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The Natural History of Neurological Recovery in Patients with Traumatic Tetraplegia

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Summary

During the years 1965 to 1986 the Rehabilitation Institute in Konstancin, Poland provided treatment for about 1400 patients admitted to hospital within the first hours or days after injury to the cervical spinal cord. This communication presents an analysis of 122 patients with tetraplegia, with absent sensation or only slight deep sensation preserved on admission. The patients showed considerable neurological recovery of the paralysed muscles. The analysis includes the age of patients, the level and degree of spinal cord injury, the mechanism of spinal injury, the time interval from injury to the return of sensation, voluntary movements and bladder automatism functions, as well as the ability to walk.
Key words: *Spinal cord injury; Tetraplegia; Neurological recovery.*

Tetraplegia due to spinal cord injury is one of the most serious consequences of injury. The general view is that people with such injuries have little chance of survival and neurological recovery is rare. The literature (Bedbrook and Sakae, 1982; Wilmot and Hall, 1986; Dietz *et al.*, 1986; Harris *et al.*, 1980; Frankel *et al.*, 1968) as well as our own observations (Kiwerski and Weiss, 1981; Kiwerski, 1986a; Kiwerski, 1986b) show that neurological recovery, sometimes of a considerable degree, can occur in such patients. Neurological recovery is obviously more likely in patients admitted with an incomplete spinal cord injury, even if there is complete tetraplegia, than in paralysed patients with no sensation preserved. But even in the latter group, neurological and quite frequently also functional recovery is not exceptional.

This paper is an analysis of a group of patients whose clinical documentation is complete and thus it is possible to time the return of deep sensation (in cases with symptoms of complete spinal cord injury (SCI) on admission), minimal voluntary movements, effective voluntary movements and the development of bladder automation.

Table I Age, level and degree of lesion

Initial neurological state	Level	Age to 20	21–40	41–60	over 60	Total
Complete	C_1–C_5	—	4	7	—	11
	C_5–D_1	5	9	8	1	23
Incomplete	C_1–C_5	10	10	3	1	24
	C_5–D_1	6	35	19	4	64
Total		21	58	37	6	122

Table II Mechanism of injury and degree of neurological lesion

Mechanism of injury	Degree of spinal cord injury Complete	Incomplete	Total
Flexion			
Dislocation	11	26	37
Fracture	2	4	6
Compression			
Contrusion	3	21	24
Crushing	8	16	24
Extension	9	18	27
No spinal damage	1	3	4
Total	34	88	122

Clinical material

In the years 1965 to 1986 there were over 1400 patients with cervical spine and spinal cord injury treated in the early post-traumatic period. In this group of patients, comprising over 800 persons with features of tetraplegia on admission, neurological recovery with restoration of voluntary movements in the lower extremities was observed in 150 patients. The analysis concerned patients who on admission had symptoms of complete SCI and after completion of treatment had paretic muscle strength of at least over 2° in Lovett's scale or over 3° in Lovett's scale if deep sensation had been preserved in the feet.

The analysed group consisted of 122 patients whose medical documentation was complete. Table I shows the age of patients and the level and degree of SCI. On admission 34 persons had a complete, and 88 an incomplete SCI with some deep sensation preserved in the feet. Injuries to the lower cervical spine were dominant (over 71%). The smallest group was young people accounting for 20%. In the analysed group there were few elderly persons. In elderly tetraplegics the mortality rate is rather high, although neurological recovery is possible.

Table II juxtaposes the degree of SCI and the mechanism of the spinal injury. Considerable neurological recovery was noted with the same frequency both in those with flexion and in those with compression injuries. Flexion injuries of the cervical spine are usually accompanied by dislocation. Fractures without dislocation are less frequent and the spinal cord is usually injured to a lesser degree. Considerable neurological recovery is more often seen in patients with an incomplete SCI due to post-traumatic vertebral displacement. In the group of compression injuries, recovery was noted in a similar number of patients. In injuries involving the vertebral body incomplete spinal cord lesions are domi-

nant. Complete spinal cord lesions prevail in injuries involving crushing or fragmentation of a vertebral body. The least numerous group consists of patients without significant radiological changes. Considerable neurological recovery was recorded in only one patient with a complete spinal cord lesion.

Dynamics of neurological recovery

The changes in neurological status in time are presented in Table III. The assessment involved the measurement of time from injury to the return of deep sensation in the feet and functional voluntary movements and the development of bladder automation. In patients diagnosed on admission as having a complete SCI, deep sensation was usually recorded within 24 hours after injury. Contrary to commonly held views, however, the persistence of a complete spinal cord lesion for over 24 hours after injury did not always indicate irreversible injury. In 6 patients the return of deep sensation was noted within the second or third day after injury, in one patient as late as the fourth day after injury. The return of voluntary movements differed in time, being rather within the first 24 hours after injury (7% of cases) and most frequent (66%) within the first 3 weeks after injury, but was also noted later.

There were patients where voluntary movement returned 4 months after injury. The muscle groups which showed some return of function gained strength gradually and relatively slowly, reaching a functional value not earlier than 6 weeks after injury and in about 25% of patients only after 3 to 6 months of rehabilitation. The length of time that bladder mechanisms took to recover corresponded to that of functional muscle strength, although in the majority of patients (over 62%) bladder automation was accomplished within 9 weeks after injury.

Functional results

In the evaluation of the results of treatment in SCI, the ever topical question is to what degree the neurological recovery can have an effect on the functional state of the patient. For our patients the most important issue is the possibility of walking, even with orthopaedic devices. If they can walk it is easier to accept impairment of function in the upper extremities. Thus we pay particular attention to locomotor function (Kiwerski, 1988). The functional results are shown in Table IV. They appear to be unexpectedly good. Thirty four per cent of patients left hospital being able to walk without any orthopaedic device, and 76% were able to walk. Ambulation with the help of a walking trolley was not regarded as functional and hence was not included in this group. Better functional results were observed in patients with incomplete SCI on admission, since the degree of neurological recovery obtained is usually greater. In that group 43% of patients could walk on leaving the hospital and functional walking was noted in as many as 84% of patients. Only 6 remained wheelchair-bound. No statistically significant differences in functional results were found when considering the level of the spinal injury.

Table III Timing of neurological recovery

Neurological recovery	1 day	2–3 days	1 week	2–3 weeks	Changes in time to 6 weeks	to 9 weeks	to 12 weeks	months
Return of deep sensation	27	6	1	—	—	—	—	—
Return of voluntary movements								
Traceable	9	22	24	25	18	12	6	
Functional	—	—	—	9	27	31	25	3
Bladder automatism	—	—	—	9	35	32	24	2

Table IV Functional results of treatment

Neurological state	Level of injury	Functional results of treatment					
		Gait				Wheelchair	
		Independent	With a cane	With crutches	Walking trolley	Independent	Dependent
Complete	C_1–C_5	1	1	4	2	1	2
	C_5–D_1	3	4	6	8	2	—
Incomplete	C_1–C_5	13	2	4	3	1	1
	C_5–D_1	25	18	12	6	3	—
Total		42	25	26	19	7	3

In patients who had a complete SCI on admission and obtained good neurological recovery, independent walking was recorded in about 12%, functional walking in 56% and 15% remained wheelchair-bound.

Conclusions

Early appropriate treatment of cervical SCI often resulted in considerable neurological recovery, even when tetraplegia was found on admission. The persistence of complete SCI symptoms within 24 hours after injury does not always indicate an irreversible lesion. Return of traceable voluntary movements in the lower extremities, although most frequently recorded within the first 3 weeks following injury, may also be noted later, even 3 to 4 months after injury. Considerable neurological recovery with intensive rehabilitation renders restoration of locomotor function possible in a significant minority of patients.

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