SURGICAL ASPECTS OF THE TREATMENT OF
TRAUMATIC PARAPLEGIA

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In the treatment of vertebral injuries with spinal cord involvement the views expressed in recent years by surgeons, some of whom advocate exploratory laminectomy whereas others favour conservative treatment, are no less controversial than they were in the time of Astley Cooper and Charles Bell, one hundred and twenty-five years ago. Even among those who advocate surgical intervention the best time for laminectomy is still a matter of some disagreement, and this applies both to early and late operations.

In assessing the indications for surgical intervention it is essential first to make a clear distinction between traumatic paraplegia due to closed spinal injuries and paraplegia due to compound spinal injuries such as stab wounds and, particularly, gunshot and shell wounds. Moreover, the term "early treatment" must be defined more clearly than has been done in the past. It has been interpreted differently by various authors. Some, when they refer to "early laminectomy," mean exploration within forty-eight hours of injury, whereas others believe that operation after one to two weeks is still "early." A distinction should be made between surgical intervention at the most acute stage, within the first three days, and operation during the next two to three weeks. Surgical intervention within the first three days may be termed "immediate operative treatment" as opposed to "early operative treatment" when the most acute stage has passed.

IMMEDIATE OPERATIVE TREATMENT

Open spinal injuries—In open or compound spinal injuries, regardless as to whether or not they have caused complete or incomplete transverse spinal syndromes, immediate operative treatment is indicated as soon as general shock has been overcome, provided only that there is no associated injury to the lungs or other internal organs. It should usually consist only of debridement. Haematomata and foreign bodies such as bullets, pieces of cloth and bone splinters should be removed whenever possible. The removal of such foreign bodies is indeed vital if there is leakage of cerebrospinal fluid. Dural tears should be closed and penicillin and streptomycin applied locally. If the dura is found to be intact it should not be opened unless there is absolutely clear evidence of a localised subdural haematoma: if there is such a haematoma and if, as in the case of cauda equina lesions, it involves the anterior and posterior roots, these should be disentangled. Such procedure was adopted during the recent war by most British and American neurosurgeons and, as a rule, it proved satisfactory.

Closed spinal injuries with complete paraplegia—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. Moreover, in complete transverse lesions in which flaccid paraplegia remains unchanged for forty-eight hours there has usually proved to be either complete crushing and destruction of the cord or at least most severe damage which is irreparable.

Importance of instituting rehabilitation immediately—These are the cases in which all efforts should be concentrated on rehabilitation from the very beginning. The main points which have to be considered even in the immediate and early stages are: the prevention of pressure sores; the control of urinary infections; the prevention of contractures of paralysed limbs.
due to faulty position, such as keeping the legs constantly adducted, the hips and knees flexed, and the feet and toes in plantar flexion; and the development of the muscles of the trunk and upper limbs on which the patient will have to rely. Everything should be done in these early stages to encourage development of readjustment forces in mind and body to compensate for loss of function in the paralysed parts of the body by increasing the action of the normal parts. Details of the management of patients with traumatic paraplegia have been published elsewhere (Sandifer and Guttmann 1944, Guttmann 1945, 1946, 1947 and 1949).

**Dangers of plaster casts and plaster beds**—The application of plaster casts is contra-indicated because it leads almost invariably to the development of deep pressure sores. This does not mean that the spine should be ignored completely, as was advocated by Magnus in Germany. From the point of view of rehabilitation it is advisable to bring a badly displaced spine into the best possible position but this can usually be maintained by pillows or blankets without the application of plaster. Plaster beds should be allowed only for transport and be discarded at the earliest possible date. At the beginning of the recent war, plaster beds were recommended for the prevention and healing of pressure sores in patients with traumatic paraplegia, the idea being that pressure was then distributed more evenly. This concept did not prove to be correct; the volume of the paralysed parts does not remain constant because there are changes in the degree of vasodilatation from interruption of the spinal vasomotor centres. In fact, in those patients with paraplegia who lay in plaster beds for months—even when these beds had been constructed by experts—not only did this method of nursing prove to be no better in the prevention and treatment of pressure sores but it actually promoted the development of sores of the most frightful type. In addition, this type of fixation may cause profound contracture of joints, distortion of the pelvis, and atrophy of the back muscles in normal parts of the body which are so vital for physical readjustment and particularly for the later maintenance of the upright position. Moreover, stagnation in the renal system caused by prolonged recumbency and immobilisation may have devastating effects on the bladder and kidneys. It has often taken months and even years of hard work to remedy, or at least to diminish, the damage caused by this form of fixation. The conclusion drawn by the author from his own experience during and after the recent war is that the use of plaster beds, except for the purpose of transport, is contrary to the fundamentals of the rehabilitation of patients with traumatic paraplegia.

**Closed spinal injuries with incomplete paraplegia**—In closed spinal injuries with incomplete cord or cauda equina lesions this writer also favours conservative treatment in the period immediately after injury; as a rule, operative intervention can be postponed safely. There are, however, extremely rare instances of rapidly increasing epidural haematoma in which operative intervention is indicated at this early stage. An excellent result thus obtained was described by McLean (1933) in a case of a fracture-dislocation of the eleventh dorsal vertebra. Twelve hours after injury the sixteen-year-old patient showed only marked tenderness in the eleventh and twelfth dermatomes with analgesia in the distribution of the first and second lumbar nerves. Sensibility in the saddle area was normal, as were the lower limb tendon reflexes. The symptoms gradually increased and thirty hours after the accident there was almost complete paraplegia with absent reflexes and sensory loss which was more marked in the lumbar regions than in the sacral regions. At operation, forty-eight hours after injury, dislocation of the vertebra was confirmed and partly corrected, and an epidural haematoma that was compressing the cord was evacuated. A posterior plaster shell was moulded to the patient before he was moved from the table. The clinical signs receded within a period of nine weeks. At the thirty-eighth week there was a residual, incomplete Brown Sequard syndrome.

**EARLY OPERATIVE TREATMENT**

**Open spinal injuries**—In compound spinal injuries, particularly those due to gunshot and shell wounds, the main purpose of early operative intervention is the removal of foreign
bodies, especially when there is leakage of cerebrospinal fluid with X-ray evidence of a foreign body within or in the neighbourhood of the spinal canal, and bacteriological evidence of infection of the cerebrospinal fluid. In such a case, removal of the foreign body is vital. A soldier was admitted to this Spinal Centre from the battle-front in Germany on December 11, 1944, fourteen days after being hit in the back by fragments of an 88 mm. shell which burst near him. He had a complete transverse lesion at Th.11, with flaccid paraplegia. There was a wound measuring 4 centimetres by 2 centimetres to the left side of the tenth thoracic vertebra which was discharging cerebrospinal fluid. Bacteriological examination showed infection with clostridia Welchii, B. haemolytic streptococcus and B. coliform bacilli. Radiographs showed a large metallic foreign body in the region of the spinal canal at the level of Th.11 which was fractured. On December 16, I removed a metallic foreign body measuring 4 centimetres by 1·5 centimetres. No attempt was made to close the dura. Post-operative treatment consisted of daily dressings with local penicillin. The wound healed gradually, and the patient, although still paralysed, is now very fit and is gainfully employed as a commercial artist.

**Closed spinal injuries**—In closed spinal injuries the indications for laminectomy during the early stages are:

1) Incomplete lesions showing progression of the neurological signs. In the writer's opinion, the presence of bone protruding into the spinal canal alone is no indication for surgical intervention in the early stages.

2) Permanent manometric block without evidence of fracture or fracture-dislocation of the spine. In such cases, which are very rare, laminectomy is justified in the early stages irrespective of whether the transverse spinal syndrome is complete or incomplete.

3) Severe and constant irritation of spinal roots caused by displacement of bone fragments or prolapse of intravertebral discs. This, however, is very rare in the early stages. Elsberg (1940), for instance, in twenty years saw only one case of incomplete spinal lesion with root pain sufficiently severe to indicate early surgical interference. In my own series of 370 patients with traumatic paraplegia treated during and after the recent war at Stoke Mandeville I have seen not a single case in which such surgical intervention was justified.

**LATE OPERATIVE TREATMENT**

Laminectomy in the late stages of traumatic paraplegia has been carried out to serve three main purposes:  

a) restoration of neural function;  
b) treatment of intractable pain;  
c) treatment of violent flexor or extensor spasms.

**Restoration of neural function**—As a general rule "late laminectomy" does not serve any useful therapeutic purpose in complete transverse lesions at any level. On the contrary, by weakening the stability of the spine and particularly the strength of those muscle groups of the back which are so essential for the upright position, it only delays the rehabilitation of the paraplegic patient to a useful social and industrial wheel-chair life. Moreover, the post-operative shock has a most harmful effect during the first few days on the peripheral vasomotor control in the paralysed parts, thus causing lowered tissue resistance to pressure and greatly increasing the danger of pressure sores. This conception is at variance with the opinion, generally held, that exploratory laminectomy is harmless.

No single patient admitted to the Spinal Injuries Centre at Stoke Mandeville with a complete transverse lesion, due either to closed or open spinal injury, had gained any recovery of neural function of the damaged spinal cord by exploratory laminectomy performed before admission. T. B. Dick (1949) compiled statistics relating to twenty-seven patients subjected to laminectomy more than seven days after injury at the Spinal Injuries Centre, Winwick. Twenty-two had complete lesions before operation and, although only two proved to be anatomically complete, no patient showed evidence of later recovery. Five operations were performed on patients with incomplete lesions: three showed doubtful improvement which probably, as the author states, was not attributable to the operation. Our observations are
in accord with those of McCravey (1945) and Cutler (1945), and it may be noted that in December 1944 the American Surgeon-General directed that late laminectomies in this type of spinal injury should no longer be carried out because it was considered useless in the attempt to restore neural function.

Furthermore, late laminectomy should not be carried out indiscriminately in incomplete transverse lesions. This writer is opposed to the recent recommendation that exploration is indicated even in the presence of neurological improvement if there is radiographic evidence of laminal damage (Haynes 1946). There is no hurry whatsoever, and it is nearly always safe to wait at least until the progress of recovery has ceased.

On the other hand, there is general agreement that laminectomy is indicated in incomplete transverse spinal syndromes when there is evidence of increasing neurological signs. The underlying cause of such clinical progression may be callus formation, or localised chronic pachymeningitis or leptomeningitis (arachnoiditis chronica progressiva cystica adherisiva). Riddoch (1927) and other authors have described cases of post-traumatic chronic meningitis in which the post-operative results were satisfactory. Forster (1929), though mentioning the satisfactory result of operation in several of his own patients, emphasised that in most patients with chronic post-traumatic arachnoiditis improvement in the spinal symptoms after operation was not very impressive; and he assumed that post-traumatic thrombosis of the spinal cord vessels was often responsible for irreversible lesions of the cord. There are also selected cases of osteomyelitis with local pachymeningitis in which exploration may be indicated. In one of my own cases in this series, in a naval officer, there was an incomplete lesion at the mid-thoracic region and, at operation, a track was found running down to the vertebra associated with localised pachymeningitis and very marked increase of fibrous tissue which was removed from the dura. The result of the operation was satisfactory in so far as there was relief from pain, and arrest of the increasing motor weakness, although the effect on the spasticity was insignificant.

Treatment of intractable pain—Pain is most frequent in cauda equina and distal thoracic cord injuries and is mainly of the causalgic type. It also occurred in patients in this series, with complete or incomplete cervical lesions, who were admitted with serious contractures of the elbow and shoulder joints. The pain may be general or it may be referred to definite parts of the limbs or trunk. It is often agonising and the life of the patient becomes almost unbearable. The treatment usually given to patients with such pain before admission to this Centre had often included long continued injections of morphine and other narcotics and, sometimes, sympathectomy or cordotomy.

The approach of this writer to the problem of pain in paraplegia, based on dissatisfaction with his own previous operative results with posterior rhizotomy and cordotomy, has been quite different from the beginning. The essential principle of treatment is to mobilise, and develop to the highest possible level, readjustment forces in the mind and body of the patient in order to master the various symptoms of his disability, including pain. This is achieved by appropriate psychological measures, healing and prevention of septic conditions, treatment of anaemia caused by sepsis, frequent passive movements and all forms of active physiotherapy including recreations and, above all, pre-vocational training which has proved the best possible form of occupational therapy by which to counteract frustration. The prescription of morphia and other heavy narcotics which obviously impedes the mobilisation and development of these adjustment forces was reduced to a minimum, and in due course was almost completely abandoned. Some years ago Gowlland (1934), when writing of the treatment of paraplegic patients, stated: "I suppose that there is more morphia, atropine and hyoscine used in the Home which I look after than in any other place of the same size in the country." He continued: "One of the snags is that some of these poor fellows who really do suffer and whose pain has been relieved by morphia, are apt to become addicts." In striking contrast to this approach, which still prevails in many centres for the treatment of paraplegia, it can be...
stated that the Spinal Centre at Stoke Mandeville Hospital is one of the medical institutions where the least amount of morphia and other heavy narcotics is used for the treatment of painful conditions. In some cases pain has not been entirely eliminated, but this has in no way prevented successful rehabilitation. Repeated paravertebral injections of novocain have sometimes been employed and in two patients, where pain was associated with severe abdominal spasm, intrathecal injections of alcohol were successful. It may be concluded that radical surgical procedures such as sympathectomy, posterior rhizotomy, cordotomy, and posterior column tractotomy have very limited application in the treatment of pain in traumatic paraplegia. Surprising as it may seem, the apparently intractable pain is best relieved by general rehabilitation and retraining of the patient.

**Treatment of violent flexor or extensor spasms**—In the past, severe flexor or extensor spasms were considered to be one of the most devastating complications of spinal cord injury, preventing rehabilitation and making the life of the patient intolerable. During the last five years much research has been undertaken by which to distinguish the various causes underlying the mechanism of this spasm, and great progress has been made in treatment. It can now be concluded that if adequate care and appropriate preventative measures are instituted at an early date after injury, exaggerated reflex activity of the paralysed limbs never becomes so severe that amputation and rehabilitation is prevented. The spasticity can be kept in check either by conservative methods or by simple operations such as lengthening of the tendo Achillis and neurctomy of the obturator nerves. Obturator neurctomy has proved to be an excellent method of restoring the sexual activities of the paraplegic patient by eliminating adductor spasm which is the main obstacle to intercourse. In patients who were admitted at later dates after injury, with profound reflex spasm of the paralysed limbs and resulting contractures, and whose previous treatment had consisted mainly of the administration of morphine and other narcotics, intrathecal injection of alcohol as described by the writer in 1946, and confirmed recently by Freeman and Heimberger (1948), Shelden and Bors (1948) and Gingras (1948), has proved very successful indeed in transforming spastic paralysis into a flaccid type which, from the point of view of rehabilitation, is so much more manageable. This method has superseded radical operations, such as posterior rhizotomy (Foerster 1929) and anterior rhizotomy (Monro 1945), which necessitate general anaesthesia, laminectomy, and all the other discomforts and dangers which inevitably are associated with major operations.

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