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INJURIES OF THE THORACO-LUMBAR SPINE WITH PARAPLEGIA

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INTRODUCTION

Until the end of the second world war traumatic paraplegia used to be a classical example of hopeless case. Since then considerable improvement has occurred in the understanding and treatment of injuries to the spine with paraplegia. The work of GUTTMANN, at the Stoke Mandeville Hospital near London, is widely known and recognised. Amazing results have been obtained by careful nursing and early rehabilitation of the paralysed patients. HOLDSWORTH and HARDY of Sheffield have made great contributions in the surgical treatment of traumatic paraplegia. They introduced the idea of internal fixation, or internal splinting, of the fractures to protect the neural elements capable of recovering. MUNRO and ROGERS have been the pioneers in this field in America.

All authorities agree that the main points in the treatment of paraplegic patients are good nursing, prevention of complications¹ and early rehabilitation. But there seems to be no unity in the actual early management of the cases. What exactly should be done? Some surgeons are in favour of early laminectomy, others advocate open reduction and plating and some are strongly against operative treatment in most cases. Should closed reduction be done, and if so, how can it be retained? Is plaster jacket useful or harmful? Should plaster bed ever be used in these cases? What is the value of Queckenstedt test in contemplating operation? What is the main purpose of the operation, reduction decompression, or protection to prevent further damage? Many questions arise and the answers are not easy to find. The views presented in the relevant literature are still rather controversial and confusing.

The present writer became interested in the problems of traumatic paraplegia while attending a short course in accident surgery in Sheffield in 1960. The writer visited the Spinal Injuries Unit at the Lodgemoor Hospital, and became inspired by the views presented by HOLDSWORTH and HARDY. Since April 1961 the author has been responsible of the treatment of paraplegia from fractures of the dorsolumbar spine in the Clinic for Ortho-

paedics and Traumatology, University of Helsinki. He has followed the policy of the last mentioned British authors. Ten patients have been treated accordingly so far. For comparison the writer collected data from previous cases. He could find 29 cases of traumatic paraplegia of the thoracolumbar spine treated in the same clinic during the previous ten consecutive years. The present study is based, apart from the literature, to the 36 cases, from which the author has enough data to make some conclusions.

Although the present writer's personal experience in the treatment of traumatic paraplegia from fractures of the thoraco-lumbar spine, is limited, the results obtained have interested the writer for further study.

SURVEY OF THE LITERATURE

The Type of Injury to the Neural Elements

Injuries to the spinal cord can be divided into different groups according to the type of the lesion. DAVIDSON divides them as follows: concussion, contusion, laceration, hematorachis, hematomyelia and compression. FOERSTER (quoted by GUTTMANN) adds to this an ischaemic lesion due to thrombosis in the small blood vessels of the cord. The pathological picture behind neurological symptoms is, according to SCARFF, due to: oedema and concussion of the cord, hemorrhage into the cord (hematomyelia), compression of the cord by fractured or misaligned vertebrae, without actual transection, transection of the cord by elements of the vertebral column. The lesion is often a combination of different types of damage.

Complete recovery is possible only from concussion. Noticeably recovery from other lesions is dependent on the amount of concussion or oedema which is combined to them. Destruction of the cord is irreparable, because the central nervous system has no noteworthy regenerative power. An optimistic attitude towards future is presented by BOSHES, who writes: »In the past few years have come the first glimmerings of hope, that the old dream of regeneration of fibers in an injured spinal cord may some day come true.«

Concussion of the cord, *commotio medullae spinalis*, is regarded as functional disturbance in the cord due to injury. This is comparable to concussion of the brain. SCARFF describes oedema and concussion under the same heading. Oedema occurs in every spinal injury which is severe enough to produce neurological symptoms. The cord can swell to twice its normal size within a few minutes. Such oedematic cord fills the dural sac even with some pressure underneath it. Oedema is the most important cause of manometric block (positive Queckenstedt test) during the first 48—72 hours after the injury (SCARFF). It begins to subside after the third post-traumatic day, and the symptoms produced by it should disappear in a

week. It is not clearly defined in the literature how soon the symptoms and signs due to concussion of the cord should subside, but it is understood that this should happen pretty early. When concussion and oedema are combined together, they will lengthen the symptoms produced by each of them. SCARFF writes further: »In the more severe and prolonged cases it may even be, that the two mechanisms just named, are augmented by the occurrence of numerous petechial hemorrhages into the grey matter of the cord». According to DAVIDSON the hemorrhages, when present, are usually due to diapedesis and are rarely caused by rupture of the vessels.

The picture of complete paraplegia in incomplete lesions of the cord is thus partly due to irreparable damage of the cord, and partly to changes which subside. The term spinal concussion is used to that part of the cord lesion, where neurological recovery is possible regardless of the actual pathology behind it. Although commotio medullae spinalis and oedema of the cord are different things, they are both included in the concept of spinal concussion, used by HOLDSWORTH for example.

Spinal concussion and spinal shock have been confused by many authors. These are two quite different conditions which should be clearly separated. Spinal shock is the state of the distal segment of the cord immediately after complete division. The distal segment of the cord is cut off from cerebral centers and has not yet got its automatic »decerebral» function. This is a transient state before the appearance of increased reflex activity. In spinal shock there is no motor activity, the corresponding segments are anesthetic, the paralysis is flaccid and the reflexes are away. In fact, the anal and bulbocavernosus reflexes may remain (NAFFZIGER, HOLDSWORTH and HARDY 1953). Spinal shock can disappear fairly quickly, or last for many weeks, before the next phase of neurological behaviour of the distal spinal segments appear. (BOSHES, BUSCH, CHUSID and McDONALD, DAVIDSON, HOLDSWORTH and HARDY, PEELE, and others).

When the spinal shock subsides, isolated reflex activity begins to occur. The reflex activity and flexor response phenomenon manifesting at this stage have been erroneously indicated as signs of favourable prognosis. It should be clear that no normal sensation or voluntary motor power can follow after spinal shock. HOLDSWORTH states: »The return of reflex activity below a cord lesion without recovery of sensation or of normal motor power, is therefore, never an indication of continuity of the cord axons, but on the contrary, is a certain sign of irrecoverable cord division».

After the stage of increased reflex activity, in complete lesions of the cord, comes the terminal phase. The reflexes diminish and the physical state,

the general health of the patient, deteriorates gradually towards final debility.

Contusion of the spinal cord is a severe localised injury, which as such is irreparable, but which can be partly combined with marked oedema and hemorrhage. In laceration there is also rupture of the membranes with leakage of the cerebrospinal fluid into the surrounding tissues. Infection can ensue and seriously complicate the picture. Hemorrhachis, bleeding into the spinal canal, can be epi-, intra- or subdural, or subarachnoid in nature. If there is marked hemorrhage, it can lead to compression and to myelopathic changes. That is very rare (DAVIDSON). Hematomyelia, haemorrhage in the cord, tends to spread in the gray matter longitudinally. Hematomyelia can be caused by direct or indirect injury. Even violent muscular strain may produce it. Usually the bleeding occurs immediately, but it can follow an interval of several hours. Compression acts directly or indirectly by preventing blood supply. Scarring can be responsible for gradual late compression. Posttraumatic thrombosis in the vessels of the cord is an assumed event, presented by FOERSTER, (quoted by GUTTMANN).

Injuries of the spinal cord and nerve roots are usually due to fractures and fracture-dislocations, which are clearly to be seen in the radiographs. But it is known, that traumatic lesions can occur in the spinal cord without noticeable radiographic changes. It should be possible, at least theoretically, to differentiate segmental lesions from tract lesions.

In the segmental syndrome sensitivity is abolished or diminished in the affected dermatomes, and flaccid weakness results in muscles which receive innervation from the injured segments. The tendon reflexes are affected accordingly. They are abolished or diminished in the damaged segments, and exaggerated in the segments caudad to the injury. This is a good diagnostic guide to the level of the lesion.

Increased and spontaneous reflex activity occurs distal to the affection even in incomplete lesions of the long tracts. (SCARFF). The positive Babinski toe sign does not follow all transections of the cord.

There are different disturbances in the function of the autonomous nervous system, depending on the level of neural destruction. It is of importance to note, that affections of abdomen and pelvis are painless, if the lesion is above the sixth dorsal segment. Another important fact to be taken into consideration is, that the blood pressure does not fall markedly, and no true surgical shock ensues injuries of the spinal cord (SCARFF, SMITH, WHITE). If a paraplegic patient is in state of shock, the cause of it should

be sought for. There must be some associated injury which deserves attention, and which is responsible for the fall of blood pressure.

Injuries to the cauda equina produce typical root symptoms with sensory changes, reflex disturbances, flaccid paralysis, or paresis, with possible fascicular twitchings. Pain, hyperaesthesia and hyperalgesia are common symptoms. That is not the case in lesions of the spinal cord.

Bladder, bowel, and sexual functions are almost invariably affected in all injuries of the spinal cord or cauda equina. The mechanism of micturition is complicated. Stretching of the bladder provides the normal stimulus for emptying. Higher centers inhibit the emptying reflex until the act of micturition is initiated. Neurogenic bladder dysfunction can be of various types. BOSHES divides them to uninhibited, reflex, autonomous, and atonic bladders.

Uninhibited bladder is closest to normal and is seen in less severe incomplete lesions. Normal voluntary control is possible, there is urgency with little frequency, but no residual. Reflex bladder results when the upper motor neurone is interrupted but the reflex arc is intact. The patient voids precipitously and there is generally a residual left in the bladder. Autonomous bladder is without external innervation. Voiding is affected by increased intra-abdominal pressure and is never complete. This is seen in some injuries of the conus medullaris and cauda equina. In atonic bladder there is no sensation and no desire to void. That is the situation during spinal shock for example.

Bowel paralysis subsides fairly rapidly and reflex evacuation of the rectum will be elicited by distension. The amount of sexual dysfunction is quite variable. The function of erection is a rather simple one and is possible even when the cauda equina is destroyed. Disturbances in sexual relations are common but some kind of gratification can be elicited if erection persists.

The roots of cauda equina are able to recover or regenerate like other peripheral nerves. Thus the injury can be neurapraxia, axonotmesis, or neurotmesis, as well as a combination of these, in character.

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Complete or Incomplete Lesion of the Cord?

If the paraplegia is partial, and segments distal to the site of injury show some function, it is clear that the cord lesion is incomplete. But total suppression of cord function below the level of injury can be due to anatomo-

mical transection of the cord or to spinal concussion in connection with an incomplete cord lesion. The immediate effect of cord division is the production of spinal shock. Now a question of practical importance arises. Is it possible to differentiate, in the first few hours, spinal concussion from spinal shock? If we can be sure that the patient is in the state of spinal shock, then no operation need to be contemplated. But if there is evidence of spinal concussion, we have to decide quickly, which would be the best treatment to provide maximum recovery. HOLDSWORTH and HARDY state that spinal concussion is distinguishable from spinal shock within 12 hours after injury. Repeated meticulous neurological examination should show some recovery from concussion very early. First comes sensibility, then motor power, and later reflexes. Reflex activity never comes first in spinal concussion. On the contrary, recovery from spinal shock is marked by the return of exaggerated segmental reflexes, change from flaccid to spastic paralysis, but no recovery of normal sensation or normal motor power. (HOLDSWORTH and HARDY). Some authors regard that recovery from concussion can start later but will occur in 48 to 72 hours (BÖHLER, quoted by NICOLL, GUTTMANN, JEFFERSON, quoted by HOLDSWORTH, and NAFFZIGER). Other writers share the opinion, that recovery can start still later (BOSHES, SCARFF, and STANGER). NAFFZIGER describes a clinical test which he considers most practical and informative in distinguishing incompleteness from completeness of cord division. The examiner should forcibly flex one of the patient's toes and compress it in such a manner, as to cause severe pain. If the patient perceives some sensation from this test, the interruption of the cord is regarded as incomplete.

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How to Distinguish Root Lesions from Cord Damage?

This is important because root lesions can recover through regeneration, which can take a long time. The spinal cord terminates in adults at the distal end of the first lumbar vertebral body. Injuries distal to this can cause pure root lesions. But higher up, root lesions are to be distinguished from cord damage. In fracture dislocation of the spine the cord is damaged at the level of the vertebral injury (HOLDSWORTH). If this does not correspond with the segmental level of the paralysis, the disparity is due to root lesion. Comparison of the clinical neurological level, with the level of cord lesion, determined by the radiograph, will thus show the pattern of cord and root damage. (HOLDSWORTH). The relationship of spinal cord segments to

vertebral bodies varies to some extent from patient to patient. According to HOLDSWORTH, the first lumbar segment lies opposite the 9th dorsal vertebra, so that between it and the first lumbar vertebra lie all the lumbar and sacral segments of the cord. Opposite the thoraco-lumbar vertebral junction lies the lumbo-sacral segmental border. According to BOSHERS, the first lumbar neurological segment is situated more distal opposite the disc between 10th and 11th dorsal vertebrae. Naturally this gives only a rough idea of the actual conditions. The spinal segments are not clearly defined, the anatomy is not exactly the same in all patients, and the mechanism of injury varies. But it is possible to make valuable observations from repeated meticulous neurological examinations. When these are correlated to radiological findings, all necessary information is available.

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Stable and Unstable Spinal Injuries

Classification of injuries into stable and unstable fractures, is as sensible in the dorsolumbar spine, as elsewhere in the body. The former are safe injuries, which do not need special protection. The latter are unsafe lesions requiring support to prevent further damage. Reduction, and fixation in order to maintain the reduced position, is another problem, and should be considered separately.

ROGERS regards as safe all vertebral body fractures, which do not involve the posterior wall of the centrum, probably over 90 per cent of the cases. He includes to the unsafe group all dislocations and crush fractures, involving the posterior wall of the centrum. NICOLL considers stable anterior and lateral wedge fractures of the vertebral body, and all fractures of the laminae proximal to the fourth lumbar lamina. NICOLL holds as unstable all fracture-subluxations with rupture of the interspinous ligament, all fracture-dislocations, and fractures of the laminae of the 4th and 5th lumbar vertebrae. He stresses further that most wedge fractures of severe degree should be regarded as unstable, because they are in fact fracture-subluxations with rupture of the interspinous ligament. WATSON-JONES points out that the stability or instability of nearly all joint injuries and fracture dislocations is related closely to associated injuries of the neighbouring ligaments. WATSON-JONES writes: »If the interspinous ligament is not ruptured, and there is no severe injury to the ligaments of the apophysial joints or to the intervertebral disc and its annular ligament, fractures of the vertebral bodies are usually quite stable in the position of slight deformity produced at the moment

of injury, and they are safe from increasing displacement . . . On the other hand if the interspinous ligament has been completely ruptured or avulsed, and there is tearing of the ligaments of the apophysial joints, the vertebral fracture is not stable and it is not safe; there may well be recurrent and increasing displacement with a threat of late compression of the cauda equina or spinal cord».

Surprisingly, the extent of neural damage does not bear a constant relationship to the severity of skeletal injury. Stable fractures can produce total incurable paraplegia, although this is rare, and there can be unstable fractures with marked displacement but without neurological damage. This has been confirmed by many authors, *e.g.* NICOLI, SCARFF, STANGER, WATSON-JONES.

Division into stable and unstable injuries does not have any practical purpose in the upper thoracic region, perhaps above the 9th or 10th dorsal vertebra. Here the situation considers pure cord lesion, nearly always complete, and internal fixation with plates and screws would be useless and impractical, because of weakness of the spinous processes. Furthermore, the use of plaster jacket or plaster bed is contraindicated according to *e.g.* GUTTMANN, HOLDSWORTH and HARDY, NICOLL, WATSON-JONES,

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Operative Indications

Before commencing discussion of operative treatment it is important to make clear distinction between open and closed injuries. There is universal agreement that all open injuries should be operated on (GUTTMANN, HOLDSWORTH, WHITE and others). The lesion should be explored, foreign bodies must be removed, a meticulous debridement should be performed, and antibiotics should be given. Open injuries are usually due to firearms and explosions and are therefore rare in civilian life.

The treatment of closed injuries with paraplegia is still a matter of controversy. GUTTMANN, who has vast experience of paraplegia, writes: »In closed spinal injuries due to fractures or fracture-dislocations this writer is in complete agreement with those who advocate conservative treatment and are strongly opposed to laminectomy as an immediate measure. This applies to injuries with complete transverse spinal syndromes at any level, including cauda equina lesions. It may be emphasised that at this stage the Queckenstedt test is of no diagnostic value in differentiating subarachnoid block

caused by oedema of the injured spinal cord or pressure from the dislocated bone».

As to the incomplete paraplegias, due to cord or cauda equina damage, he is almost equally conservative. Nevertheless, GUTTMANN is not totally negative towards operation. He sees indications for laminectomy during the early stages in the following conditions. Incomplete lesions which show signs of progression, persistent manometric block without evidence of fracture or fracture dislocation in the vertebral column, regardless of whether the spinal syndrome is incomplete or complete. Irritation to nerve roots of severe degree, caused by fragments of bone or disc prolapse, is a further indication to laminectomy, although a very rare one. These lines are followed also by HOLDSWORTH, PENNYBACKER and WATSON-JONES.

Some surgeons are clearly in favour of early laminectomy in most cases (HAGELSTAM, STREET, TARLOV, WANNAMAKER). Others, like COMARR, LOYAL DAVIS and FRYKHOLM, regard it indicated mainly, or only, in the presence of demonstrable block in the spinal subarachnoid space. But according to HOLDSWORTH laminectomy is rarely of value in such patients for the maximum neurological damage is sustained at the time of injury and if the cord is not divided, recovery will occur without decompression. He writes further: »In partial cord lesions with anatomical displacement of the spine, restoration of vertebral alignment is sufficient to free the cord from pressure whilst fixation will prevent further damage».

Open reduction with internal fixation, or to be more accurate, internal splinting, performed after the reduction, is a rather new approach to the problem (HOLDSWORTH and HARDY 1953). Operative replacement is regarded imperative in fracture-dislocations with locking of articular processes and desirable in fractures of the vertebral body involving the posterior wall of the centrum (ROGERS, WATSON-JONES). When open reduction is performed it would seem advisable to proceed with internal fixation. With the exception of the conditions mentioned above, the value of reduction is questionable. WATSON-JONES considers reduction desirable in most cases, whilst STANGER doubts whether it matters at all. The method of internal fixation, with plates and screws or bolts, is favoured by BARNES, DICK, HOLDSWORTH and HARDY, MERLE d'AUBIGNÉ and BÉNASSY, NICOLL, WATSON-JONES, WILES and WILLIAMS among others. This applies to certain fractures and fracture-dislocations of the dorso-lumbar spine. The main endeavour of it is to protect nerve roots, and sometimes the incompleteness of cord lesion, from further damage. If this policy can save some paraplegics from wheelchair life, it has certainly served its purpose, and proved its justification.

Furthermore, it may make the patient more comfortable in the early stages of nursing.

As to the stable fractures, where no protection is needed, apart from good nursing of course, the indications for operation might well be those stated by GUTTMANN.

The value of late laminectomy is worth considering. GUTTMANN states as a general rule, that it does not serve any useful therapeutic purpose in complete transverse lesions at any level. But on the other hand, it is indicated in incomplete lesions which show increasing neurological signs. The late progression can be caused by callus or scar formation. WHITE writes: »Late laminectomy is of doubtful value though it is occasionally helpful in relieving radicular pain«.

The treatment of intractable pain and violent spasms etc. is out of the scope of the present investigation.

OWN INVESTIGATIONS

Description of the Material

During the years 1952—1962 altogether 39 cases of traumatic paraplegia of the thoracolumbar spine were treated at the Clinic. In three of the cases the radiographs are lacking or the notes are insufficient for evaluation. The material thus consists of 36 patients, 30 males and 6 females. Most of the patients were young adults, there were neither children nor old-aged people in the series. A few of the patients had got primary treatment elsewhere and were sent to us later. Due to the fact that there are no paraplegia centers in Finland yet, unfortunately almost all patients had to be transferred to various hospitals later for further care.

Of these 36 patients with traumatic paraplegia of the thoracolumbar spine, seven died shortly after the accident. One case is too recent for ultimate neurological evaluation. In all the other cases we have either information of several years duration or strong evidence that no recovery is likely.

TABLE I. — *Causes of fractures*

Fall from height	18
Crushed	8
Traffic accidents	5
Hit by falling object	4
Fall on the ground while carrying heavy weight..	1
Total cases	36

Table I shows that half of the injuries were due to fall from height. Most patients fell from high scaffolding while at work, some fell from the roof by slipping, three attempted suicide by jumping down from a window and one come down 26 metres in a falling crane. The mechanism of crushing took place in various ways; collapsing structures, crushing under heavy slow vehicles etc. From the five traffic accidents four were due to motor

bicycles and one was a car collision. Hit by falling object was usually due to a rather heavy weight which the patient partly escaped from.

Distribution of fractures among various vertebrae is seen in table II.

TABLE II. — *Distribution of the fractures among different vertebrae*

Thoracal	I	.....	—
»	II	.....	1 fracture
»	III	.....	—
»	IV	.....	1 fracture
»	V	.....	3 fractures
»	VI	.....	3 »
»	VII	.....	3 »
»	VIII	.....	1 fracture
»	IX	.....	2 fractures
»	X	.....	4 »
»	XI	.....	4 »
»	XII	.....	10 »
Lumbar	I	.....	9 »
»	II	.....	3 »
»	III	.....	2 »
»	IV	.....	1 fracture
»	V	.....	—
Total fractured vertebrae			47

The tendency of injuries to affect particularly the thoraco-lumbar junction is clearly seen even in this small series. This fact is well presented in the relevant literature. Before analysing the material closer we feel justified to divide it into three different groups. The first of these contains fractures of the dorsal spine proper, namely fractures of D1 to D 11 inclusive. In the second group are fractures of the dorso-lumbar junction, that is D 12 and L 1. The third group, fractures of L 2 to L 5 consist those paraplegias only, which affect the cauda equina.

Fractures between 1st and 11th Dorsal Vertebrae — Practically Pure Cord Lesions

The 14 patients in this group had 22 fractured vertebral bodies. In three cases were three vertebrae fractured simultaneously and in two cases were two fractured vertebral bodies. There were four deaths in this group. All of them had multiple fractures and other injuries which directly or indirectly contributed to the patients death. The cause of death was twice cerebral contusion, once subarachnoid hemorrhage and severe tracheobronchitis with atelectasis of the lungs in one case. The latter had fracture of the second dorsal vertebra with high paraplegia. Seven of the ten cases left, showed no neurological recovery. In three instances some improvement was noticed. In two of these cases the improvement was slight and in one case rather marked. These were fractures of D 10 and D 11. The two with slight improvement were treated by immediate postural reduction and plaster jacket. The plaster jacket had to be taken off fairly soon because of complications. One of the patients developed pressure sores under the plaster and the other got abdominal distress. Both patients were then treated in a plaster bed for a while, and subsequently in ordinary bed rest. The complications cleared off gradually, the postural reduction was not fully maintained, but some neurological recovery could be traced. The sensibility impaired somewhat and the proximal muscles of both lower limbs got some power. This allows walking with crutches, although it is difficult, partly because of weakness and partly because of spasticity.

The one particular case, which showed marked improvement has some interesting features and will be presented in detail as follows.

26 years old laborer was involved in a tractor accident, he got jammed under the vehicle and incurred severe pain and deformity in the back. He could not move his lower limbs and told that he was not aware of the lower part of the body for a while. The pain was felt only in the back, although he had compound fracture of the left tibia. The patient was immediately transported to the local hospital. He did not sustain surgical shock, was conscious all the time and complained of aching pain in the back and lower abdomen. Clinical examination was reported to have shown complete paraplegia below the level of the lesion. The radiograph disclosed unstable frac-



Fig. 1.



Fig. 2.

Fig. 1. — Fracture-dislocation of the 10th dorsal vertebra with locking of the articular processes. The injury produced immediate complete paraplegia below the level of the lesion.

Fig. 2. — Open reduction and stabilisation with plates and screws has been performed.

ture and dislocation of D 10—D11 with locking of articular processes (fig. 1). Twenty-one hours after the accident the patient was transferred to us. Neurological examination revealed now hyperesthetic dermatomes D11—D12, and the dermatomes L 1 and L 2 were not anesthetic any more, they were hypesthetic. Below that level there was complete anesthesia. All myotomes below the level of the injury were paralysed. Only very weak anal reflex could be traced.

The question arose how to act in this case. Twenty-one hours after the injury the anal reflex was weakly present, dermatomes D11 and D12 were hyperesthetic, dermatomes L1—L2 showed some recovery, and that was all positive in otherwise complete paraplegia below the bony lesion. Should these signs be regarded as proof from completeness or incompleteness of the cord lesion? Dermatomes L1—L2 could belong to the distal end of the proximal cord segment and the signs could mean beginning disappearance of spinal shock. But if this were incomplete cord lesion with locking of the articular processes how could the cord be protected? We regarded operation, open reduction and internal fixation with plates and bolts justified.



Fig. 3. — The plates could not prevent gradual slipping of the fracture during three months, but this did not disturb good neurological recovery.



Fig. 4 A.



Fig. 4 B.

Fig. 4 A and 4 B. — Position of the fracture 19 months after the original injury. The neurological recovery remained good and there was no deterioration of function later. The plates were removed four months after their introduction.

The operation was performed under general anesthesia, reduction was achieved by excision of one of the facets and the fracture-dislocation was stabilised by Williams plates and screws (fig. 2). The lamina of 11th dorsal vertebra was fractured and loose and had to be removed before the plates were fixed.

The following day we could notice that dermatomes L3 and L4 were working. A week after, the right hamstring muscles contracted voluntarily and so did extensor digitorum longus in the left foot. Three weeks after the operation the patient could move his right foot and contract voluntarily muscles in both thighs, the knee jerks could be traced as well as the right ankle jerk. The patient could urinate and pass faeces without help, the indwelling catheter drainage was removed. Sensibility was normal, except in a small area distal to the skin wound in the left leg. The plates could not prevent gradual slipping of the fracture during three months (fig. 3), but this did not disturb good neurological recovery.

The follow-up examination 19 months later showed that the patient could walk without any help but preferred to use on stick outdoors. The patient had uninhibited bladder function, evacuated normally, had useful erection but no ejaculation. Sweating in the lower limbs was exaggerated. There was some spasticity in the legs too, but this seldom caused trouble. All qualities of voluntary movement were working, although there was weakness in certain groups of muscles, specially in the left leg. The plates had been removed four months after their introduction. The patient did not complain of any pain. He also had good movement in the back. Radiographs showed that the position of fracture was nearly the same as before the reduction (fig. 4 A and 4 B).

The present writer regards it very likely that internal fixation in this case has contributed to the neurological recovery. The writer feels further that the nursing of the patient in a busy surgical ward had been well aided by the plate fixation during the first few weeks after the injury. It seems evident that the incompleteness of the cord lesion in this case could not have been protected without operative intervention of this sort.

Fractures of Dorso-Lumbar Junction (D12 and L1) — Mixed Cord and Root Lesions

This group consists of 16 patients with 19 fractures. Three patients had both vertebrae fractured. Three patients died within two weeks of the injury. One of them had pulmonary embolism, another had rupture of the pleura with pulmonary complications, and the third patient died from perforated ileitis with peritonitis and pneumonia. Nine patients showed no neurological improvement, and in three cases the neural damage increased clearly and markedly during the conservative treatment. They did not improve later either. In two of these cases the paraplegia was practically produced by postural reduction in hyperextension.

In four instances some recovery was noticed. The S 1 dermatomes were hypesthetic and the myotomes L 5 and S 1 were weak twice. The disturbance in sensibility disappeared and the motor components gained strength. The third patient had both dermatomes and myotomes of L5—S1—S2 affected and these recovered partially. The fourth case was a fracture-dislocation of D12—L1 where the third and fourth lumbar roots showed some improvement in the beginning but this recovery deteriorated later again. The patient can now walk with crutches but he needs one splint. He had mixed cord and root lesion where some root recovery took place. Late laminectomy was performed with doubtful value.

Open reduction and internal fixation was taken into clinical use rather late and after its introduction no fractures of D12 or L1 with paraplegia have occurred so far.

Fractures between 2nd and 5th Lumbar Vertebrae — Root Damage only

This group consists of six fractures in six patients with cauda equina paraplegia. There were no deaths in this series. One case is a fairly fresh one, but because of certain features it will be described at the end of this chapter. In all other five cases the observation time is over one year, and all patients have shown neurological improvement to some extent. The improvement was marked twice. In those instances open reduction and internal fixation were performed and this is probably the explanation for the good neurological result. The case reports of these two are as follows.

25 years old painter fell down from the scaffolding of 15 metres high. Fortunately there was a big heap of sand where he came down. He sustained concussion of the brain, a slight hemothorax, and fracture of L3 with paraplegia below that level. The patient complained of agonizing pain in the back and in both lower limbs, he was somewhat upset and stated that the pain was absolutely intorelable. The L3 dermatome was hypesthetic in the left and hyperesthetic in the right side. The left side was anesthetic below that level but to the right the dermatomes L4—L5—S1 appeared hypesthetic. All motor activity and jerks were abolished below the lesion. The radiographs showed unstable fracture of L3 and fractures in all transverse processes of the lumbar spine (fig. 5, unfortunately the antero-posterior x-ray picture is not clear enough for demonstration). Because of the fairly good general condition of the patient, he was operated immediately under general anesthesia. Open reduction and internal fixation to L3 was done (fig. 6), and the anal wound was revided and sutured. The hemothorax could be controlled later by repeated punctures. After four weeks he could urinate and excrete without difficulty and there was no residual urine. Both sensibility and motor power showed improvement all the time. The plates and bolts were removed 4 months later and the position of fracture slided gradually back to the original (figures 7 A and 7 B). In a follow-up examination nearly a year after the injury the patient could walk without support but prefered to use a cane outdoors. The roots L5 and S1 on the left side have not recovered but all other roots show function.

The second patient is a 18 years old laborer, who car went into the ditch and he was thrown out of it. He incurred fracture of the skull and fracture

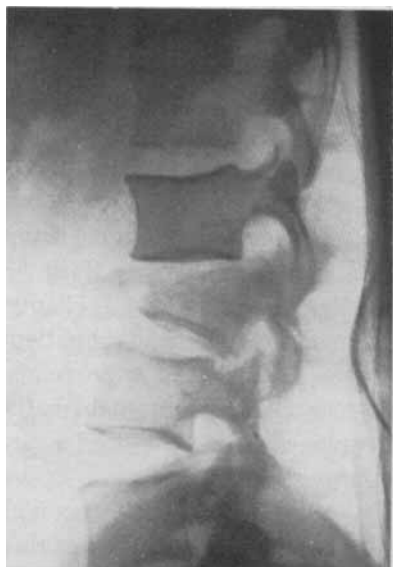


Fig. 5.

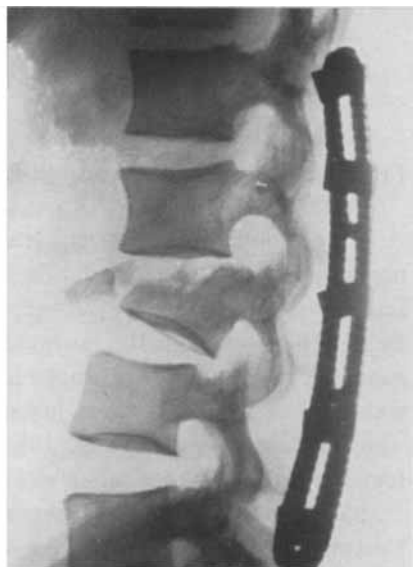


Fig. 6.

Fig. 5. — Unstable fracture of the third lumbar vertebra with paraplegia below the lesion. The patient complained of agonizing pain in the back and in both lower limbs.

Fig. 6. — Open reduction and internal fixation has been performed.

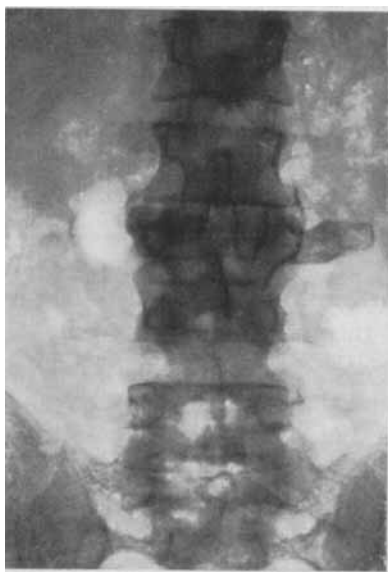


Fig. 7 A.



Fig. 7 B,

Fig. 7 A and 7 B. — The position of fracture deteriorated but marked neurological improvement continued. Control radiographs nearly a year after the injury. The plates were removed four months after their introduction.

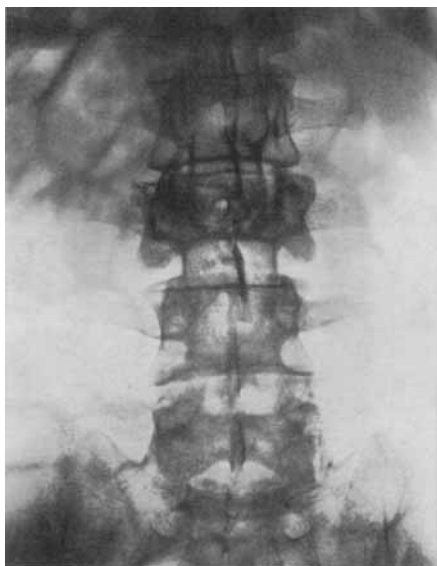


Fig. 8 A.

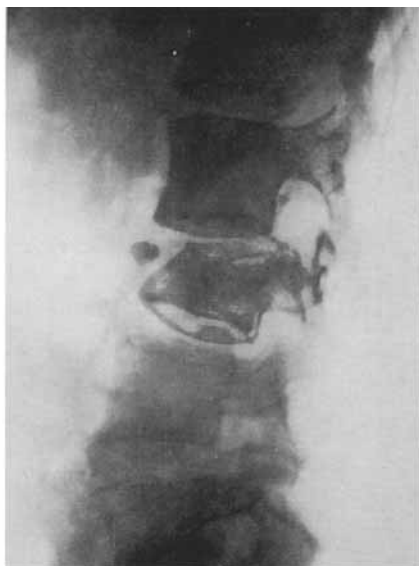


Fig. 8 B.

Fig. 8 A and 8 B. — Unstable fracture of the third lumbar vertebra with increasing neurological signs. Complete motor paralysis developed gradually below L. 3 during the first 24 hours.

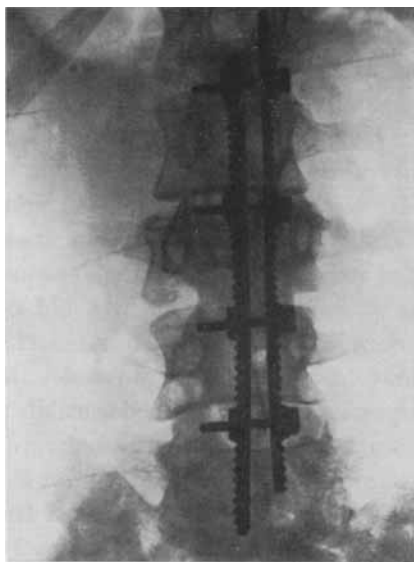


Fig. 9 A.



Fig. 9 B.

Fig. 9 A and 9 B. — Open reduction and plating was performed one day after the injury, the recovery started soon and became remarkably good.

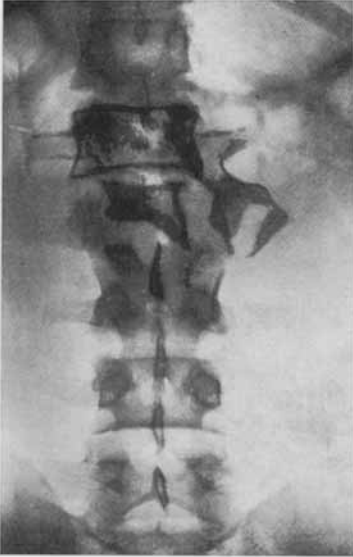


Fig. 10 A.

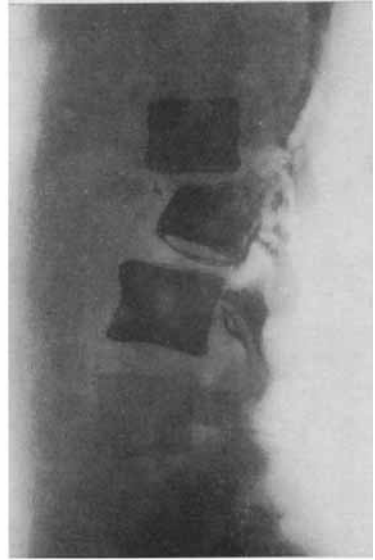


Fig. 10 B.

Fig. 10 A and 10 B. — Fractures of the first and second lumbar vertebrae with comminution of the corresponding laminae, pedicles and spinous processes. There was partial paraplegia.

of L3 with paraplegia. At first he could move the right foot but gradually both feet became paralysed. He was immediately transferred to the nearest hospital and was sent to us the following day on admission, there was a total motor paralysis below L3, the jerks were abolished, but the dermatomes were not anesthetic. Dermatomes L3—S1 were hypesthetic on both sides and he had paresthesiae in both legs. The radiographs revealed unstable fracture of L3 (figures 8A and 8B). Open reduction and plating was immediately performed (figures 9 A and 9 B). Some improvement could be traced already the following day. Voluntary contraction in some muscles of the thighs could be noticed but no movement could be produced until several weeks. Normal urination became possible in a week. The sensibility recovered in two months and he could start walking with crutches three months after the injury. He returned to work as a laborer 8 months after the injury. The patient walks without support, motor power, mobility of the back and both lower limbs are about normal again. He gets some backache after heavy work but can manage with it. A new occupation is planned for him and vocational training starts soon.

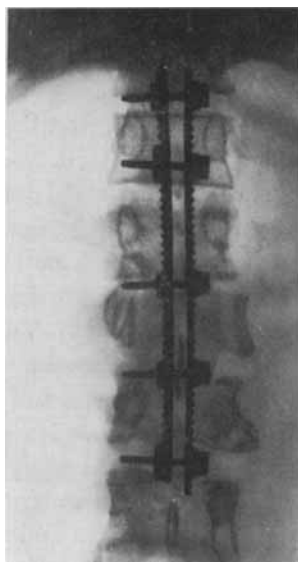


Fig. 11 A.



Fig. 11 B.

Fig. 11 A and 11 B. — A loose laminar fragment was removed and two long curved plates were fixed to five spinous processes. Reduction was not attempted because of gross comminution of the fractures and because of noteworthy function below the lesion. The symptoms were aggravated after the procedure.

The present writer feels that internal fixation played important role in the good neurological recovery of these two cases. The other three cases in this group of paraplegia did not show that amount of recovery. One of them was operated upon similarly, and the other two were treated conservatively. The sixth case in this series is a recent one, the observation period being not more than two months at the moment. But this case presents some special features of interest and is therefore reported here.

He is a 16 years old boy, who was knocked down with his motor bicycle by a van. He sustained a partial paraplegia below L3. The radiographs disclosed fractures of L1 and L2, the latter being displaced. The laminae of both vertebrae were fractured and specially the lamina of L1 was severely comminuted and displaced (figures 10 A and 10 B). Hypesthesia below L3 and weakness in the motor power occurred below the level of the lesion. Because we did not have a Stryker frame it was difficult to decide should we operate immediately or not. Closed reduction and putting on a plaster jacket could be dangerous because of the instability with loose laminar fragments. He was transferred directly to the operating theatre where the

fracture was explored in general anesthesia. A loose laminar fragment was removed and two long curved plates were fixed to five spinous processes (figures 11 A and 11 B).

When the patient awoke from the anesthesia we noticed that the paraplegia had deepened. He could not move his lower limbs at all. We were puzzled from the situation, took a control x-ray picture and could not detect any change in the position of the fractured bones. The operation could not have been very detrimental because the muscles were already detached from bone by the injury and we only removed one loose fragment and fixed the plates. Fortunately some recovery began to appear. The area of sensory disturbance diminished clearly and the hamstring muscles started to contract. Because the recovery was slight we suspected pressure in the fracture area, took better x-ray pictures and disclosed another loose fragment of bone in the spinal canal (fig. 12). At the reoperation one month after the primary that loose laminar fragment was removed opposite the maximum deformity. The whole comminuted lamina, and the plates and screws were also removed.

This operation was performed only recently thus we are not able to judge the ultimate fate of this case yet. Unfortunately the primary radiographs



Fig. 12. — When better radiographs were available another loose laminar fragment was disclosed in the spinal canal. This and the whole comminuted lamina of the first lumbar vertebra as well as the plates were subsequently removed.

were of poor quality and we could not get adequate information from them. One important loose fragment was not detected at the primary operation and this probably was responsible for postoperative pressure towards the nerve roots. Although the plates are now removed we believe that the fracture is not so unstable, because of the one months healing time at the site of the injury. Furthermore there may be no pressure to the nerve roots and we hope that they would recover.

Should such comminuted fractures be operated or not? The writer's impression is that they should be treated in a Stryker frame. If there would be marked root irritation and x-rays would show displaced bony fragments in the vertebral canal, then exploration and removal of the fragments would seem justified. First class radiographs are mandatory for orientation and control x-rays should be taken before the wound is closed in this type of fractures. Local anesthesia might be safer than general anesthesia because of protective muscle spasm.

Methods of Treatment and Results

Altogether seventeen operations were performed to the 36 patients in order to affect favourably the neurological recovery. The methods of treatment are enumerated in the table III.

TABLE III. — *The methods of treatment*

Bed rest only.....	9 cases
Plaster bed only	4 »
Closed reduction and plaster jacket	11 »
Decompressive laminectomy in some stage	9 »
Open reduction and internal fixation	8 »

In all the eleven cases where plaster jacket was used, postural reduction was attempted before application of the plaster. In six cases it was done immediately after the injury and in the rest of the cases some time later. It has probably been of no positive value in any instance. In fact the paraplegia was 'practically produced twice by postural reduction and no recovery was noted in these two cases later. The plaster jacket had to be removed fairly soon because of pressure sores, or because of inconvenience to the patient in all except one of the cases. In no instance was the reduction fully maintained, but it usually remained somewhat better than the original position. The position of the fracture whether good or bad, had no correla-

tion to the neurological state of the patient. The deterioration of reduction never increased neurological symptoms. This applies as well to the series of closed reduction with plaster jacket, as to those of open reduction and internal fixation. The same observation was made by STANGER in his series. Further aggravation of neurological picture was noted twice due to lack of fixation.

Eight of the patients got pressure sores and all had urinary infection at least in the early stages.

From the nine laminectomies, three were done early. By early laminectomy we mean that it has been performed within three days from the injury. The other laminectomies were carried out a few weeks or several months later. No one of the early laminectomised patients showed any recovery. Half of the late laminectomies showed some recovery and half did not. Those who improved did so even before the operation and the improvement continued after the laminectomy. It is difficult to know the real value of laminectomy if there are no convincing objective signs of recovery because the patients usually are very anxious to see improvement and may therefore exaggerate their observations. The late recovery was always related to the nerve roots.

One of the patients treated by bed rest and one treated in plaster bed recovered slightly. All others which showed improvement had some form of «active» treatment. What is the real value of this «activity» is of course difficult to evaluate. One might state perhaps that they would have recovered anyway. On the other hand, the only patients who showed marked neurological improvement, had been openly reduced and internally fixed.

One must admit that all patients with internal fixation did not do well. One died in pulmonary embolism, two did not improve at all and one became worse. The latter case has been described in the previous chapter and we hope for ultimate recovery in that fairly recent case of cauda equina paraplegia.

Of the four favourable cases of internal fixation, three recovered markedly and one improved slightly. It is to be noted that the position of reduction deteriorated even in this series towards the original situation in about three months. The plates could not resist weight bearing stress. Actually this is not surprising. The important fact is that the neurological recovery was not affected by the gradual sliding of the injured bones.

If open reduction and fixation with plates is of definite value in certain cases, the question arises, how does it work. One could think that reduction creates decompression in the injured area in the important early stage,

when hematoma and oedema are dominating. Fixation with plates protects the neural elements, until the nature gets time to adapt to the circumstances. In many great deformities of the spine, which develop gradually, like scoliosis and Pott's disease, neurological symptoms and signs are seldom seen.

In one of our cases, where open reduction and fixation might have been beneficial, we could not operate because of furunculosis in the back. No operation was performed for fractures which we believed to have been stable. In one case of low partial paraplegia we did postural reduction and used plaster jacket for four months with moderate success.

The paralysed bladder was always treated with indwelling catheter drainage, preferably of the Foley type and irrigated regularly. The catheter was clamped for some hours in order to educate the bladder to periodic reflex action. When this started to work, the catheter was removed and the amount of residual urine was measured. If the residual remained negligible, the indwelling catheter drainage was discontinued.

Summary of the fate of the present series of 36 paraplegics is as follows: 7 patients died shortly after the injury.

20 of the cases showed no neurological recovery, and in fact three of them became worse. In two instances the symptoms were grossly aggravated by postural reduction in hyperextension, and one case deteriorated due to lack of support in the early stages.

In 9 paraplegics improvement of the neurological picture was noted. One of these deteriorated later again due to instability of the spine and one particular case worsened because all loose fragments were not detected at the operation.

In one patient only the recovery can be related to cord function, in all other instances the improvement was due to root recovery. In the former and in two of the latter cases the improvement of neurological function was marked, in the rest of the cases it was slight.

DISCUSSION AND CONCLUSIONS

The fate of completely paraplegic patients is tragic. They are usually young people in their best years of life when the trauma to the spine occurred suddenly and unexpectedly. These patients fall easily into desperation and get passive if those responsible of their treatment and care, can not encourage them by right approach to the problem. Traumatic paraplegia is a fairly rare condition. General and orthopaedic surgeons as well as other members of the hospital staff do not get experience in its treatment unless those patients are collected into special centers from the very beginning. This is fully realised in countries like Great Britain and the United States of America. Despite difficulties and psychological setbacks, a great number of paraplegics have been rehabilitated to useful members of the society. They have been brought back to more or less active, and even happy life. Visits to paraplegia centers, such as Lodgemore and Stoke Mandeville in England for example, convince visitors of the remarkable results that can be obtained. Further experience will be gained and new hope is yielded to the forthcoming paraplegics that way.

The essential factors in the care of paraplegics are good nursing, prevention of complications and early rehabilitation. The surgical treatment of traumatic paraplegia seems still to be a matter of controversy. But as far as the present writer knows, nobody claims that surgery would always be useless even in the closed injuries of the thoraco-lumbar spine with paraplegia.

Hence we have to at least contemplate surgical aspects in evaluating the possibilities of neurological improvement in most cases. The patients or their relatives are anxious to know whether anything could be gained by surgical intervention. The surgeon takes heavy responsibility if he denies the patient a change, even a slight one. Surgeons responsible for the management of traumatic paraplegia must strain to clarify their indications of operation, — and keep in mind that *prima regula est non nocere*. Both conservative and operative treatment can be harmful if the indications and contraindications are not properly considered beforehand.

In the present series the position of reduction was not fully maintained in any of the cases but this never aggravated the neurological picture. This applies as well to the closed reduction with plaster jacket as to the open reduction with internal fixation. The present writer's experience is in accord with that of NICOLL's and STANGER's for example, namely that the maintenance of the reduced position is not essential to good functional recovery. STANGER goes as far as to state that he doubts whether reduction matters at all. The writer would not dare however to leave the displacement unreduced in cases of paraplegia. The reduction can provide decompression which might be decisive to recovery in some cases. If the surgeon can provide fixation to the bones, the injured tissues could be protected during the critical first few weeks after the accident. If on the other hand a complete paraplegia produced by bony injury is above the 10th dorsal vertebral body one doubts the value of operative interference of any kind. Even closed reduction would be useless because it could not be retained. Those cases should probably be treated by early rehabilitation only.

The writer has performed open reduction and internal fixation with plates and bolts eight times. In three of these cases marked neurological improvement was gained and it is likely that fixation has contributed to this, since these are the only cases in the writer's series where striking recovery could be traced. The one case with incomplete cord lesion and spinal concussion which resulted to complete immediate paraplegia below the level of the lesion at as high as the 10th dorsal vertebra, is particularly interesting. Now, 19 months after the operation, the patient walks outdoors with one stick and can *e.g.* voluntarily forcibly extend and flex his toes. It is in accord to HOLDSWORTH's and HARDY's teaching that spinal concussion and spinal shock should be and can be differentiated at the early stage of paraplegia. This case showed remarkable recovery of cord function and is probably rather unique.

The present writer believes that in his eight internal fixations, the operation has been beneficial in four, useless in three and harmful in one of the cases. The latter teaches that good radiographs are mandatory for proper evaluation of the bony injury and that the spinal canal should be explored if there is any doubt of the circumstances at the site of the lesion before the plates are fixed to the spinous processes.

It is to be noted that the paraplegia was practically produced twice by postural reduction in hyperextension and that in further two instances the neurological symptoms were aggravated during conservative treatment.

In the following we will summarize the main points of conservative

and operative treatment at the early stage of traumatic paraplegia due to closed injuries of the thoraco-lumbar spine. We may divide the early treatment into five categories; nursing in bed only, closed reduction and plaster jacket, open reduction and internal fixation with plates and bolts, nursing on a Stryker frame, and laminectomy.

Nursing in Bed Only. — This applies without doubt to all fractures of the upper thoracic spine, perhaps above the 10th thoracic vertebra. The paraplegia at that level is usually complete due to division of the cord (HARDY). Nothing could be gained from surgery if there is definite bony injury. Massive disc prolapse, which is probably a very rare possibility, should of course be removed wherever it produces severe neurological symptoms. If we can regard the fracture stable there is no need for fixation (HOLDSWORTH and NICOLL). The question of decompression arises. Some sort of postural reduction takes place anyway by nursing in bed as compared to the position at the moment of the accident. It is likely that no further decompression is necessary (HOLDSWORTH). GUTTMANN treats practically all his cases this way.

Closed Reduction and Plaster Jacket. — If not contraindicated, this could be the treatment to some patients with low paraplegia, if the fracture is relatively stable. The reduction would take place in hyperextension and the aim of plaster fixation would be to retain the reduced position. It is understood that the paraplegia should be below the first lumbar segment in these cases, otherwise pressure sores would inevitable occur under the plaster. For the same reason plaster bed is contraindicated (GUTTMANN, HOLDSWORTH and HARDY, WATSON-JONES and others). Contraindications for closed reduction in hyperextension are fracture-dislocations with locking of articular processes, fractures of the vertebral body involving the posterior wall of the centrum (ROGERS and WATSON-JONES) and probably comminution of the laminae or pedicles.

Open Reduction and Internal Fixation (or Splinting) with Plates and Bolts or Screws. — This is at present advocated by many authors in unstable fractures of the dorsolumbar spine (BARNES, DICK, HOLDSWORTH and HARDY, MERLE D'AUBIGNÉ and BÉNASSY, NICOLL, WATSON-JONES, WILES, and WILLIAMS). If exploration of the fracture and laminectomy would be indicated for some reason, e.g. pressure by displaced fragments of bone, it would seem advisable to proceed with internal fixation. According to ROGERS, local anesthesia is preferable in open operative reduction.

Nursing on a Stryker Frame. — An alternative to internal fixation is the use of a frame which permits turning of the paraplegic patient without tor-

sional strain on the spine (HOLDSWORTH). One would think that plating provides better support against danger of displacement if the spinous processes, laminae, and pedicles are intact. A frame of the Stryker type remains the only choice in grossly comminuted fractures or when plating cannot provide fixation (WILLIAMS).

Laminectomy. — GUTTMANN and HOLDSWORTH believe that early laminectomy is indicated if progressive deepening of the paraplegia occurs in the hospital. Increasing neurological signs during the transportation from the place of accident to the hospital can be due to the instability of the spine. The treatment should then be directed towards stability. If no fracture or dislocation can be detected in injuries of the spinal cord and nerve roots, the QUECKENSTEDT test should be performed and in case of manometric block laminectomy should be done immediately regardless of completeness or incompleteness of the paraplegia (GUTTMANN). In late laminectomy, the indications for operation can be chosen more freely. When stability is achieved and the neurological behaviour of the patient is known we can estimate more accurately the possible gain or loss from a laminectomy. The results of late laminectomy are contradictory. Many surgeons in America are in favour of laminectomy, both early and late, but most British authors take a reserved attitude in the matter (BARNES, COMARR, LOYAL DAVIS, GUTTMANN, HOLDSWORTH, ROGERS, STREET, TARLOV, WATSON-JONES, WHITE, and others). HAGELSTAM of Finland published forty-eight late laminectomies with fifteen favourable results. Since late laminectomy contrary to the early one, does not cause noteworthy instability it can not have the same contraindications than the latter. It can therefore be performed with less restriction if there exist a slight change of improvement.

It should be understood that the indications for operation discussed above stand for closed injuries of the thoraco-lumbar spine with paraplegia. All authors agree that immediate operative treatment is mandatory in every open lesion. Those should be explored, foreign bodies removed and meticulous debridement should be performed.

In concluding the present writer would say as follows. — Each new case of traumatic paraplegia is like an arithmetical example to calculate. It is our first duty to make a careful clinical and neurological examination immediately, take good radiographs and repeat the neurological examination in a few hours to trace any improvement or deterioration which might have taken place. Then we have to correlate the x-ray findings to the clinical picture. After some hours of observation we should be able to evaluate the lesion and make a rough estimation of the prognosis.

Operative indications and contraindications should be considered according to the known facts. Every single case should be judged individually. The treatment can be conservative or operative depending on the circumstances. One should not take the attitude that nothing can be lost by exploration. It is to be remembered that the procedure of reduction can be dangerous, particularly if there is complete muscle relaxation. Open reduction is safer and preferable if one proceeds cautiously and can provide fixation to the injured parts in order to protect the neural elements at least during the critical weeks after the accident.

In case of irreparable lesion of the spinal cord, no time should be spent to the treatment and the rehabilitation should be started immediately. In all other cases something can be gained by individual treatment. It is hard work to find out which case is which, but it seems to be possible and is certainly worth while.

The aim of our treatment is, apart from good nursing, prevention of complications and early rehabilitation, to provide the best possible neurological recovery whenever there is the chance. Sometimes this can be achieved by conservative approach, and sometimes by different kind of operations. There is no general rule.

To the writers opinion, the problem of early management of traumatic paraplegia has not been solved. The views presented in the literature are still somewhat controversial. The treatment of paraplegia should be concentrated to special centres from the very beginning. It is our duty to strain for further development in the understanding, treatment and care of these unfortunate victims of modern age.

SUMMARY

In the first part of this investigation the writer presents theoretical and practical classification of injuries to the spinal cord and nerve roots. The nature of cord lesion, distinction of root damage from cord destruction, stability or instability of the spinal injuries, and operative indications are considered separately in the light of relevant literature.

The second part of the work deals with investigations based on the writer's material of 36 paraplegias due to injuries of the thoraco-lumbar spine. Seven of these patients died shortly after the injury. Twenty of the cases showed no neurological recovery, and in nine instances improvement was noted. The recovery was marked in three and slight in six cases. The contribution of treatment is contemplated. The symptoms were aggravated in four cases of conservative and one case of operative treatment. The causes of deterioration are also analysed.

In the discussion different aspects of the problem of traumatic paraplegia are surveyed. The essentials in the management of paraplegics are specified as follows: good nursing, prevention of complications, early rehabilitation, and concentration of these cases to special units from the very beginning. The actual early management of paraplegia is a problem which deserves special consideration. The conservative and operative treatment of closed injuries of the dorsolumbar spine is divided into five categories and these are discussed separately. Nursing in bed only, closed reduction and plaster jacket, open reduction and internal fixation with plates and bolts, nursing on a Stryker frame, and laminectomy, are all regarded to have their indications. The writer compares each new case of traumatic paraplegia to an arithmetical example. Careful clinical and meticulous, repeated neurological examinations should be performed and the findings are to be correlated to the radiographs. Every single case must be judged individually. There is no general rule. The treatment can be conservative or operative depending on the circumstances. The nature of neural damage should be evaluated in order to get an idea of prognosis. When the consequences are found, the treatment should be planned accordingly.

It is regarded possible to work out a rough prognosis of paraplegia during the first few hours after the injury. In case of irreparable destruction of the cord, the spinal injury should be ignored and the rehabilitation started at once. In all other instances something can be gained by individually planned treatment.

In conclusion the writer claims that the problem of early management of traumatic paraplegia has not been convincingly solved, and that it is our duty to strain for further development in the understanding, treatment and care of these unfortunate victims of modern age.

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