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# THE PROGNOSIS OF PATIENTS SUSTAINING SEVERE CERVICAL SPINE INJURY (C2–C7 INCLUSIVE)

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**Abstract.** In a study of 145 patients with severe cervical spine injury, it was found that 79 had serious neurological disturbance. A policy of the earliest possible referral to a spinal paralysis service is recommended. Associated injuries and in particular a head injury can make early precise neurological diagnosis difficult, and may affect management of the spinal injury. The use of Gardner Wells Skull Tongs and the Edinburgh Simpson Bed is recommended. Early spinal operation does not influence outcome of neurological function. Anatomical re-alignment of the spine is not essential for neurological recovery. Myelography is very rarely of benefit in assisting diagnosis and treatment. Glucocorticosteroids and Mannitol do not appear to influence neurological recovery.

The prognosis in relation to clinical neurological syndromes is discussed.

**Key words:** Spinal cord injury; cervical cord syndromes; multiple injuries.

DURING the 5-year period, 1973–77, 266 patients with a cervical spine injury were admitted to the Spinal Paralysis Service in Edinburgh (Royal Infirmary of Edinburgh and Edenhall Hospital, Musselburgh). Of these patients 145 have been studied, and analysed (Tables I and II), omitting patients with atlanto-axial injuries and those with minor vertebral and minor neurological abnormality. Seventy-nine had severe neurological disturbances, and 66 had severe vertebral

TABLE I

Age and sex distribution

| Age years | 10–20 | 21–30 | 31–40 | 41–50 | 51–60 | 61–70 | 71–80 | 81–90 | Total |
|---|---|---|---|---|---|---|---|---|---|
| M | 25 | 27 | 14 | 17 | 11 | 7 | 9 | 2 | 112 |
| F | 2 | 3 | 3 | 4 | 5 | 7 | 7 | 2 | 33 |
| Total | 27 | 30 | 17 | 21 | 16 | 14 | 16 | 4 | 145 |

TABLE II

Place where accident occurred

| RTA | Work | Home | Sport | Other |
|---|---|---|---|---|
| 68 | 16 | 29 | 20 | 12 |
| 46% | 12% | 20% | 14% | 8% |

injury but minor neural abnormalities. These latter (66) patients represent an important group as they are 'at risk' from several points of view: failure and delay in diagnosing the serious cervical spine injury, the risk of mis-handling at the location of the accident (Table III), during transportation and indeed in hospital. There is a risk of causing a 'second injury' to the precarious vital cervical neural elements.

The organisation, policies and facilities for the care of the injured will influence the type of patient admitted to spinal centres, and when that patient will arrive in a hospital with the specialised staffing and facilities required. This is reflected in Table IV, which shows that a significant number had severe multiple injuries and in particular 12·5 per cent had a serious associated head injury. The time taken for the admission of patients to the Service is shown in Table V; 92 (63·5 per cent) being admitted within 5 hours of the accident.

In this series of patients, an attempt has been made to reduce dislocations and fracture-dislocations promptly (Table VI), and to see if this influenced the neurological prognosis. But, as has been shown also by other workers, such as Frankel *et al.* (1969), Heiden *et al.* (1975), and Maynard *et al.* (1979), there was no obvious

TABLE III

| Untrained | Trained | Doctor |
|---|---|---|
| 21<br>14·5% | 119<br>82·0% | 5<br>3·5% |

TABLE IV

Serious associated injury

| Head | Chest/Abdomen | Limb |
|---|---|---|
| 18<br>12·4% | 3<br>1·5% | 17<br>8% |

TABLE V

Time from injury to hospital admission

| 0–5 Hours | 5–24 Hours | More than 24 hours |
|---|---|---|
| 92<br>63·5% | 18<br>12·5% | 35<br>24% |

TABLE VI

Time to achieve complete vertebral reduction after injury

| Hours | | | | | | |
|---|---|---|---|---|---|---|
| 0–4 | 5–8 | 9–12 | 13–16 | 17–24 | 1–2 Days | Over 2 days |
| 10<br>7% | 17<br>12% | 10<br>7% | 4<br>3% | 13<br>9% | 23<br>16% | 18<br>12% |

benefit. This was also the case with trials of glucocorticosteroids and with diuretics (20 per cent mannitol I.V.) in the majority of the 145 patients. As an additional aid to diagnosis and to evaluate the investigation in patients with severe cervical spinal trauma, positive contrast myelography was carried out in 26 patients. Rossier *et al.* (1975) found gas myelography to be of real value, but certainly positive contrast myelography was of no help in our patients, apart from one where a fractured lamina was seen to be impinging on the dorsal aspect of the spinal cord and this was not evident in the plain radiographs (Gillingham *et al.*, 1978). Like Sypert and Mozingo (1976) we found that, in expert hands, myelography carried no risk to the patient; but this, of course, is not a valid reason for using it.

With the aim to minimise the period of skull traction and immobilisation on a special frame or bed, 48 patients had operative spinal fixation (20 by an anterior procedure, 14 posterior, and 14 by a combined posterior and anterior procedure). One patient had a laminectomy to remove an indriven lamina. Utilisation of Gardner Well Skull Tongs (Harris, 1977), and the Edinburgh-Simpson bed (McClemont *et al.*, 1978) is the method of choice; 40 per cent of our patients were treated thus, and if in category D or E were discharged home within 1 month of sustaining their injury. None of these patients showed neurological deterioration. No patient had late spinal instability; this occurred in 5·4 per cent of Cheshire's patients (1969) and in two of the Frankel *et al.* (1969) 218 patients. The overall mortality was 8·9 per cent; but the mortality directly related to the spinal cord injury was 2·7 per cent. Associated injuries, and/or the patient's previous poor cardiac state (three patients had a history of previous myocardical infarction), influenced the mortality and morbidity rates.

In the 132 survivors, the patient's neurological status on admission was compared to that on discharge, using the Stoke Mandeville scheme (Frankel *et al.*, 1969) Table VII. But our series is much smaller, and includes a large number of patients who had severe vertebral trauma with minor neurological disturbance, placed in category 'E' on admission. No patient with a complete lesion (Category 'A') on admission recovered to reach 'D'; and no patient in 'B' reached 'E'. In Frankel's study (1969) (Table VIII) of 42 patients with a complete lesion (tetraplegia) on admission, 21 had some sensory recovery (AB), ten had some non-

TABLE VII

Neurological status on admission and on discharge in 132 patients

| | | | | |
|---|---|---|---|---|
| A A | A B | A C | A D | A E |
| 18 (+6) | 2 | 1 (+1) | 0 | 0 |
| B A | B B | B C | B D | B E |
| 2 | 1 | 1 | 1 (+1) | 0 |
| C A | C B | C C | C D | C E |
| 0 | 1 | 6 (+3) | 7 (+1) | 1 |
| D A | D B | D C | D D | D E |
| 0 | 1 | 1 | 17 (+1) | 34 |
| E A | E B | E C | E D | E E |
| 0 | 0 | 0 | 0 | 38 |

NOTES: (1) Category 'E', 'on admission patients', are patients with severe vertebral injury and minor neurological disturbance.
(2) The figures in brackets are those who died.
(3) This table corresponds to Table IIIB, Frankel *et al.*, 1969.

TABLE VIII

Table IIIB from Frankel *et al.*, 1969. Neurological status on admission and on discharge of 218 patients

| | | | | |
|---|---|---|---|---|
| A A | A B | A C | A D | A E |
| 81 | 21 | 10 | 11 | 0 |
| B A | B B | B C | B D | B E |
| 3 | 9 | 2 | 14 | 5 |
| C A | C B | C C | C D | C E |
| 0 | 1 | 4 | 11 | 5 |
| D A | D B | D C | D D | D E |
| 0 | 0 | 0 | 30 | 11 |
| E A | E B | E C | E D | E E |
| 0 | 0 | 0 | 0 | 0 |

functional motor recovery (AC), and 11 had useful recovery of motor power (AD). Maynard *et al.* (1979) in analysis of 114 patients found that four of their 62 patients with tetraplegia at 72 hours became 'AD', and one 'AE', and suggest that these five patients had been incorrectly diagnosed because of cognitive impairment resulting from associated head injury.

A study of the clinical syndromes arising from cervical spine injury (Table IX) confirms most of the findings of Bosch *et al.* (1971), and of Braakman and Penning (1976). 'Subtotal' cord syndromes (that is not falling into the other 'partial cord syndrome' categories) have the best prognosis, followed by patients with a central cord syndrome, Brown-Sequard syndrome, and with the poorest prognosis in patients with an anterior cord syndrome. If there is complete motor paralysis but some sensory preservation, functional motor recovery is quite unlikely according to Suwanwela *et al.* (1962). The experience of Frankel *et al.* (1969) is better, but that of Braakman and Penning (1976) is not good. Concerning neurological recovery in patients with a central cord syndrome, our results are similar to those reported by others (Schneider *et al.*, 1973; Gros *et al.*, 1960; Rand & Crandall, 1962; Bosch *et al.*, 1971); the younger the patient and the sooner motor recovery begins, the better the prognosis; and although they were eventually able to walk, the majority were left with weak upper extremities and in particular weak and often useless hands.

TABLE IX

Clinical syndromes—showing neurological status on admission and on discharge

| | | Neurol. state on admission | | | | | Neurol. state on discharge | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Syndrome | Number | A | B | C | D | E | A | B | C | D | E | Dead |
| Complete tetraplegia | 28 | 28 | — | — | — | — | 19 | 1 | 1 | — | — | 7 |
| Anterior cord | 5 | — | — | 4 | 1 | — | — | — | 4 | 1 | — | — |
| Central cord | 19 | — | 1 | 6 | 12 | — | — | — | 3 | 12 | 3 | 1 |
| 'Brown-Sequard' | 6 | — | — | 2 | 4 | — | — | — | — | 4 | 1 | 1 |
| 'Subtotal' cord | 46 | — | 2 | 7 | 37 | — | — | 1 | 4 | 3 | 34 | 4 |
| Total | 104 | 28 | 3 | 19 | 54 | — | 19 | 2 | 12 | 20 | 38 | 13 |

## Discussion

This is a study of a heterogeneous, complex group of patients with many important variables. There is some difficulty in devising a suitable clinico-pathological classification of patients with severe injury of the cervical spine. Thus, even excluding the often significant associated injuries which are not infrequent in these patients (Harris, 1968), if the patient's spine was previously anatomically normal and had no pathology (such as cervical spondylosis), then we would require a large, statistically meaningful, number of patients to be admitted immediately to a spinal service of excellence over a short period of time for investigations and treatment by the same medical and nursing and other staff to enable guide-lines for prognosis to be enunciated.

Some difficulty is experienced in utilising systems of classification, but the best is that of Frankel *et al.* (1969) from Stoke Mandeville, although Maynard *et al.* (1979) had difficulty in agreeing on Category 'D' neurological state on admission, *i.e.* 'motor useful', implying that there is useful motor power below the level of the lesion; therefore these latter authors devised a modified scheme. We feel that the 'clinical syndrome' classification has some merit regarding the functional neurological outcome. But there is little reported work on the neurological level (upper and lower motor neurone) concerning the prognosis of upper limb function. We have not attempted this in this particular paper, although, obviously it is extremely important, and probably more important than recovery of neurological function in the lower limbs. We are fortunate in having Mr Douglas W. Lamb, Consultant Orthopaedic Surgeon, as a member of staff of the Service as he is an expert on the paralysed upper limb. We also have the facilities of a Biomedical Engineering Unit.

In general terms, in severe brain injury, children and young adults fare better than the old, but this is not so far obvious in serious spinal injury. In most instances, the neurological damage occurs at the time of injury (Guttmann, 1976), but there is a risk of a second injury; also the initial radiographs of the spine do not, of course, necessarily show the degree of deformity present initially; the contrary is more often the case. As we have found, and has been mentioned by Hachen (1974), relatively more patients with partial cord lesions are seen when spinal cord injury patients are expertly handled initially and are speedily referred to a spinal unit. Unfortunately there is a serious shortage of spinal units and of trained personnel, but we do not have a waiting list for 'new cases'; all referred patients, and some come from outlying parts of Scotland, including the islands and oil-rigs, are admitted forthwith, according to the tenets and teaching of Guttmann (1976). We prefer early reduction of dislocations and fracture-dislocations, although to date it does not appear that neurological recovery is influenced favourably by doing this. Our patients are soon, within a few days if the neurological lesion does not seriously hamper respiration and if there are no serious associated injuries, placed on an Edinburgh-Simpson Low-pressure Bed, and are mobilised as quickly as possible. Vertebral column instability, a much maligned term, is not a problem.

Early myelography has been tried but is of very little value.

No attempt has been made to analyse and to discuss the prognosis of respiratory, urinary bladder, bowel or sexual functions in this communication.

There has been a great resurgence in experimental animal studies in spinal cord injury, including the important work of Black and Markowitz (1971); Ducker and Hamit (1969); Hedeman and Sil (1974); Osterholm and Matthews (1971);

Tator (1972) and Tator and Deecke (1973), and important new chemo-pathophysiological information is being reported, along with studies on various forms of treatment. However, unfortunately, it would not appear that there are direct applications to spinal cord injury in man. Our experience with the use of glucocorticosteroids, and with intravenous 20 per cent mannitol is not promising.

We are indebted to our neurosurgical, orthopaedic, general surgical and radiological colleagues for their cooperation in this study. It is salutary to survey clinical experiences to provide feedback so that policies may be assessed and modified, that wrong and unnecessary investigations and therapies are discontinued, and that the closest possible coordination is achieved. Above all, prevention must at all times be stressed.

## Summary

One hundred and forty-five patients with severe cervical spine injury, from C2 to C7 inclusive, have been studied in relation to their neurological prognosis. Ninety-two (63·5 per cent) were admitted to a spinal paralysis service within 5 hours of the accident. The investigation and management are described. The type of clinical syndrome resulting from the injury influences the neurological outcome.

## Résumé

145 malades avec des lésions de la moelle épinière cervicale dé C2 à C7 inclus ont été étudiés regardant leur prognostique neurologique. 92 (63·5%) furent admis au centre de paraplégie dans les cinq premières heures après l'accident. Les investigations et le traitement sont décris dans le texte. Le syndrome clinique résultant de l'accident influence le résultat neurologique.

## Zusammenfassung

145 Patienten mit schweren Verletzungen der vertebrae cervicalis (von C2 bis einschließlich C7) sind im Zusammenhang mit ihrer neurologischen Prognose untersucht worden. 92 (63·5%) wurden innerhalb von fünf Stunden nach dem Unfall in eine Fachabteilung für Rückgratsverletzungen aufgenommen. Untersuchungen und Behandlung werden beschrieben. Die Art des klinischen Syndroms nach der Verletzung beeinflußt die neurologischen Folgeerscheinungen.

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