glandular epithelium. The reason for this high activity in the cytoplasm may be the same as accounted for the similar behaviour for alkaline phosphatase. *But it must be noted that the activity of the acid phosphatase in the cancerous tissue being manifested in a uniform precipitation can not at all be considered as a means of diagnosis of cancer.* This is due to the fact that the formation of the uniform precipitate due to acid phosphatase activity has been recorded even in benign pathological conditions. Such irregular behaviour has not been noted in any of the tissues showing alkaline phosphatase activity. And so, a detection of alkaline phosphatase activity therefore could be regarded as a reliable method for diagnosis of cancer of the prostate.

It is interesting to note that with tests for both acid and alkaline phosphatase in normal and as well as in non-cancerous tissues, no difference in the activity could be recorded. They behave more or less in a similar way and thus the test should not be applied for detecting the non-cancerous pathological conditions of the prostate.

Lastly, the author wishes to emphasise once more that he is fully aware of the limitations of the visual method of observation of the degree of activity of the enzymes. As such the rate of activity as denoted by the number of '+' signs may not be considered as an absolutely accurate one but at least it gives an idea of the approximate range of precipitation. It is hoped that through the invention and

application of more refined methods involving even Spectro-photometric methods, they would yield more confirmatory data establishing the validity of the suggestion put forward.

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# PANCREATITIS *

## (A study of 25 patients)

*by S. S. ANAND, C. P. SAWHNEY and P. N. CHHUTTANI, Amritsar.*

Although we had entertained acute pancreatitis as a possibility in an occasional abdominal catastrophe for some time, yet our familiarity with its clinical recognition and its management especially of the less acute and recurrent forms of the disease is a matter of less than three years during which period we have seen 25 patients suffering from pancreatitis of varying degrees of severity. We are of the opinion that the disease is not diagnosed as often as it occurs and would remain relatively neglected till serum amylase estimations are done for upper abdominal pain with the same frequency as total and differential white cell count for appendicular inflammation.

We propose to outline here the main clinical and laboratory findings and briefly refer to the treatment carried out.

*Historical :*

Claessen (1842) in his monograph on disease of the pancreas clearly defined chronic inflammation of the pancreas and gave criteria distinguishing it from carcinoma. He specifically pointed out that acute attack may lead to the chronic disease. Comfort et al (1946, 1948) have made a valuable contribution to the understanding of acute and chronic relapsing pancreatitis.

*Aetiology :*

In spite of the many theories promulgated, the aetiology of pancreatitis remains obscure although the role of back pressure in the pancreatic duct, excessive alcohol and food, and of trauma are widely admitted. However, we came across history of alcoholism in relation to an attack only in 3 (12%) patients. The attack of pain in one patient was preceded by a blow on the epigastrium. Siler and Wulsin (1950) have provided a classification of the various possible aetiological factors (Table I).

TABLE I

*Modified from Siler and Wulsin (1950)*

1. Reflux of bile into pancreatic duct resulting from obstruction at the ampulla of Vater by :
   - (a) Calculus.
   - (b) Spasm of the sphincter of Oddi.
   - (c) Oedema of the papilla.
2. Obstruction of the pancreatic duct by :
   - (a) Pancreatic calculus or ampullary calculus.
   - (b) Tumours, inflammation, oedema and fibrosis.
   - (c) Epithelial metaplasia in small ducts.
   - (d) Surgical ligature.
   - (e) Duodenal diverticulum.
3. Vascular factors.
4. Trauma :
   - (a) Accidental.
   - (b) Surgical.
5. Alcohol factor.
6. Metabolic factors, i.e. protein deficiency.
7. Neurogenic and emotional factors.
8. Biliary tract disease.
9. Infection.
10. Miscellaneous factors :
    - (a) Reflux of duodenal contents into duct.
    - (b) Anaphylaxis.

* A paper read at the XVII Annual Conference of the Association of Surgeons of India at Amritsar, Dec. 1955.



*Clinical picture :*

*Age and Sex :* Maximum number of cases occurred between ages of 35 to 45 years (Table II). There were 18 females (72%) in our series. Reports elsewhere show males to predominate by 2 to 1, but our own series provided a much higher incidence in the female. This may well be due to our being on the look out for pancreatitis especially in those awaiting biliary tract surgery.

TABLE II

*Age and Sex Distribution*

| S. No. | Age group | Total No. of cases | No. of males | No. of females |
|---|---|---|---|---|
| 1 | 0—10 yrs. | — | — | — |
| 2 | 11—20 yrs. | 5 | 2 | 3 |
| 3 | 21—30 yrs. | 6 | 1 | 5 |
| 4 | 31—40 yrs. | 9 | 3 | 6 |
| 5 | 41—50 yrs. | 5 | 1 | 4 |
| 6 | 51—60 yrs. | — | — | — |
| | Total | 25 | 7 | 18 |

Clinical picture of pancreatitis is variable, ill defined and depends to some extent on the severity of pancreatic involvement. It mimics very closely various upper abdominal catastrophies and consequently the clinical diagnosis is often difficult. However, the old attitude that the disease is essentially unrecognizable clinically, is no longer valid. We can, with a certain degree of surety lay our hands on pancreas as the seat of disease, if we are conscious of its existence and scrutinize the history and physical signs carefully.

TABLE III

*Symptomatology*

| S. No. | Symptoms | No. of cases | Percentage |
|---|---|---|---|
| 1 | Pain | 25 | 100% |
| 2 | Vomiting | 18 | 72% |
| 3 | Distension | 6 | 24% |
| 4 | Fever | 14 | 56% |
| 5 | Anorexia | 19 | 76% |
| 6 | Weakness | 16 | 64% |
| 7 | Jauudice | 5 | 20% |
| 8 | Diarrhoea | 3 | 12% |

Pain was the outstanding manifestation of the disease in every case (Table III). It was generally severe, but occasionally it was mild : characteristically it was of a constant nature but colicky intermittent pain was complained of in 5 cases. The pain was mostly localised to the epigastrium or right hypochondrium. If the attack was very severe, the pain was felt diffusely all over the abdomen. Although pain in the left hypochondrium is said to be common in pancreatic involvement, it was found to be localised to that part in only one of our cases. In another case it was felt in the right flank. Out of the thirteen cases with right hypochondriac pain, eleven had evidence of gall bladder disease. This gives a probable explanation of the association of right hypochondriac pain with epigastric pain in cases of pancreatitis.

TABLE IV

*Localization of Pain*

| Site of pain | No. of patients | Percentage |
|---|---|---|
| Epigastric | 20 | 80% |
| Right hypochondriac | 16 | 64% |
| Left hypochondriae | 1 | 4% |
| Whole abdomen | 6 | 24% |
| Right flank | 1 | 4% |

TABLE V

*Radiation of Pain*

| Site of radiation | No. of cases | Percentage |
|---|---|---|
| Back | 19 | 76% |
| Interscapular and infra-scapular region | 4 | 16% |
| Right shoulder region | 1 | 4% |
| No Radiation | 8 | 32% |

The pain may remain localized or may radiate to various regions of the body. In majority of cases, i.e. 19 (76%) pain radiated to the back. It may however be referred to the right shoulder, infra-scapular and interscapular regions (Table V). The duration of the attack varies directly with the severity of disease. Generally the attack lasts for three to four days but may last only for a few hours to twenty four hours. In 6 (24%) cases where the attacks were of a very acute nature, pain persisted for ten to fifteen days. The interval between the attack in individual cases varied from a few days to many months in our cases (Table VI).

TABLE VI

*Duration of Attacks*

| S. No. | Duration | No. of cases | Percentage |
|---|---|---|---|
| 1 | A few hours to 24 hours | 4 | 16% |
| 2 | 3 to 4 days | 15 | 60% |
| 3 | 10 to 15 days | 6 | 24% |

Vomiting was a common symptom. If the attack was mild, there was only nausea and retching, but if the pain was at all severe, vomiting was an exhausting feature.

Distension occurred only in 6 cases (24%) and especially in the relatively severe cases. It pointed to the underlying paralytic ileus brought about by irritation of the peritoneum by the pancreatic enzymes liberated in the peritoneal cavity. Distinction reflects severity of the disease. hence progressive distension is regarded as a serious prognostic sign.

Fever was present in 14 (56%) cases, generally ranging between 99-100°F. Anorexia was common during the acute stage but appetite returned as the attack subsided. Fatty dyspepsia was not met with. None of our cases had diarrhoea as a notable symptom although 2 patients had a mild diarrhoea following an acute attack.

TABLE VII

*Physical Signs*

| S. No. | Signs | No. of patients | Percentage |
|---|---|---|---|
| 1 | Tenderness | 18 | 72% |
| 2 | Guarding or rigidity | 1 | 4% |
| 3 | Mass | 9 | 36% |
| 4 | Distension | 6 | 24% |
| 5 | Induration | 1 | 4% |
| 6 | Jaundice | 5 | 20% |
| 7 | Ascites | 1 | 4% |

The physical signs were as variable as the symptoms (Table VII). Their proper interpretation was a valuable aid to diagnosis. Tenderness, a most important single physical sign, was met with in 20 cases (80%). In mild attacks of pancreatic oedema local epigastric tenderness may often be the only finding. The tenderness varied with the severity of the disease. In fourteen cases it was localized to epigastrium, in nine to right hypochondrium, while in only two cases were we able to detect it in the right flank. Left hypochondriac or left renal tenderness because of involvement of the tail of pancreas, was not met with in any case.

Guarding and rigidity of abdomen was a rare finding in spite of quite a number of severe cases. It was noted in only one case.



A palpable tender mass appearing in the epigastrium following an acute episode of pancreatitis, was found in 9 cases. It appeared within 3 to 7 days after the onset of the attack. It increased in size gradually but resolved and disappeared completely shortly after subsidence of attack in two cases. In the remaining seven the mass went on increasing gradually so that after some time it attained quite a huge size : the appearance of psuedo-pancreatic cyst was a valuable diagnostic sign of preceding attack of acute pancreatitis.

The mass may be formed in the right hypochondrium, when it is the result of liberation of pancreatic ferments though foramen of Winslow stimulating inflammatory reaction around the gall bladder. Along with pericholecystitis, the omentum, transverse colon, pylorus and the duodenum may become adherent to each other and to the under-surface of liver and cause difficulty in distinguishing the case from one of cholecystitis.

Jaundice of moderate degree occurred in approximately one-fourth of our cases. In the majority jaundice was of obstructive type which disappeared with the subsidence of the attack. The precise cause of jaundice in two cases was found on operation to be an obstruction of the common bile duct by pressure of an enlarged head of the pancreas. In one case there was a big calculus in the common bile duct and in another multiple small stones were detected. Other causes of jaundice such as associated hepatitis and absorption of broken down proteins have been mentioned by Warren and Cattell (1953).

Grey Turner described an area of discoloration in the flank of a patient suffering from acute pancreatitis and pointed out its diagnostic significance. We have not been able to detect it in any of our cases. This discoloration is said to be accompanied by diffuse induration in the flank, which could however be demonstrated in one of our cases. This sign is too rarely observed to be of help in the diagnosis. Oedema of the flank indicates extensive pancreatic necrosis and is supposed to be of serious prognostic value (Warren and Cattell, 1953). However, the only case with a similar finding in this series made an early uneventful recovery.

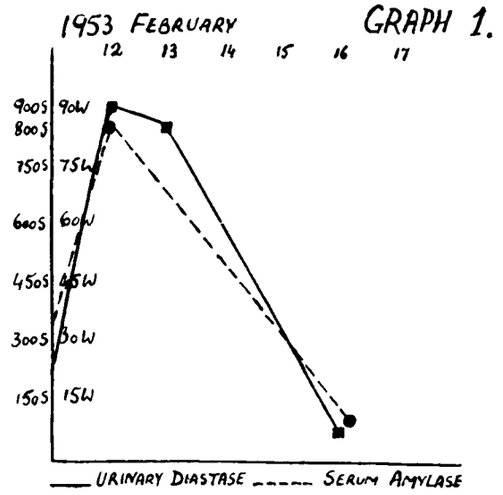
Shock is an uncommon finding and may be absent even in acute episodes. We were not able to detect any demonstrable degree of shock in any of the 25 cases. Fallis and Plain (1939) found shock in only 2 of 26 recorded cases, while Paxton and Payne (1948) observed significant hypotension in 11.7 per cent of patients.

Ascites was present in only one case. It is of no diagnostic value.

*Laboratory Investigations :*

Mild glycosuria occurred in two of our patients. Two others both examples of pseudocysts, had a diabetic glucose tolerance curve. No case showed albuminuria. A mild leucocytosis was seen in 13 patients, the total leucocyte count varying between 10,000 to 16,000 per cmm. Serum calcium estimations were not done.

In 7 of our patients serum bilirubin was raised : in two the cause was found to be




Graph 1.

Graph showing sudden and significant rise in serum amylase followed by a sudden fall after subsidence of pain in a case of acute pancreatitis.

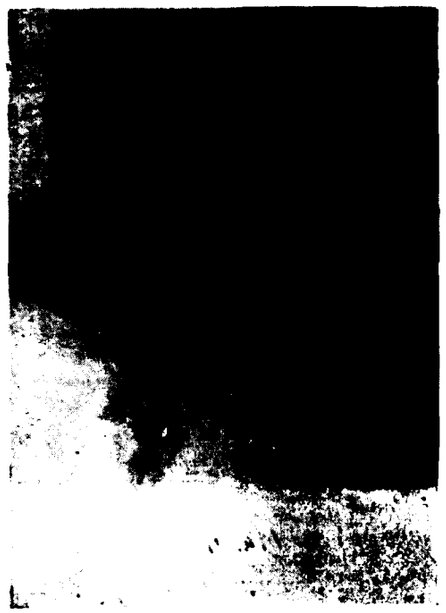


Fig. 1.
Lateral view after cholecystography showing presence of pancreatic calculi.

Fig. 2.
Plain X-ray abdomen in a case of acute pancreatitis showing an isolated loop of paralytic ileus in the left upper abdomen.

an enlargement of the head of pancreas, one had a calculus in the common bile duct and another had multiple small biliary calculi; the remainder did not submit to surgery and we do not know the exact cause of jaundice in them. Liver damage was demonstrable in 2 of our series. Liver biopsy was however done in 2 cases, one a known alcoholic showed fatty degeneration and the other necrosis and regeneration of liver cells. Serum amylase and urinary diastase were estimated as a routine in all our cases and figures above 320 Somogyi units per 100 c.cs. of blood were taken as confirmatory provided the levels fell to normal after the subsidence of the attack (Fig. 1). In 3 of our patients where serum amylase figures were not raised at the time of examination, diagnosis was based on operative findings of an enlarged and firm pancreas, scattered fat necrosis and a spastic sphincter. Urinary diastase figures of above 40 Wohlgemuth units per c.c. of urine were regarded as suspicious although not much relied upon unless serum amylase was also elevated significantly.

On radiological study pancreatic calculi were demonstrable in one instance only (Fig. 1). An isolated loop of paralytic ileus in the left side of abdomen, considered to be characteristic of acute pancreatitis (Grollman 1950) was detected in another case (Fig. 2). In all cases where pseudo-cysts developed, there was a diffuse opacity in the upper abdomen. In one, the diaphragm was raised and its movements were restricted, leading to a diagnosis of subphrenic abscess but on exploration a pseudo-cyst was found to extend from the diaphragm to the right iliac fossa (Fig. 3). Cholecystography attempted in all cases, showed a non-functioning gall bladded in 16.



Fig. 3.
X-ray chest showing raised right dome of diaphragm. On screening its movements were limited. (From a case of psuedocyst forming soon after acute episode of pancreatitis).

Fig. 4.
Barium meal study in a case of psuedocyst (developing after pancreatitis) showing widening of the duodenal loop with a pressure effect on the pyloric antrum and duodenum.

Fig. 5.
Barium meal study (in a case of psuedo-pancreatic cyst developing after acute pancreatitis) showing pushing forwards of the stomach against the anterior abdominal wall.

Fig. 6.
Barium meal study showing pressure effect on the lesser curvature of stomach, pyloric antrum, pylorus and duodenum.

Barium study of gastro-duodenum was carried out in all except 2 cases but positive findings were met with only when pseudo-cysts had formed. Duodenal loop was widened with pressure effect in 3 (Fig. 4), stomach was pushed forwards and downwards in 3 (Fig. 5) and 2 others showed a pressure effect on pyloric antrum duodenal loop and body of stomach (Fig. 6).

*Treatment :*

Management of an acute attack required routine conservative measures such as relief of pain by repeated doses of demerol; restriction of feeds orally until the disease was inactive; continuous gastric aspiration by an indwelling Ryle's tube; maintenance of nourishment, fluid and electrolyte balance, and administration of antibiotics as a prophylaxis against infection. The Ryle's tube aspiration prevents distension as well as prevents passage of acid chyme into duodenum, thereby avoiding stimulation of pancreatic secretion, thus providing rest to the diseased organ.

Operative interference was the only choice in relapsing pancreatitis. It was aimed at checking further recurrences so as to avoid increasing fibrosis and consequent dysfunction resulting from each attack. Many procedures have been practised (Table VIII) but we have mainly concentrated on sphincterotomy, using both endocholedochal and transduodenal approach. Gall bladder was removed in all such cases irrespective of presence or absence of any evidence of cholecystitis, though the rationale of removing a healthy gall bladder is not too obvious.

Surgery was resorted to in 18 of our patients in whom 22 operations were performed (Table IX).

TABLE VIII

*Classification of surgical manoeuvres applicable to the treatment of pancreatitis (Cattell and Warren, 1953)*

Indirect :

A. Biliary tract procedures :
   1. Cholecystectomy — Choledochostomy.
   2. Biliary — intestinal anastomoses.
   3. Sphincterotomy.

B. Gastrointestinal diversion :
   1. Gastroenterostomy.
   2. Pyloric exclusion.
   3. Gastrectomy.

C. Nerve interruption :
   1. Sympathectomy
      i. Thoracolumbar sympathectomy.
      ii. Splanchnicectomy.
   2. Vagotomy.

Direct :

A. Drainage of cysts.

B. Lithotomy.

C. Anastomosis :
   1. Continuity.
   2. Diversion.

D. Resection :
   1. Distal pancreatectomy.
   2. Pancreato-duodenectomy.
   3. Total pancreatecotmy.

TABLE IX

*Variety of surgical procedures employed in 18 cases of relapsing pancreatitis.*

| S. No. | Type of operation | No. of operations |
|---|---|---|
| 1 | Cholecystectomy | 3 |
| 2 | Cholecystectomy with dilatation of sphincter of Oddi | 2 |
| 3 | Sphincterotomy { endocholedochal | 4 |
| | { transduodenal | 7 |
| 4 | Simple drainage of psuedocyst | 2 |
| 5 | Marsupialization | 1 |
| 6 | Internal drainage into jejunum by Roux-en-Y loop anastomosis | 3 |
| | Total number of operation | 22 |

Except for 2 cases recently operated on, all have been followed for more than one year. Cholecystectomy alone or in combination with dilatation of the sphincter gave poor results in all the 4 patients where it was tried. Of the 11 cases in whom sphincterotomy was done, 9 had good and 2 poor results (Table X).



TABLE X

*Follow up results.*

| S. No. | Type of operation | Total No. of cases | Result | | | |
|---|---|---|---|---|---|---|
| | | | Good | Fair | Poor | Not traced |
| 1 | Cholecystectomy | 3 | — | — | 3 | — |
| 2 | Cholecystectomy with dilatation of sphincter of Oddi | 2 | — | — | 2 | — |
| 3 | Sphincterotomy — Endocholedochal | 4 | 3 | — | 1 | — |
| | Sphincterotomy — Transduodenal | 7 | 6 | — | 1 | — |

Blind sphincterotomy through the common bile duct has been superseded by transduodenal sphincterotomy in our practice now. We lost 3 cases in all after surgery, one after cholecystectomy, one due to haemorrhage after sphincterotomy and the other due to gastro-intestinal haemorrhage on the 14th post-operative day after Roux-en-Y anastomosis in a pseudo-cyst.

Our limited experience would favour a transduodenal sphincterotomy as the method of choice in the treatment of relapsing pancreatitis but this is a mere tentative appraisal since sufficiently long time has not elapsed yet to adduce convincing evidence. Besides we have not attempted distal pancreatectomy or pancreato-duodenectomy with contralateral thoracolumbar sympathectomy, the most promising combination according to Cattell and Warren (1953), in any patient so far.

SUMMARY

Twenty-five cases of pancreatitis studied during three years have been reported. Seven cases developed psuedopancreatic cysts and four showed disturbances in carbohydrate metabolism. Serum amylase above 320 Somogyi units and urinary diastase above 40 Wohlgemuth units were the main laboratory criteria for diagnosis. In three cases, diagnosis was based on the operative findings of an enlarged firm pancreas, areas of fat necrosis and psuedopancreatic cyst formation or spastic sphincter of oddi. Acute cases were treated conservatively while surgery was resorted to in cases of relapsing pancreatitis. The operative procedures included cholecystectomy in 3, cholecystectomy with dilatation of sphincter of oddi in 2 and sphincterotomy in 11 cases. A follow up of 1—2 years showed good results following sphincterotomy.

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# A PRESACRAL FOETIFORM TERATOMA

*by SUBIR K. CHATTERJEE, Calcutta.*

## Introduction

One could hardly begin a discussion on the very difficult subject of teratoma in a better way than by quoting the following introductory remark of Wright:—"The confusion between true tumours and congenital malformations is nowhere greater than in the group of abnormal growths that are generally known as 'teratomas'. The distinctive feature which led to the inclusion in a common category of all these complex structures, was the incorporation within a single mass of a wide variety of tissue and organoid components which are ordinarily derived from all three of the embryonic germinal layers." Taking this as a working definition for the present pending further discussion, one can classify teratomas on the basis of site as genital and extragenital. The former, occurring in the ovary and testis are fairly common place and usually conform to type. The latter are of infrequent occurrence, and hence of great theoretical interest; they have been grouped as intra-cranial, intra-oral (or epignathi) cervical, intrathoracic, retroperitoneal, presacral, and sacrococcygeal. On the basis of structure, a few of these teratomas presenting a varying proportion of highly differentiated structures resembling foetal parts have been subgrouped under the heading 'Foetiform'. It has been our privilege to encounter a child of six exhibiting just one such foetiform teratoma in the presacral region. We have considered it worthy of a detailed description because of the extreme rarity of certain of its features, particularly in this country, and because it gives an opportunity to review and discuss very briefly the highly controversial literature on the subject of foetiform teratomas.

## CASE REPORT

P.P., a male Bengali child, aged six years, was admitted in September 1949 in the Medical College Hospital, Calcutta, with history of a lump in the lower abdomen. This, the mother said, was present since birth and was slowly growing, but did not cause any other symptoms. On examination, the child was found to be somewhat stunted for his age. He had an oval mass in the lower abdomen, intra-abdominal, with clearly defined upper, right, and left margins, five inches by four inches in size, smooth, firm, not tender, quite immobile, and dull on percussion but having intestinal coils in front of it. On rectal examination, the lower limit of the mass was felt, two inches above the anus, anteriorly and to the left; it was irregular and fixed to the left lateral pelvic wall but not to the rectum itself. Both testes were felt in the scrotum. There was no projection of the mass posteriorly behind the sacrum and coccyx, nor any clinical evidences of neurological involvement.

A plain skiagram of the lower abdomen (Fig. 1) was most revealing. A few long bones, a tooth and some irregular bones were visualised enclosed in a radio-opaque shell, in front of the lower lumbar and sacral vertebrae of the patient. A Barium enema study was next undertaken to show the displacement of the pelvic colon upwards and to the right, and the freedom of the bowel from adhesions. Intravenous pyelography showed that both ureters were displaced far out with angulation but not with any impairment of renal function at that time (Fig. 2).

Fig. 1.
Skiagram of pelvis of patient showing long bones and teeth enclosed in a radio-opaque shell.

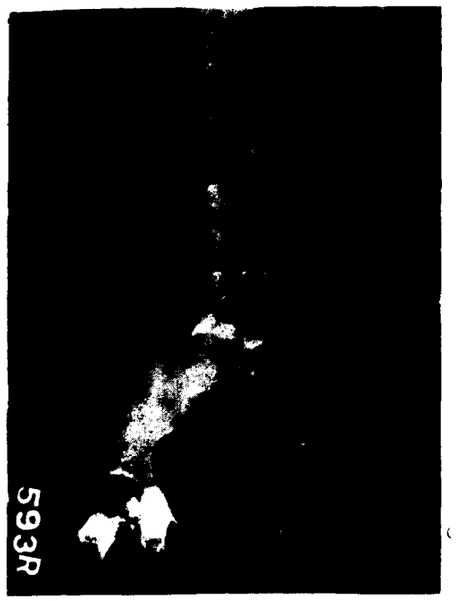


Fig. 2.
Skiagram of intravenous pyelogram showing displacement of ureters.

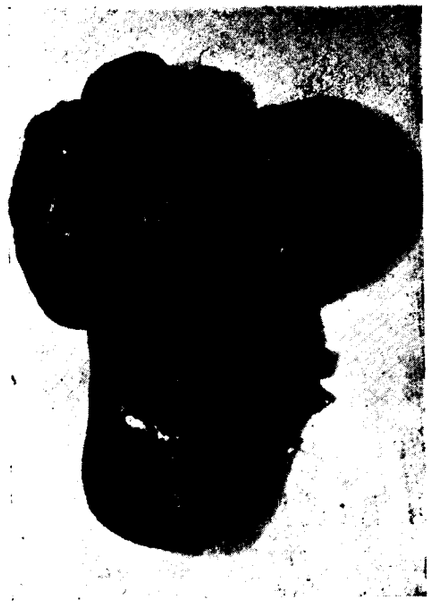

Fig. 3.
Photograph of 'Reverse' side of object.

Soon after the investigations were concluded and while treatment was being planned, the patient got fever with cough and cold. Two days later, he began to complain of severe pain in the lower abdomen radiating down to the left thigh and knee. Temperature was high and remittent. The tumour was for the first time tender and larger in size. Pain increased progressively and soon radiated to both thighs; gradually increasing flexion deformity of both hips developed. Oliguria with strangury, diarrhoea and tenesmus set in; the patient began to get drowsy and distressed, his face became puffy, his renal angles, particularly the left, became very tender, and the veins on the abdominal wall became distended. The abdominal swelling became larger in size and increasingly tender. Rectally, the anal canal was found dilated; the lower limit of the tumour was now one inch from the anus, softer, hot, very tender and more extensive, with the rectal wall fixed to it. The urine contained plenty of red cells and pus cells; non-protein nitrogen in the blood rose to 48 mgs. per 100 ml.

Despite the antibiotics then available, the patient continued to go downhill till he began to pass pus per annum several times, with severe tenesmus. At this time a small opening was felt in the anal canal one inch from the anus leading into the tumour, and the drainage thus afforded gave the patient some relief. This was shortlived however; soon the fever returned with cachexia and listlessness and rapidly increasing oedema of the lower half of the body. Urine contained frank blood and chunks of necrotic matter and hence there was intense strangury. The abdomen as a whole became greatly distended and resistant and very tender, and the mass could no longer be identified clearly. Anuria and pulmonary oedema ended the story on 10-1-1950.

*Postmortem Findings.*

Only a limited postmortem was possible, our access being restricted to the abdomen. The peritoneal cavity contained free fluid. There was a large rounded retroperitoneal mass opposite the lower lumbar vertebrae and sacrum. It was firmly fixed to the bony pelvis and there were dense adhesions between it and loops of small intestine, urinary bladder, pelvic colon and rectum; into the last the mass had ulcerated and burst. The mass also involved the structures on the posterior abdominal wall — the nerves of the lumbosacral plexus, the inferior vena cava which was much compressed, and the ureters which were grossly

Fig. 4.
Photograph of 'Obverse' side of object.

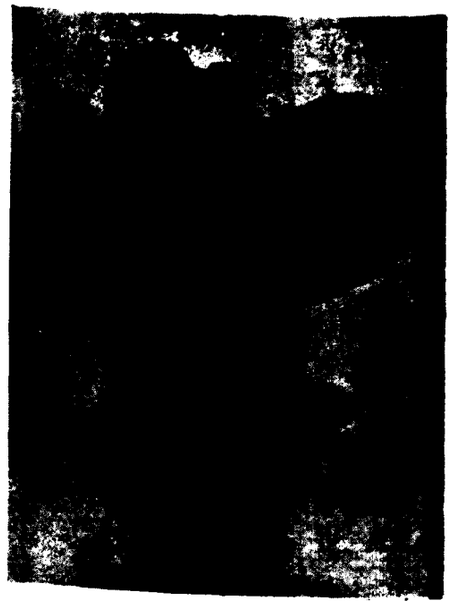

Fig. 5.
Skiagram of object showing skeletal elements clearly.

displaced and compressed with consequent hydronephrotic changes in the kidneys. The mass itself consisted of a very firm thick-walled sac with a very irregular and shaggy inner surface; it was filled with sanguinopurulent fluid, some of which was escaping per rectum, and contained inside it a freely mobile object. The connections between this structure and the sac wall were very slender and could not be definitely established. The cause of death was undoubtedly haematogenous infection of the mass with suppuration and spread and pressure effects on neighbouring structures, particularly the ureters.

*The Object.*

This was four inches by three inches in size, and presented quite clearly an 'obverse' and a 'reverse' surface. The description is more easily begun from the reverse surface (Fig. 3). This consisted of a vertical oblong piece, completely lined with skin-like epithelium; it was four inches long and one and a half inches wide at its widest part; this was one inch from the lower pole, which was rounded; the upper pole was more tapering. The reverse aspects of three appendages could also be seen; the two upper ones were globular and shapeless, but the lower one presented three distinct digits pointed towards the right. At the upper end a tuft of hair could be seen.

On the 'obverse' (Fig. 4), the three appendages could be much more clearly seen. They were all completely lined with skin-like epithelium. The most interesting lower appendage resembled a lower limb bud and exhibited a foot-like piece with three small digits complete with nails. Proximal to this was a second segment folded on itself and connected to the lower pole of the vertical axial piece in such a way that the digits pointed to the left and a deep concave groove was formed above between the vertical piece and the appendage. Bony elements could be palpated in this appendage without difficulty, and mobile joints demonstrated between these bones. The two smaller appendages sprung roughly opposite each other from the upper end of the vertical segment; they were shapeless and soft and homogeneous to the feel; the left-hand one was larger and spheroidal, the smaller right-hand one was more flattened.

In between the site of attachment of these two appendages, a number of complex structures were seen. Firstly, two teeth resembling incisors, dis-



Fig. 6.
Photomicrograph of tissue taken from an upper appendage.

Fig. 7.
Photomicrograph of tissue taken from the heart-like structure.

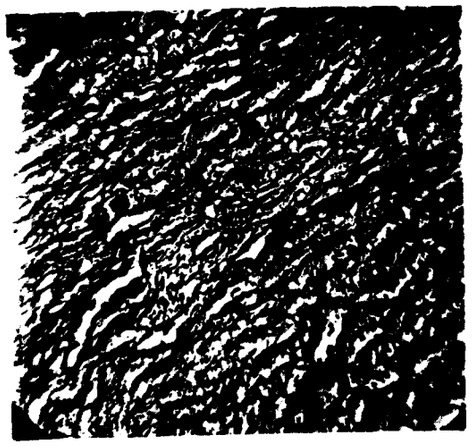

Fig. 8.
Photomicrograph of tissue taken from the intestine-like structure.

posed horizontally with their crowns pointing to the right and their roots embedded in a jaw-like structure which felt bony hard. To the right of this was a small thin soft pedunculated appendage pointing upwards and attached by its lower end to the front of the upper pole of the vertical segment. Adjacent to this was a tuft of long rather coarse hairs pointing upwards (these had been visualised earlier from the reverse). Below the teeth was another small pedunculated appendage attached only by its upper end, and resembling a miniature heart. This could be lifted upwards and forwards to reveal another pedunculated structure, with a thickening along its free lower convex border, and a smaller upper concave border attaching it to the vertical segment, very suggestive of a mesentery with a loop of gut.

A skiagram of the object was taken to get a clearer idea of the disposition of the bones than was possible in the skiagram of the patient with the teratoma in situ (Fig. 5). A long bone was seen running down the entire length of the vertical segment, and a series of short long bones with joints between them, constituting the bones of the lower digit-bearing appendage. A few irregular flat bones were found in the upper part of the object, between the attachment of the globular appendages; no bony elements were seen in the latter. Moreover the shadow of two incisor teeth embedded in a piece of bone was clearly seen here.

The desire to preserve the specimen with the minimum of mutilation has stood in the way of histological study as thorough as one would like to have done. Small portions of tissues were taken from one of the upper appendages, the heart-like structure, and the intestine-like structure. The first (Fig. 6) revealed the structure of fatty tissue with a surface lining of fairly normal skin complete with hair follicles, sebaceous and sweat glands. The section of the organ resembling

heart was stained differentially with van Giesen's stain; this showed that it consisted of fibrous tissue only (Fig. 7), with no muscular element. Likewise, the structure below this was found to consist of fibrous tissue lined with an endothelial layer (Fig. 8).

## Discussion

*Clinical.*

The clinical and radiological features of the case were sufficiently conclusive to warrant a diagnosis of presacral teratoma in the antemortem state. Teratomas in this region have been rather infrequently described in the past as compared to retroperitoneal and sacrococcygeal ones. In fact only a few observers have granted to the presacral teratomas the honour of a separate entity. Some have included them under the heading of retroperitoneal, as indeed they are; others have considered them to be a variety of Sacrococcygeal teratoma, which instead of growing backwards and downwards towards the exterior, extended forwards and upwards into the pelvis and lower abdomen, from behind the rectum. Like the more usual kind of Sacrococcygeal teratoma, they are attached to the front of the sacrum and coccyx and like them they are usually present at birth. Some of these extend in both directions—upwards and forwards into the pelvis as well as downwards and backwards between the buttocks. Those which, like our case do not extend in the latter direction manifest themselves some time after birth either as a lower abdominal swelling or by mechanical effects on the alimentary, urinary and the nervous systems, or by undergoing malignant change. Only irregular calcification was revealed in the majority on radiological examination, only a few showing more mature calcification with recognisable parts of the foetal skeleton or teeth. Although a high proportion of tissue differentiation is encountered in about 10 to 15 percent of true sacrococcygeal teratomas (Gross), few indeed of the retroperitoneal and presacral teratomas have been reported as possessing the structures met with by us.

The prognosis of untreated cases of this condition is uniformly gloomy, death supervening in the majority in infancy or childhood from urinary or intestinal obstruction or from malignant change, often with secondary spread to the lungs. The only treatment of any avail is surgical removal of the entire mass, but this is not always practicable due to fixation of the mass and its vascularity. The transperitoneal route, using a transverse incision is the one advocated by many; few have preferred the retrorectal route after excision of the coccyx. Shock and haemorrhage are the two problems intimately connected with the operation—massive transfusion and efficient means of haemostasis are essential. The operative mortality is considerable. Out of Arnheim's fifteen cases. ten underwent operation; two died soon after and three within the next fifteen months. Of the unoperated cases all died; four with benign lesions and one with papillary adenocarcinoma. The chance of operating upon our case before complications had set in was lost — the post-mortem examination however left us in no doubt that if we had taken it, the object itself would have been removed but its sac would have been quite irremovable.

*Pathological.*

The tumour in our case consisted of a thick walled sac containing sanguinopurulent fluid and a peculiar object lying almost free within it. The presence of well-recognised structures like bones, teeth, hair, and more particularly a limb bearing digits with nails constitute the main interest of this object. The problem that has to be faced in this connection, is. in the words of Nicholson, this: "There are two ways of regarding a teratoma; as an aborted organism that has failed .... to produce an orderly soma, or as a malformation that has partially succeeded, creditably on the whole, in producing a number of somatic tissues. In the former view the teratoma is analogous to the double monsters, in the latter, it is relegated to the harmatoma or tumours."



Nicholson goes on to say "In the one case every real or simulated likeness to an embryo is accentuated, and depreciated in the other. It is by striking the happy mean and exercising care to make our descriptions as colourless and objective as possible that we can hope to attach true values to the phenomena we see."

Most authorities of the past would unhesitatingly place the teratoma in the first category, agreeing with Bland-Sutton's definition of a teratoma being "an irregular conglomerate mass, containing tissues and fragments of viscera belonging to a suppressed foetus, attached to an otherwise normal individual." In other words the tissues of the teratoma were supposed to belong to an individual other than the host; and various ideas were expressed regarding the relationship of this individual to the host — whether it was that of a twin or an offspring.

Exhaustive studies of the subject in subsequent years, particularly by Nicholson, Needham and Willis has resulted in the pendulum swinging entirely in the opposite direction. Willis in fact defines a teratoma as a "true tumour composed of multiple tissues of kinds foreign to the part in which it arises." The parent cells of this unusual neoplasm have been thought to be the undifferentiated pluripotent cells found in the gonads and in relation to the primitive streak and its derivatives, these being the locations where the greatest concentration of primitive cells exist in a foetus over the longest period of time (Gross). The three criteria that Willis has laid down before he is prepared to accept an object as a separate individual are axiation or the presence of an axial skeleton; metameric segmentation or evidence of somites, and organogenesis. It is regarding this third feature that most of the confusion exists. Willis thinks that though a high degree of tissue differentiation and correlations undoubtedly occur in teratomas, there is no development of systems or organs. He finds that there are "masses of nervous tissue but no brain, masses of bone but no bones, renal tissue but no kidneys, muscular tissue but no muscles. Teeth occur without a mouth, tonsillar tissue without a pharynx, digits without a limb."

Our acceptance of Willis' interpretation would lead us to exclude from the heading teratoma those objects which do show axiation, metameric segmentation and organogenesis, and which he would consider to be true inclusion twins or 'foetus in foetu'. Such objects have however been described by other authors as teratomas without any fine distinction, for instance by Gross, Kummel and Hoeven (quoted by Potter). Lord, on the other hand, has recently striven to establish clearly that a 'foetus in foetu' is in fact a malformation while a teratoma is a neoplasm, and that the presence or absence of a vertebrate organisation is the cardinal point of differentiation between them. She has contrasted the clinical and pathological features, prognosis and treatment of two personal cases of intra-abdominal 'foetus in foetu' and seven similar collected cases (including two of those cited above) with ten collected cases of what she calls "undubitable" intra-abdominal "foetiform teratoma". While these may show some striking resemblances to mature organs and parts, they do not exhibit any vertebrate organisation.

The term 'foetiform' for such teratomas was first used by Nicholson, who as a result of a meticulous study of several such teratomas has this to say on the subject:—"'Foetus' is commonly assumed to have evolved by an orderly process of development from an ovum; and a mature, fertilised ovum at that.... We are unconsciously committed to certain theories of teratogenesis from the start and find it difficult not to look for and find strange and impossible likenesses to the human form. And since it is an amiable weakness of teratology to fancy that the words similarity and identity are synonymous, we readily see in a horrid tumour a smiling babe." Nicholson agrees basically with Willis that the teratoma is not a variety of inclusion twin and goes on to say that

what he misses most "in the established teratoma is the coordinating action of a whole upon its parts; in more scientific language, evidence for the action at any stage of development of a dominant organiser for a body".

This finally brings into the discussion the work of the experimental embryologist and the conception of the control of development by chemical substances in the nature of steroids produced in the embryo itself. Development has been shown to proceed normally under the coordinating influence of a dominant organiser or axial organiser; local differentiations are brought about by the activities of locally produced subsidiary organisers and mutual interaction between adjacent primarily independent tissues. Teratomas are thought to result from the escape of a group of pluripotent cells from the influence of the axial organiser—their subsequent non-axial intrinsic determination is due to the liberation of lower grade evocators at abnormal times and places or to abnormal persistence of competence to respond to normal evocators. As Needham says "what lies behind all the strange phenomena which we see in the teratoma is the failure of the individuation field, at some point early in development, to control the action of evocating substances". There is no doubt however that the situation is still far from clear and much work remains to be done before any particular teratoma can be assigned its exact position in the field of oncology.

## Summary

A case of presacral foetiform teratoma which terminated fatally has been described. The teratoma has been studied after postmortem removal. The relevant literature regarding diagnosis, prognosis and treatment of such teratomas has been reviewed. The pathological problem presented by this particular teratoma has been discussed in an effort to determine its correct place in human oncology.

## ACKNOWLEDGMENT

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# THYROID METASTASIS IN BONE

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

Secondary thyroid tumours of bone is a subject of much interest, specially when they present the normal structure of thyroid gland. A case report is presented in this paper where the patient came to hospital with the complaint of a swelling in the thigh. A diagnostic biopsy was done and the swelling proved to be a metastatic thyroid tumour with the histological picture of a normal thyroid gland.

## CASE REPORT

L.M., age 55 years, Hindu female came to the Calcutta National Medical College Hospitals on 1st March, 1955 with the complaints of pain and swelling in the middle of her right thigh of two weeks duration. On examination a diffuse swelling was found in the middle of her right thigh. Skin over the swelling was tense and there were no dilated veins on its surface. The swelling was tender, of variable feel — firm at some places and soft at others, and fixed to the underlying bone. It was not pulsatile. Further examination revealed a big swelling involving the whole of her thyroid gland. The size of the thyroid swelling was that of a big orange, with firm and lobulated feel. Apparently she did not attach any importance to her thyroid lump. On enquiry, it was found that it appeared about ten years ago and slowly increased up to the present size causing no trouble whatsoever.

There was no evidence of hyperthyroidism and she had her menopause about 12 years back.

Skiagram of the thigh swelling (Fig. 2) showed central rarefaction and trabeculation of the right femur at its middle. There was extensive bone absorption and expansion of the femur, but the continuity of the bone was maintained.

Clinical and radiographical examination revealed no other similar lump in any other part of the body.

Clinically the thigh swelling was diagnosed as Ewings' tumour.

Femoral swelling was found to be highly vascular, when incised for Biopsy.

*Histological findings :*

The picture of the tissue removed from the thigh swelling is shown in Figs. 3-a and 3-b. Sections show well formed colloid filled vesicles lined by cubical cells. Part of the section shows clumps of cuboidal cells suggesting an acinar arrangement but there is no definite lumen formation. The cells are larger than normal thyroid epithelial cells, and their nucleii are hyperchromatic but there are no mitotic figures. The stroma is less prominent and some of the blood vessels are narrowed and distorted by the acinar cells. There is no area which suggested malignancy.

The patient left the hospital of her own accord, without any operation either on her thigh or the neck.

Fig. 1.

Photograph of the case showing a lump in the middle of the right thigh and enlargement of the thyroid gland.

Fig. 2.

Skiagram of the thigh swelling showing involvement of the femur at its middle with rarefaction, trabeculation, and expansion of the bone.

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



Fig. 3-A.

Photomicrograph of the bone tumour showing well formed colloid filled vesicles lined by big cuboidal cells with hyperchromatic nuclei. No mitotic figure is seen. Clumps of Cells, at places show acinar arrangement without definite lumen formation. Blood vessels are narrowed and distorted. (H & E x 100)

Fig. 3-B.

Part of Fig. 3-A in higher magnification. (H & E x 450)

## COMMENTS

Thyroid epithelial cells are in close relation to the endothelium of the sinusoidal blood spaces with little or no intervening basement membrane. That is why thyroid tumours have a tendency of early haemic dissemination with metastases in lungs and bones, even before cervical lymph involvement and often these cases come to hospital with the complaint of bone tumours. In Simpson's [14] (1926) review of 77 cases, 94.8% sought medical advice for tumours of the thigh. The case under discussion, though enlargement of her thyroid was present, came to the hospital with complaint of a bone tumour. This is because the thyroid enlargement was giving no trouble and had been present for more than ten years. Thyroid metastasis in bone may not be associated with clinical enlargement of the gland. In other groups of cases the history of removal of thyroid for a benign tumour is a constant finding. The complaint of a bone tumour, the unsatisfactory radiological findings — which can only show involvement of the bone by the growth, and absence of any clinical enlargement of thyroid gland in some cases — often leads to the wrong diagnosis of this tumour as a primary neoplasm of bone. Rosenburger [11] recorded a case in which the limb was removed as a bone sarcoma was diagnosed. Willis [17] (1941) reported a case in which the pathological fracture was thought to be due to sarcoma and extensive deep X-ray therapy was given.

The expansile tendency of the secondary bone tumour as observed in the present case, with erosion and trabeculation, is characteristic of thyroid metastasis. According to Coley[5] (1949), roentgenographic findings of such metastatic tumours, when solitary may be mistaken for cystic disease or osteogenic sarcoma of osteolytic type or aggressive giant cell tumour.

Usually the bone tumours are very vascular and pulsatile so much so that they are mistaken for aneurysms. Rhea[12] (1926) recorded a case in which the iliac artery was ligated for a pulsatile bone tumour of greater trochanter of femur mistaking it for an aneurysm. In a case of sternal metastasis some of the great vessels were ligated by Cramer[2] by mistake. Sometimes the bone tumours are pale and bloodless (Connel[3] — 1930 — case no. 2). In the present case, as in Connell's[3] (1930) case no. 1, the tumour was highly vascular but there was no pulsation in it.

In 1893 Von Eiselberg[15] described such metastatic tumours as "a menstrual phenomenon." Most of the reported cases show definite relation of clinical manifestation to menstrual phases. But we found no such relation in our case. The advanced age of the patient under discussion fits in with the observation of Solan[13] (1954). He stated that bone metastasis rarely occurs in early age whereas lymphnode and lung metastases usually do so. Bone metastasis according to him is "a function of the age of the patient."

The list of bones involved in order of frequency was charted by Simpson[14] (1926) in his excellent review. The most commonly involved bones were found to be Skull & Vertebral bodies.

Thorough clinical and radiographical investigation failed to find any other metastatic lesion in the case under discussion. Joll[10] (1923) is of opinion that single osseous deposit may be the only metastasis in the whole body, whereas Ehrhdt[7] mentioned that bone metastases from thyroid are rarely single and cases in which autopsy examinations were available always showed multiple secondary deposits.

The metastatic bone tumours have the property of secreting thyroxin and may even take over the function of the thyroid gland. This is best exemplified by a case of Von Eiselsberg[15] in which tetany ('cachexia strumi priva') was developed after the removal of thyroid for cancer. The symptoms of tetany disappeared on the appearance of metastasis in the sternum which was subsequently removed and followed by reappearance of symptoms. Recently Solan[13] (1954) and many others have shown from the $I^{131}$ uptake that bone metastases show greater capacity for function than any of the primary thyroid cancers. This fact supports the clinical and experimental observations that in different environmental conditions transplanted thyroid cancers can revert towards functional and organised tissue.

The benign resemblance of the structure of metastatic thyroid in bone led Cohnheim[4] (1876) to advocate the idea of vascular transportation of normal thyroid tissue and its growth as a benign tumour in some distant situation. But Bell[1] (1924), Simpson[14] (1926), Ward[16] (1949) and many others opposed this view and discussed that though the bone tumour gives a picture of normal thyroid, undoubted areas of malignancy can be found in the thyroid gland, although often requiring careful serial sections of the entire gland. Unfortunately the tissue from the neck swelling was not available in the present case, so a valuable finding regarding the nature of the primary thyroid swelling cannot be recorded. Though the histological picture of the bone tumour shows no evidence of malignancy, it resembles that of Jeffries[9] case examined by Ewing in which dural metastasis showed normal regularity of alveoli but the cells were large and their nuclei were hyperchromatic.

Willis[18] (1953) is of opinion that thyroid tumour with evidence of invasion or metastasis is always malignant, irrespective of its histological picture. Solan[13] (1954) observed that follicular type of thyroid cancer has a tendency to metastasize in bones whereas papillary ones do so in the lymph nodes, lungs and other soft parts.



We consider the present case as an instance of follicular variety of thyroid cancer with metastasis in the femur. As histopathological criteria of thyroid malignancy are much less reliable than in any other organ we fully agree with Ward[16] (1949) that careful clinico-pathological study and long follow up is the only way of establishing the nature of a tumour in disputed cases.

## Summary

1. A case of thyroid metastasis in right femur with a normal histological picture is reported and pertinent literature reviewed.

2. The change in behaviour of thyroid cancer in bone metastasis is discussed.

3. The difficulty in diagnosing the bone tumour as a thyroid metastasis is stressed upon.

4. The case is interesting in that the bone tumour was diagnosed as a primary one and the relation to thyroid was only revealed after the histopathological examination of the biopsy material.

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# CONGENITAL ANOMALY OF INTESTINAL ROTATION AND MESENTERIC ATTACHMENT

*by B. SINGH and S. S. BASU, Madras.*

In the course of a series of special dissections undertaken by one of us for the investigation of the blood supply to the pancreas this case of abnormality of the intestines came to notice. In view of some of the interesting features manifested by the specimen, which would lend some understanding to the developmental processes of intestinal rotation, it is considered worthy of record. The subject was an adult male. The observations were as follows :—

(1) *Duodenum* : The duodenum consisted of only the first and second parts, the third and fourth parts were absent. The first part about 1½″ long, started as usual from the pylorus of the stomach to the right of the middle line in transpyloric plane and ran upwards, backwards and to the right and came in relation with the inferior surface of the liver in close contact with the fundus of the gall-bladder. The second part measured 3¼″ and running vertically downwards, reached the level of the upper border of the 3rd lumbar vertebra where it became continuous with the jejunum forming the duodeno-jejunal flexure. Thus the 3rd and the 4th parts of the duodenum were absent.

A peritoneal recess, which admitted the tip of the index finger, was directed upwards and to the right for ¾″ behind the duodeno-jejunal flexure.

(2) *Small intestines* : The small intestines commenced from the duodeno-jejunal flexure ½″ to the right of the middle line at the level of the upper border of the 3rd lumbar vertebra. The entire small intestine was found lying on the right side of the abdominal cavity. The terminal part of the ileum crossed to the left at the level of the intervertebral disc between the fourth and the fifth lumbar vertebrae an inch below the bifurcation of the aorta, and opened into the posteromedial aspect of the caecum about ½″ to the left of the middle line.

(3) *Caecum and appendix* : The caecum measured 2¾″ in length and 2¼″ in breadth. It was lying almost in the middle line over the bodies of the 5th lumbar and the 1st sacral vertebrae. It was hanging freely into the upper posterior part of the pelvis. The appendix was attached to the right border of the caecum ¾″ below the ileo-caecal junction.

(4) *Colon* : (Fig. 1). The total length of the ascending and the transverse colons together was 25″. Starting from the caecum at the level of the lower border of the 4th lumbar vertebra, the colon ascended vertically upwards ½″ to the left of the middle line upto the lower border of the 2nd lumbar vertebra (1st segment), where it took a sharp turn to the right and ran horizontally for 4″ and reached the inferior surface of the liver (2nd segment). Here it took a complete turn forming the hepatic flexure, and running horizontally to the left for 5½″, above the previous segment, reached the left hypochondrial region (3rd segment). Then it made another sharp bend and proceeded vertically downwards for 5″ lying in the left lumbar and iliac regions and reached the level of the brim of the true pelvis (4th segment). From here it again turned upwards and ascended for 5½″ behind the previous segment to reach the spleen (5th segment). Then forming the splenic flexure it continued as the descending colon (6th segment) which was lying in its normal position behind the 4th and the 5th segments of the colon described above. Thus the segments Nos. 1 & 2 formed the ascending colon while the 3rd, 4th, 5th, segments represented the transverse colon.

(5) *Mesentery* : (Fig. 2). It was common to the small intestines and the large gut upto the splenic flexure, there being no separate transverse mesocolon. The mesentery was attached transversely across the middle line, starting ½″ to the right of the middle line at the level of the upper border of the 2nd lumbar vertebra it proceeded to the left for 2¾″ to reach the splenic flexure.


Fig. 1.

Showing the general arrangement of the gut.
S.I. — Small intestine.
C. — Caecum.
L. — Liver.
1, 2, 3 and 4 — Represent the first four segments of the colon. 5th and 6th segments are behind the 4th segment.

Fig. 2.

Showing the attachment of the mesentery to the posterior abdominal wall. The coils of intestine have been lifted up.

(6) *Greater omentum* : It was attached above to the greater curvature of the stomach and below to the upper border of the segment no. 3, and to the left borders of the segments no. 4 and 5. It consisted of two layers of peritoneum without the usual reduplication.

(7) *Peritoneal band* : There was a peritoneal band starting from the back of the mesentery as a small fold which after winding round the jejunum at a point about 2½″ from the duodenum reached the anterior surface of the mesentery. Here the band broadened out and continued to the left along the anterior surface of the mesentery and crossing the anterior surface of the 1st segment of the large gut 2¼″ above the caecum, reached the right border of segment no. 4 where it merged with the visceral peritoneum of the gut.

(8) *Liver* : The right lobe of the liver was found to be normal. The left lobe was

larger in size than usual, and extended to the left under the diaphragm related to the upper fourth of the diaphragmatic surface of the spleen.

## Discussion

To understand the nature of such an anomaly, a knowledge of the embryology of intestinal rotation is essential. The rotation of the gut normally takes place in 3 stages :—

The first stage of rotation occurs between the 5th and 10th weeks of intra-uterine life, when the mid-gut loop lies in the umbilical cord. In this stage the loop which lies in the sagittal plane undergoes an anti-clockwise rotation by 90° so that the pre-arterial or the cranial segment becomes the right and the post-arterial or the caudal segment becomes the left.

The second stage of rotation occurs during the 10th and 11th weeks. Here as the herniated loop is being withdrawn into the abdominal cavity, a further anti-clockwise rotation of 180° about the axis of the superior mesenteric artery takes place. Thus with the completion of this stage, the total anti-clockwise rotation of 270° about the axis of the superior mesenteric artery has taken place from the initial sagittal position of the loop. It is in this stage of rotation that the definitive arrangement of the intestine is attained.

The 3rd stage of rotation extends upto the time of birth or a short time after. The importance of this stage is not due to the very minor degrees of further rotation which takes place during this stage, but lies in the final arrangement and fixation of the gut within the abdominal cavity.

As the rotation is mainly confined to the mid-gut loop, it is in the derivatives of this portion of the gut that the errors of disposition are mostly met with. Further the major part of the rotation occurs during the 2nd stage. Hence most of the anomalies of the intestinal rotation appear during this stage. The possible anomalies are :—(a) Non-rotation, (b) Reversed rotation, (c) Mal-rotation.

The effect on the disposition of the gut of each anomaly will be thus :—

(a) *Non-rotation* : The small intestines lie chiefly to the right of the middle line. The terminal part of the ileum may cross the middle line to reach the left iliac caecum or it may terminate about the midline in a pelvic caecum. The colon is confined to the left side of the abdomen. The caecum which lies in the pelvis or the left iliac region is reversed, i.e. the ileum enters it from the right side. The ascending colon passes upwards from it usually a short distance to the left of the middle line, to reach a position behind the greater curvature of the stomach. Between this point and the normally placed splenic flexure a narrow " U " shaped loop of the transverse colon is formed. The relation of the transverse colon to the greater omentum is maintained normal. The descending and pelvic colons take their usual course (hind gut). In such cases the viscera undergo a great variety of secondary fixation by mesenterial adhesions. The caecum usually is quite mobile and is suspended by a mesentery attached over the lower lumbar vertebra.

Such disposition of the intestines occurs most probably due to the fact that there being no rotation, the caecum and the colon return first and so are pushed to the left by the subsequently withdrawn small intestines. The other changes are consequential to these (Dott, 1923).

(b) *Reversed rotation* : Here instead of the usual anti-clockwise rotation, clockwise rotation takes place and as a result the transverse colon lies behind the superior mesenteric artery and the duodenum crosses in front of it. Except that the surfaces of the intestines will be reversed, the intestines occupy their normal position.

(c) *Mal-rotation* : As the name implies there are in such cases irregular defects of rotation. In these cases several malpositions of the intestines which cannot be fitted into the previous two defects of rotation will occur.



Taking into consideration the effects (as described above) produced by the anomalous rotations, the present case seems to be a case of non-rotation of the mid-gut.

*Surgical importance* : Apart from the fact that any abnormal position of the intestines is of surgical importance, both from the diagnostic and the operative points of view, there are some additional factors of importance to be considered in cases of non-rotation of the gut.

(1) The mesentery being attached by a short base is in grave risk of undergoing torsion.

(2) The caecum being free tends to form adhesions with the neighbouring structures leading in some cases to the compression of a part of the intestines.

(3) The extra peritoneal bands of the type described here may also cause kinking and obstruction of the intestines.

## Summary

A case of congenital anomaly of the intestines in a dissection room subject (male adult) is reported. The caecum lay almost in the middle line over the bodies of the 5th lumbar and the 1st sacral vertebra hanging into the pelvis. The ileum enters its posterior surface from the right side. The ascending and transverse colons which were disposed in loops almost entirely on the left side of the abdominal cavity consist of five segments. The mesentery which was common to the small intestines, the ascending and the transverse colons was attached horizontally to the posterior abdominal wall at the level of the 2nd lumbar vertebra. Other minor anomalies met with have also been described.

It is suggested that the condition is the result of an arrest of rotation or non-rotation of the embryonic gut. The surgical importance of the anomaly has also been indicated.

## Acknowledgment

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# EXCISION OF THE LEFT LOBE OF THE LIVER FOR CAVERNOUS ANGIOMA

*by T. BALAKRISHNAN, Kozhikode.*

A case of solitary deposit in the liver, secondary to a slow growing tumour of the rectum, was reported by Ogilvie in 1953 [1]. In resecting this growth, he had used a new technique of dissection. A pair of artery forceps was drawn through the liver with a gentle stroking movement. When the artery forceps was held up by a strand of tissue, this was clamped and cut, and the dissection continued. In this way, the growth could be removed with half an inch of healthy liver tissue all around.

I had occasion to use this technique recently and found it exceedingly simple and effective.

The patient, a woman, Madu, aged 40 years was admitted on 5-11-55. The points relevant to this report are given below. She had noticed a tumour in the upper abdomen for the last 5 years. On examination she was emaciated, and a large tumour was noticed in the left hypochondrium. It was soft, not tender, and could be easily pushed to the right of the middle line. It was taken to be an enlarged spleen. A barium meal examination showed a typical cascade stomach.

On 9-11-55 exploration was done through a long high left paramedian incision. The tumour was found to be the markedly enlarged left lobe of the liver. Stomach was pushed to the extreme left and the spleen was small. The tumour greatly resembled a large pendulous breast and could be easily bent to the right on its axis. Due to the long continued drag, its attachment to the right lobe seemed oblique rather than vertical. It had a general cystic feel, and a number of lime-sized cysts and a larger number of different sized rounded hard whitish nodules could be seen and felt. Much fibrosis was also evident. The rest of the liver and the other abdominal viscera were normal. The limits of the growth were quite plainly discernible, the coronary ligament superiorly and to the left, and the falciform ligament on the right. It was about three inches thick at its line of union with the right lobe.

Tempted by the absolute localisation of the disease process, and fortified by a dim recollection of the technique described above, it was decided to resect the left lobe. It is incredible how easy it was to go safely across the liver. As the strands of vessels came into view, they were clamped and cut, and this made the dissection almost bloodless. The veins in the thickened outer fibrous covering, near the medial edge of the left coronary and the lower edge of the falciform ligament did cause trouble, but it could be easily controlled. There was no bleeding at all from the cut edge of the liver, and at the end of the operation, the field was perfectly dry.

Convalescence was uneventful, and the patient was discharged from Hospital on the 12th day.

Pathological report: "A small whitish nodule consisting of numerous cavernous angiomatous spaces, separated by thick fibrous septa. One portion of the tumour shows similar spaces but mostly filled up by eosinophilic a-cellular material. No evidence of any liver cells."

I am reporting this case to show the safety and simplicity of this technique of resection of the liver. Textbooks of Operative Surgery such as Orr's, and Maingot's Abdominal Operations do not mention this technique. I have no doubt that this method would enable safe removal of many localised lesions of the liver.

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# A METHOD OF TRANS-ABDOMINAL, TRANS-DIAPHRAGMATIC VAGOTOMY IN THE DOG

*by G. ALLEN and D. M. HANCOCK, Vellore.*

## Introduction

The protection of the dog against the ulcer provoked by a course of injections of histamine-in-bees wax (Varco [1], Hay [2], Lannin [3], Wangensteen [4], State [5]) has become a standard method in the experimental evaluation of a satisfactory operation for peptic ulcer in man. Wangensteen holds that no new operation for peptic ulcer should be carried out in man until it has been shown to confer protection in the dog or other satisfactory experimental animal against the histamine-provoked ulcer. He also states that the operation which protects the dog against the ulcer induced normally by histamine-in-bees wax is unlikely to be followed by recurrent ulcer when used in man (Wangensteen [4]).

Vagotomy, combined with gastro-enterostomy or various types of gastrectomy and segmental gastric resection, carried out in the dog is now an established procedure in experimental ulcer surgery. The vagotomy is usually done as a separate procedure through the chest although the division of the nerves at the cardio-oesophageal junction by a trans-abdominal approach has also been described. We wish to record a relatively easy and simple method of sectioning the nerves in the posterior mediastinum using a trans-abdominal trans-diaphragmatic approach.

## Dissatisfaction with previous procedures

We have been profoundly dissatisfied with the orthodox sub-diaphragmatic method with division of the branches of the vagi at the oesophago-gastric junction. This is not only a tedious procedure, but also usually inadequate as it is difficult to get all the branches, and an incomplete vagotomy often results, as we have found at post-mortem examination. The trans-thoracic method of vagotomy involves a two-stage procedure, complicated anaesthesia, and carries with it a definite morbidity.

With the idea in view of finding a better method, one of us (G.A.) dissected the vagus nerves at post-mortem in 5 dogs. Furthermore, at operation in 27 dogs we have noted carefully the distribution of the vagal trunks at the lower end of the oesophagus.

## Anatomy

The vagi descend over the lower oesophagus with one or more large communicating branches between them. However, at a variable distance above the gastro-oesophageal junction they form into two trunks, one lying anteriorly and the other posteriorly. These two trunks are closely bound to the oesophagus at the gastro-oesophageal junction and just beyond this junction they burst into a shower of branches on the anterior and posterior surfaces of the stomach. However, one inch above the gastro-oesophageal junction, the two trunks lie quite free in a well-defined posterior mediastinal pouch. This pouch is a large epithelial lined pocket extending from the inferior pulmonary vein superiorly, to the gastro-oesophageal junction inferiorly. The pouch is bounded, on the left, by the right lateral surface of the oesophagus, and on the right, by the lower posterior part of the diaphragm. Anteriorly the whole pouch is roofed over by pleura and posteriorly the pouch is separated from the left pleural cavity by a thin diaphanous membrane on which lies the single trunk of the posterior vagus after it has left the posterior aspect of the oesophagus. The anterior vagus lies on the anetrior aspect of the oesophagus as a single trunk close to the left lateral limit of the pouch. The pouch may communicate with the pleural

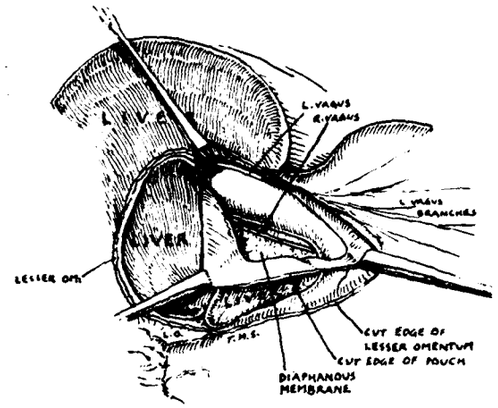


Fig. 1.
Diagram showing the view obtained when a generous incision has been made into the pouch and the edges widely retracted.

Fig. 2.
Photograph showing stomach pulled downwards and to the left. The edges of the pouch are retracted outwards. The anterior vagus is seen gripped with a haemostat. The posterior vagus is seen lying on the diaphanous membrane separating it from the left pleural cavity. It has been pulled outwards from its usual position by traction on the edges of the pouch.

Fig. 3.
The posterior vagus has been freed and retracted with a hook. A rent has purposely been made in the diaphanous membrane during the separation of the nerve and a free communication with the left pleural cavity is clearly seen. (N.B.—It is usually possible to separate this nerve without entering the pleura.).

Fig. 4.
The edges of the pouch have been closed by a continuous cotton suture. The lower edge of the liver has been retracted upwards with a haemostat.



cavity either by a large opening anteriorly or posteriorly by numerous small holes in the diaphnous membrane described above. On the left side the pleural cavity comes down beyond the level of the oesophago-gastric junction.

### Technique

The animal is anaesthetised with intravenous nembutal, an endotracheal tube passed, and the pharynx packed firmly around it. After the abdomen is opened the greater curvature is mobilized and the duodeno-hepatic ligament is divided. The stomach is pulled down and the lesser sac is entered through an avascular area high up in the lesser omentum. The pouch is identified by noting the junction between the diaphragm and the oesophagus on the right side. The muscle fibres here are grasped in forceps and the tendinous connection between the diaphragm and the right side of the oesophagus incised transversely. The shining oesophagus, and the diaphanous posterior pleura are immediately seen (Fig. 1). The edges of the pouch anterior to the oesophagus are now pulled upwards and the anterior vagus identified. It is pulled out with a hook, divided between clamps, tied off and allowed to retract. The stomach is now pulled downward and to the left, the right lower cut edge of the pouch is now pulled out and the posterior vagus is seen lying on the diaphanous membrane as a single trunk (Figs. 2 & 3). It is carefully separated and divided between clamps and tied off. Occasionally large veins accompany this nerve. The pouch is now closed with a running suture of cotton which re-attaches the diaphragm to the oesophagus (Fig. 4).

### Difficulties

We have been impressed by the ease with which a complete vagotomy has been accomplished. The procedure takes about 10 minutes. The only trouble we encountered was the development of pneumothorax either immediately after opening the pouch, or on picking up the posterior vagus. The former is easily understood if it is remembered that often the pouch communicates with the pleura. It the latter, the diaphanous posterior membrane may be ruptured in separating the posterior vagal trunk. Formerly on opening the pouch we used to immediately pack the pouch with a long piece of gauze but this usually led to further tearing of the pocket, aggravation of the pneumothorax and "flapping" of the mediastinum. We have found that a method of countering the pneumothorax is to keep the pouch wide open while the vagotomy is being performed. In some cases, despite this manoeuvre, a valvular tension pneumothorax still occurs. In these cases we introduce a trocar and cannula into the left pleural cavity through the diaphragm, remove the trocar and connect the cannula to an under-water seal. At the same time an attender continues positive pressure air inflation through the endo-tracheal tube using an "Oxford Inflating Bellows". Once the pouch has been closed off any residual pleural air is expressed through the cannula by manual pressure over the chest. A purse string suture is inserted around the site of diaphragmatic puncture and closed as the cannula is withdrawn. Of these manoeuvres, just detailed, positive pressure artificial respiration is the most important. Valvular pneumothorax is immediately bilateral in the dog, and, unless relieved, fatal in a few minutes. Air inflation can usually be discontinued once the pouch has been closed.

### Summary

Emphasis is laid on the protection of the dog against the histamine-in-bees wax induced ulcer as a standard method for the evaluation of a satisfactory operation for peptic ulcer in man. Vagotomy combined with other intra-abdominal procedures is becoming increasingly used in the treatment of peptic ulcer. Evaluation of these combined procedures in animals requires a one stage operation, as valuable time is lost, and the morbidity is increased, when trans-thoracic vagotomy is added to the intra-abdominal procedure. A safe, easy

and complete method is described for the dog — the vagi being divided in the posterior mediastinum using a trans-abdominal trans-diaphragmatic approach.

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## ADDENDUM

Since writing this paper and submitting it for publication Dr. Somervell drew our attention to the existence of the pneumato-enteric recess on the right side of the gullet in the 4 mm. human embryo. There is also a small recess on the left side of the gullet but this very quickly disappears. Hamilton, Boyd and Mossman (1946) state that the right recess progressively enlarges and with the development of the diaphragm the upper portion becomes separated from the lower. The upper portion forms a "small closed subdiaphragmatic mesothelial cavity —the infracardiac fossa" while the lower portion is stated to form the primitive lesser sac. Recently Barrett (1954) has stressed the importance of a pre-formed peritoneal sac lying in the mediastinum in the aetiology of para-oesophageal hernia. He thinks this sac may be due to persistence of the right pneumato-enteric recess.

We feel that the mediastinal pouch that we have described is the equivalent structure in the dog, to the infracradiac fossa of man. In the dog it is larger and more evident than in man where the infracardiac fossa is a mere vestigial structure. In the 33 dogs that we have examined this pouch has always been closed off from the peritoneal cavity. We hope to investigate this point further by examining sections of the dog embryo. We were interested to note the close relation of the right vagus nerve to the infracardiac fossa in the section of the 25 mm. human foetus produced by Morris (1954).

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# ORTHOPAEDIC SECTION

## CONGENITAL PSEUDARTHROSIS OF THE TIBIA

### (Treated by Massive Double Onlay Homogeneous Bone Graft taken from Father)

*by R. MAHADEVAN, Madras.*

### INTRODUCTION

Congenital pseudarthrosis of the tibia typically involves the junction of the middle with the lower third of the bone and is characterised by indolence of the fragments, minimal callus formation and a persistent non-union which is very difficult to rectify. The adjacent fibula may or may not be involved. Not all cases are of congenital origin. Some infants are normal at birth, pseudarthrosis developing after a fracture sustained in infancy. In others, the infant is born with an angular deformity of the tibia but no fracture, pseudarthrosis developing in later months or years, as a result of fracture or corrective osteotomy (Watson-Jones, 1955). The condition is also sometimes referred to as 'Birth Fracture' of the tibia, but differs from other birth fractures as of the femur, humerus and clavicle where rapid union with massive callus formation is the rule. Indeed nothing will stop these from uniting, but tibial birth fractures persistently fail to unite. In no other condition is bony union so difficult to obtain. Cases have been reported where as many as 14 or more operations have been done before bony union ultimately resulted. Putti reported 11 failures in 13 bone-grafting operations. Often, after many years of treatment cases ended in amputations because the limbs were shortened, atrophic and functionally useless (Watson-Jones, 1955). As late as May 1939, the President of the British Orthopaedic Association, speaking on bone-graft said that no satisfactory way of grafting birth fractures of the tibia has been found (McFarland, 1940). So persistent is this particular type of non-union that the term 'malignant non-union' has been suggested for it, under the impression that osteolysis here is almost malignant in its capacity to absorb all bone within reach.

Fortunately, the condition is one of great rarity. Many text books in Surgery including some of the special treatises on orthopaedic surgery do not even mention the condition. The first case I saw in our country was in 1944 and I had two more cases under my care thereafter. The case described here in detail was the first. The second was under observation for too short a time after operation, and the whereabouts of the patient not being known, the end result could not be assessed. The third case was not operated, as permission was refused by the parents. Usually there is gross deformity of the leg by the time the infants are brought for treatment (Figs. 1, 2 and 3) particularly if weight bearing had been allowed, as is often the case and as had happened in this particular case also.

### AETIOLOGY AND PATHOLOGY

These are not yet fully understood. Whether it is of congenital origin is itself doubted, for it is seldom associated with other congenital deformities. In some cases the child is born normal and the deformity evidences itself later. The term 'birth fracture of tibia' is also therefore questioned. At any rate these terms are not applicable to all cases. No abnormality has been found in the calcium, phosphorous or phosphatase levels of the blood; there is no hereditary factor (Watson-Jones, 1955). Suggested theories as to the causation are:

(1) Congenital defect in the tibia resulting from a deficiency in the germ cells.

(2) Congenital absence of the nutrient artery of the tibia.

(3) Fracture through a bone cyst followed by non-union (Boyd H. B., 1941).

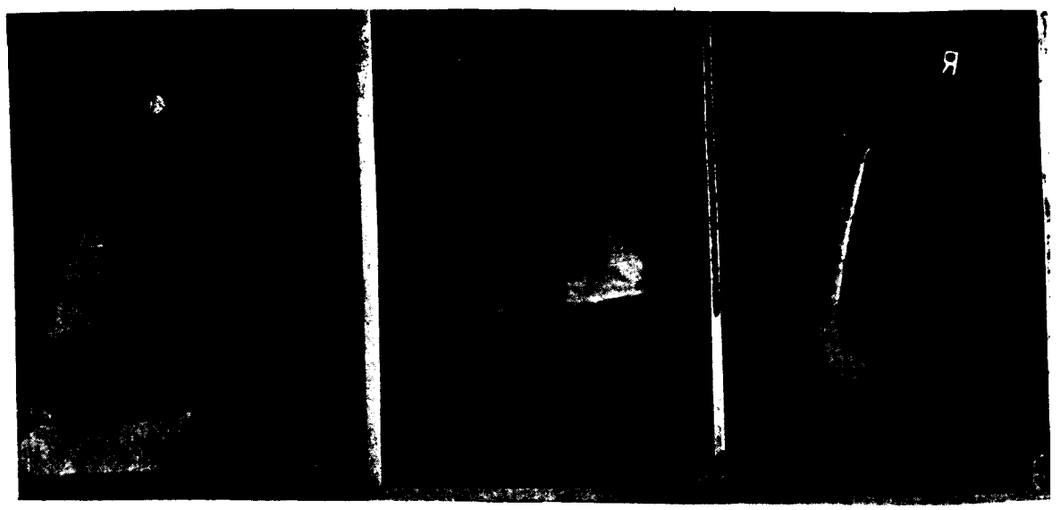

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Shows the deformity at the time of admission, viz., 8th January, 1951.

Figs. 2 & 3. Skiagrams, lateral and A.P. views at the time of admission. The fibula is also involved.

Fig. 4. Fig. 5.

Figs. 4 & 5. Another case of congenital pseudarthrosis which shows extensive cystic changes in the shaft of tibia with involvement of fibula also.

(4) That it results from a fatigue fracture of a congenitally abnormal tibia, but that its persistence depends entirely on mechanical factors (McFarland, 1951).

(5) That it is due to the same mechanical causes that cause non-union in fractures at the same site in adults (Watson-Jones, 1955) viz., poverty of blood supply to this area, shearing strain and imperfect immobilisation.

The first two causes may account for a congenital defect in the tibia. Pseudarthrosis which develop after birth are probably due to bone cysts and in these, the fracture is usually noted sometime during the first two years of life (Boyd H. B., 1941). Boyd refers to cases reported by Scott, illustrated by serial radiograms, showing the tibia before the cyst was demonstrable, followed by the development of the cyst, pathological fracture and formation of pseudarthrosis. Pathologically and roentgenologically the cysts resemble those seen in osteitis fibrosa, but differ from the latter in that whereas healing with callus formation is the rule in cysts of osteitis fibrosa, there is no attempt whatever at healing in congenital pseudarthrosis. In some cases there is no evidence of any cyst and the proximal and distal



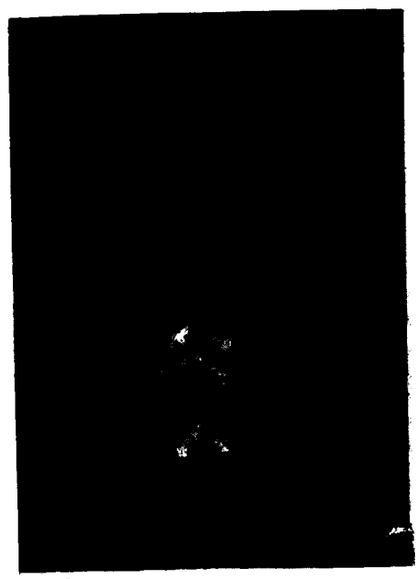

Fig. 6.
Shows the double onlay grafts.

Fig. 7.
Skiagram showing the Krischner's wires introduced and incorporated in the plaster for secure immobilisation.

fragments of the tibia show bony tapering ends. Possibly these are of congenital origin, result of absence of a segment of tibia due to a deficiency in the germ cells or absence of nutrient artery.

Duraiswamy (1950) by injecting insulin into the yolk of hen's eggs caused various congenital defects in the chicken, particularly skeletal abnormalities which can be compared to osteogenesis imperfecta. Possibly then, some similar influence is at work in the human embryo, resulting in a dysplasia of the mesenchyme which later results in a defect of the tibia. McFarland (1951) says that there is no doubt that in all cases of pseudarthrosis a defect exists in the shaft of the tibia in addition to the fracture itself. The defective area varies in length and may involve nearly the whole shaft (Figs. 4 and 5).



It is well known that fractures of the lower third of the tibia in the adults also, are notorious for their non-union. Taking into consideration the various theories and various types of pseudarthrosis met with, it seems very likely as mentioned by Watson-Jones (1955) that pseudarthrosis arises from the same local conditions that cause non-union of fractures in adults, viz. similar site, known paucity of blood supply to the area, shearing strain because of angulation and imperfect immobilisation.

*Association with other diseases*: In some cases reported, the condition was associated with congenital bow legs, and in others with Von Recklinghausen's neurofibromatosis (Moore, B. H.). Whether these diseases have any causal relationship is not clear.

Fig. 8.

Fig. 9.

Figs. 8 & 9. (X-rays on 7-5-51) show condition after removal of portions of the grafts. For further details see text.

## CASE REPORT

U., an infant boy about 10 months old, was first seen in 1944 for treatment of congenital pseudarthrosis of right leg. The deformity was corrected and the limb immobilised in plaster. He was lost sight of till 1951, when he was 7 years old. He had been walking on the limb and Fig. 1 shows the gross deformity and shortening of the leg. Figs. 2 and 3 show the skiagraphic appearances. The tibial pseudarthrosis at the classical level and the involvement of the fibula also are clearly shown.

On 15-1-51 the pseudarthrosis was exposed, connective tissue and eburnated bone excised till healthy marrow was seen, deformity corrected and massive double onlay bone grafts each 3" x ¾", taken from the tibia of the father, were laid on and screwed in place with 3 vitallium screws on each side (Fig. 6). Because of the massive grafts, the deep facia could not be approximated over them. The skin and subcutaneous tissue also did not come together in places. To ensure perfect immobilisation two Krischner's wires were introduced one below the tuberosity of the tibia and the other through the os-calcis and were incorporated in the plaster (Fig. 7).

2-3-1951. Krischner's wires removed. Plaster renewed.

7-5-1951. The gap was filled with bone, but the outer graft was in great part bereft of soft tissue coverings; so part of this graft and the three screws keeping it in place which had loosened had to be removed. The top portion of the medial graft also was bare and this bit of bone also was removed. The raw area was dusted with sulphanilamide powder and limb encased in plaster. Figs. 8 and 9 show the condition after removal of these portions of the grafts.

16-11-1951. Plaster removed. Firm bony union was evident. The raw area that was present at the time of the previous examination (7-5-1951) was now covered over by healthy skin. A small sequestrum and a screw that was loose were removed. A walking caliper with a high heeled shoe was provided.

27-4-1952. The father reported to say that the boy was able to walk good distances without discomfort.

1-6-1954. Firm union (Figs. 10 and 11). Patient walked about freely but measurements showed a shortening of 2.4" (Fig 12) with resultant pelvic tilt and scoliosis (Figs. 12 and 13). An appropriate high heeled shoe fitted with cork heel was provided. Previously the patient was walking off and on without any corrective shoe. He was now advised to wear it all the time except when recumbent.

3-5-1956. Patient was seen today. He was able to walk about and run about well without any discomfort. He is able to take part in most of the school sports, and recently he was able to visit a hill-temple getting up and down the 1000 and odd steps. The shortening of the tibia was now only 1½". The femur on the right (affected) side was longer than the left (healthy side) by ½". The various measurements are shown in the table below. Fig. 14 shows the latest skiagraphic appearances.

TABLE 1.

Measurements of Lower Limbs as on 3-5-1956.

| | Right | Left |
|---|---|---|
| Ant. sup. spine to adductor tubercle | * 14½" | 14" |
| Ant. sup. spine to int. malleolus | 26½" | 28" |
| Tibial tuberosity int. malleolus | 10¼" | 11⅞" |

* The femur on the affected side was ½" longer than on the healthy side.



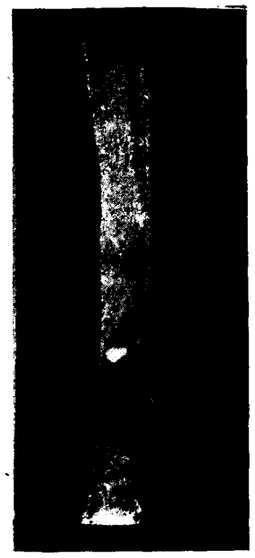

Fig. 10.

Fig. 11.

Figs. 10 & 11. Show the condition on 1-6-54. There is firm bony union. The lateral view shows the reformation of the medullary canal. There is a slight hour-glass constriction at the area of the old pseudarthrosis.

## DISCUSSION

The difficulty of obtaining firm bony union in these cases has already been described. Wilson obtained remarkable success in securing bony union both in acquired and congenital pseudarthrosis of the tibia, by a simple method of two-stage transplantation of the fibula into the tibial fragments, the principle of which is illustrated in Fig. 15. He in a way has anticipated the well known McFarland's method. Those who are interested must peruse his original paper (Wilson, 1941). However, 4 of his 9 patients at the time of the operation were adults, the youngest patient being aged 5. 3 of the 9 cases required supplementary bone-grafting operations, before firm bony union could be obtained.

As far as can be ascertained, the first recorded successes in the treatment of pseudarthrosis of tibia in childhood were

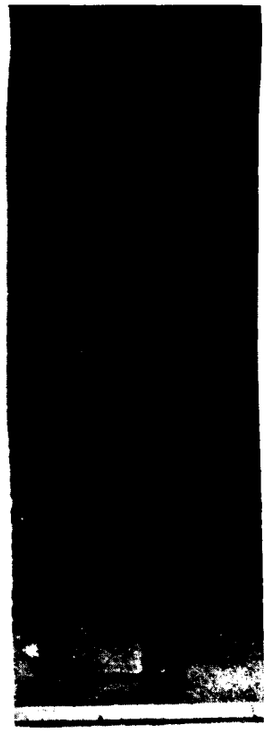

Fig. 12.

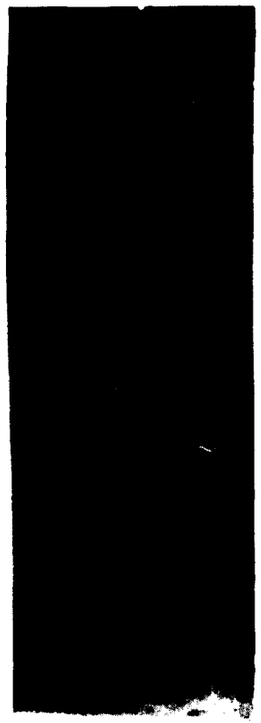

Fig. 13.

Figs. 12 & 13. Clinical photographs (as on 1-6-54), figure 12 shows the shortening (2·4") and figure 13 the consequent pelvic tilt and scoliosis.

by the by-pass graft operation (Fig. 16) introduced in 1937 by McFarland (McFarland, 1940). He also described the use of double onlay graft later described by Boyd also (Boyd, 1941). Boyd not only used dual grafts, but filled the gap and all around with cancellous bone. He considered this an important step, as cancellous bone is a powerful Osteogenic factor. In the case reported here, double onlay graft was inserted, but no cancellous bone was put in, to fill the gap.

McFarland adopted his method originally, under the impression that there is something sinister in the area of non-union (a malignant non-union as it were, which has already been referred to) and thought it necessary to avoid opening up the area. It is now known that the success of his by-pass graft operation is due to the sound fixation of a stout graft to a broad base of bone well above and below the site of pseudarthrosis, in such a position that the inhibitory effect of angulatory strain is excluded by short circuiting the angulation (Watson-Jones, 1955). Indeed, where the angulatory strain is not properly corrected, fracture may recur after bony union, but at a different site, i.e. at the new site of stress. Watson-Jones quotes and illustrates such a complication with skiagrams (Watson-Jones, 1955).



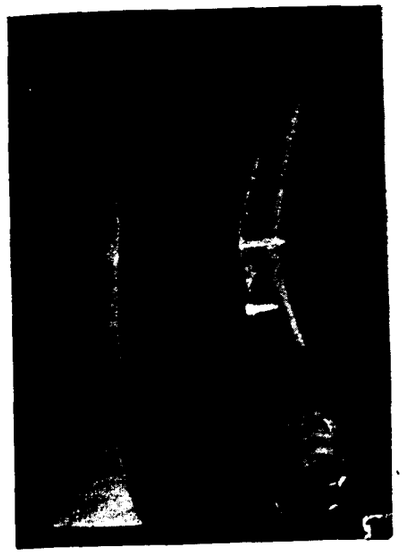

Fig. 14.

Shows the skiagraphic appearances two years later (3rd May, 1956). The lateral view shows the complete reformation of the medullary canal but the hour-glass constriction is still evident. *At this time, the shortening of the right lower limb was only 1½".* For further details see text and table I.

Fig. 15.

Diagram showing the principle of Wilson's operation of "Fibular Transplant".

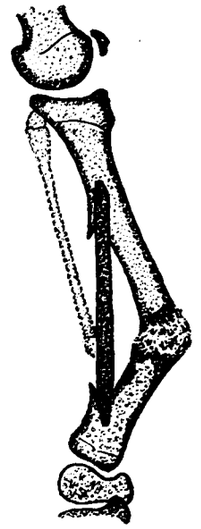

Fig. 16.

Diagram showing McFarland's operation of "By-pass Bone Graft".

Many of the earlier bone graft operations failed, because an inlay graft was often used, taken from the child itself, (from opposite tibia usually). This involved so much interference with the already slender bony ends of the pseudarthrosis, that a large gap resulted and the inlay graft that could be used was too small to serve any useful purpose. Obviously, therefore, autogenous grafts were not useful and homogenous grafts had to be utilised for obtaining large grafts. Once this was realised, the development of dual onlay grafts was the only obvious next logical step. Another advantage of onlay graft is, that as much as possible of the patient's bone at the site of pseudarthrosis can be preserved. This lessens the degree of shortening that may otherwise occur.

Before the method of double onlay autogenous grafts was developed, it was the consensus of opinion that the older the patient the better were the chances of securing bony union. Canurati states that surgery should not be attempted under the age of 6 years. But the disadvantage of

such a delay is that the deformity and shortening of the leg increase with the growth of the child. These may happen even with the best cooperation of the parents in ensuring that weight bearing is avoided and in spite of appliances like leather braces for preventing deformity. It is therefore better to operate before weight bearing begins and the method of double onlay grafts seems the best for operating at such an early stage. The graft should extend as far down the tibia as possible without causing damage to the lower tibial epiphysis and for an equal distance or more above the fracture site. The larger the graft the better the results, and in small children the graft may extend even up to the upper tibial metaphysis (Boyd, 1941).

At the time of operation, tenotomy to lengthen a shortened tendo Achillis, or correction of valgus deformities usually seen in cases with fibular defects, may all be required. Autogenous grafts may be preferable theoretically but as to why this is not so, has already been explained. Homogeneous grafts have worked out successfully. In the case reported here, the patient and the donor were of the same blood group. It probably makes little difference whether the patient and the bone donor are of the same blood group, since bone and not blood, is transfered. In fact, the first bone graft on a human being was done in 1880 by Macewen and at that time the very idea of blood grouping had not emerged, though the possibilities of blood transfusion had been thought of even earlier. He did the operation to fill a gap of 5″ in the shaft of the humerus of a boy who had osteomyelitis two years previously. On looking back, it is now very interesting to note that at the operation Macewen utilised 5 wedge shaped pieces of bone, from the tibias of various persons on whom he had performed osteotomy. The graft took well (Burns, 1948). Allan De Forest Smith reported successful homogeneous bone grafts from donors in whom blood grouping was not the same as that of the recipient, as well as in instances where the blood was compatible (Boyd, 1941).

In the case reported here, the father of the boy, himself a doctor, was 45 years old when bone graft was taken from him. For nearly three years he experienced pain and tenderness in the area from where the graft had been taken. He is now quite alright, but has not tried walking more than three miles at a stretch. This he is able to do without discomfort. He was somewhat anaemic at the time of operation. This, and his age probably interfered with the process of bone regeneration. At school other children made fun of the boy's deformity, which caused in him a definite psychological upset. It is the realisation of this fact, more than even the obviously increasing deformity, that made the father ultimately decide to get the child operated. Now, with the correction of the deformity the child has grown out of this psychological upset. He walks easily, runs and plays about well and is able to take part in at least some of the school games.

## Summary and Conclusion

1. Congenital pseudarthrosis of the tibia is a rare but interesting condition, in which the chief difficulty lies in securing good bony union.

2. The aetiology of the condition is not yet fully known. The various possible factors and theories adduced are briefly discussed. In spite of various views, the most fitting explanation seems to be a simple one, as often happens in such controversial questions.

viz. that congenital pseudarthrosis arises from the same local conditions that cause non-union of tibial fractures in adults in the same site, i.e. poverty of blood supply in the area, shearing strain because of angulation and imperfect immbolisation.

3. The secret of success in treatment lies in ensuring sound fixation of the graft with the host fragments in accurate alignment. The best method of achieving this seems to be by double onlay autogenous graft, a method which can be adopted before the infant begins to walk. By operating at such an early stage, deformity and shortening can be minimised.

4. Alternative operations like Wilson's fibular transplant and McFarland's by-pass graft, are briefly discussed.

5. Detailed description is given of a case of congenital pseudarthrosis with considerable deformity in a boy of seven, successfully treated by massive double onlay bone grafts taken from the father.



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## THE XVIII ANNUAL CONFERENCE

The XVIII Annual Conference of the Association of Surgeons of India will be held at Indore during the last week of December 1956. Dr. B. B. Ohri, M.S., F.R.C.S., Professor of Surgery, M. G. M. Medical College, Indore, is the Local Secretary, and members will receive individual intimation regarding details and exact dates of the Conference from him in due course.

At the Conference, the following subjects will be discussed :—

1. *Cancer of the Lung*—

   Opener : Dr. A. K. Basu, Calcutta. (Surgical aspect)
   Seconder : Dr. R. Dutt Chowdhuri, Calcutta. (Pathological aspect)
   Seconder : Dr. N. B. Roy, Calcutta. (Radiotherapeutic aspect)

2. *Hypospadias*—

   Opener : Dr. R. N. Sinha, Patna.
   Seconder : Dr. R. N. Sharma, Lucknow.

3. *Spinal Injuries particularly of the Cervical Spine*—

   Opener : Dr. H. K. Sarkar, Calcutta.
   Seconder : Dr. A. K. Saha, Calcutta.

Besides these, the following Anaesthetic papers will be read at the Conference in conjunction with the above papers :—

1. Anaesthesia in Cancer Lung
   by Dr. S. K. Chatterjee.
2. Anaesthesia in Surgery of Spine
   by Dr. S. K. Bakshi.
3. Anaesthesia in Pediatrics
   by Dr. M. S. Kohili.

In addition to the above a few "Short Papers" will be read at the Conference. Members will get separate notice from the Hony. Secretary about this during the 1st week of September, 1956.

**Subjects for discussion at future meetings**

19th Meeting :

1. *Non-malignant Stricture of Oesophagus*
   by Dr. Subrata Banerjee, Calcutta.
2. *Surgery of Intracranial Vascular Lesions*
   by Dr. B. Ramamurthi, Madras.
3. *Tumours of the Testis*
   by Dr. E. J. Borges, Bombay.

20th Meeting :

1. *Acquired Facial Defects*
   by Dr. M. Mukherji, Calcutta.
2. *Hydronephrosis—Experimental and Clinical Studies*
   by Dr. B. N Balakrishna Rao, Gwalior and 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. P. K. Sen, Bombay.

## SECTION OF ORTHOPAEDICS

The following letter from the Secretary, Orthopaedic Section of the Association of Surgeons of India, is published for information of the members :—

ORTHOPAEDIC SECTION OF THE ASSOCIATION OF SURGEONS OF INDIA.

Department of Orthopaedic Surgery,
Prince of Wales Medical College,
BANKIPORE — PATNA-4.

Dated July 16, 1956.

Dear Friend,

As you already know an Orthopaedic Section of the Association of Surgeons of India was formed about two years ago and at the last annual conference at Amritsar the following two resolutions were adopted :—

(1) "Resolved that the formation of a Section of Orthopaedics within the Association of Surgeons of India be regularised with powers to elect its own Sectional President and other Office-bearers for the working of the Section ; and to frame such bye-laws as may be found necessary."

(2) "Resolved that a Section of the Indian Journal of Surgery be devoted to Orthopaedic Surgery under the direction of a Sectional Editor elected by the Orthopaedic Section. The articles for this Section shall be edited by the Sectional Editor and submitted to the General Editors for suitable action."

I bring the above to your notice so that if you have any articles or case reports in Orthopaedic Surgery you may please send it for publication in the Indian Journal of Surgery. All these articles may please be forwarded directly to our Editor of the Orthopaedic Section, Dr. N. S. NARASIMHA AYYAR, 221, Thambu Chetty Street, Madras-1.

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We have been carrying on the activities of the Orthopaedic Section by arranging regional meetings which have been held at different places in India. Last time we met at Calcutta on the 14th and 15th of April, 1956. The draft rules and regulations of the Orthopaedic Section have already been circulated last year in June and it has been decided to put them up before the General Body Meeting of the Orthopaedic Section at the annual conference of the A.S.I. scheduled for INDORE. I shall be grateful if you please help me with your ideas and any suggestions in this respect that you would like to be considered at the INDORE session. I may mention the following :—

"The membership of the Orthopaedic Section will be open to those who are members of the A.S.I. and will be limited to those who practise Orthopaedic Surgery exclusively or as a major part of their work. The membership will be scrutinized by the Executive Committee of the Orthopaedic Section which will also advise the A.S.I. regarding honorary or associate membership."

Will you please write to me giving me your assent, in the light of the above, whether your name be noted down as an Orthopaedic Surgeon for merbership.

It has been decided to hold another regional meeting of the Orthopaedic Section of the Association of Surgeons of India at PATNA MEDICAL COLLEGE, on the 29th and 30th of September, 1956. We are trying to arrange a scientific section on Orthopaedic problems including demonstration of clinical material. In this connexion may I request you to please let me know at your earliest convenience about the following points :—

(a) Whether you accept our request to join this Regional Meeting at PATNA on the 29th and 30th of September, 1956.

(b) Please intimate the number of persons coming with you and your directions for making arrangements of accommodation.

(c) Please mention the title of the paper or the subject of your discussion that you wish to take up before this meeting.

(d) Please inform all those interested in Orthopaedic Surgery and extend them the invitation to attend the meeting giving us their names and addresses. All the members of the Association of Surgeons of India are requested to join Others practising Orthopaedic Surgery or its allied sub-divisions may be invited as 'guest observers' provided you send me their details as requested above.

(e) An early reply within a week of the receipt of this letter with any of your suggestions regarding the programme of this regional conference and on any other points mentioned above will be greatly appreciated.

Thanking you and with kind regards,

Yours sincerely,
B. MUKOPADHAYA,
*Honorary Secretary,*
Orthopaedic Section of the
Association of Surgeons of India.

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## CONTRIBUTORS—August, 1956

1. Dr. M. V. Sirsat, M.D., Pathologist, Tata Memorial Hospital, Parel, Bombay-12.
2. Dr. Dhruba Kumar Sen, M.B.B.S., Hony. Junior Visiting Surgeon, Nilratan Sircar Medical College & Hospital, Calcutta.
3. Dr. S. S. Anand, M.S., F.R.C.S., F.C.C.P., F.A.C.S., Professor of Surgery,
   Dr. C. P. Sawhney, M.B.B.S., Asst. Professor of Medicine, &
   Dr. P. N. Chhuttani, M.B.B.S., Research Assistant, Dept. of Surgery, Medical College, Amritsar.
4. Dr. H. Roy,
   Dr. A. C. Guha, &
   Dr. S. M. Ghose,
   Dept. of Pathology & Surgery, Calcutta National Medical College, Calcutta.
5. Dr. Subir K. Chatterjee, M.B., F.R.C.S. (Eng.), Hony. Senior Visiting Surgeon. Nilratan Sircar Medical College & Hospital, Calcutta (4, Victoria Terrace, Calcutta-16).
6. Dr. Balbir Singh, M.B.B.S. (now Asst. Professor of Anatomy, Medical College, Amritsar), &
   Dr. S. S. Basu, Institute of Anatomy, Stanley Medical College, Madras.
7. Dr. T. Balakrishnan, M.B.B.S., Asoka Hospital, Kozhikode (S. Malabar).
8. Dr. G. Allen, M.B.B.S., &
   Dr. D. M. Hancock, M.B., F.R.C.S.,
   Christian Medical College Hospital, Vellore (S. India).
9. Dr. R. Mahadevan, M.S., F.R.C.S. (Eng. & Edin.), Professor of Surgery, Madras Medical College & Surgeon, Govt. General Hospital, Madras-3.