SPARING OF SENSATION TO PIN PRICK PREDICTS RECOVERY OF A MOTOR SEGMENT AFTER INJURY TO THE SPINAL CORD

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We have reviewed 59 patients with injury to the spinal cord to assess the predictive value of the sparing of sensation to pin prick in determining motor recovery in segments which initially had MRC grade-0 power.

There were 35 tetraplegics (18 complete, 17 incomplete) and 24 paraplegics (19 complete, 5 incomplete), and the mean follow-up was 29.6 months. A total of 114 motor segments initially had grade-0 power but sparing of sensation to pin prick in the corresponding dermatome. Of these, 97 (85%) had return of functional power ($\geq$ grade 3) at follow-up. There were 479 motor segments with grade-0 power but no sparing of sensation to pin prick and of these only six (1.3%) had return of functional power. Both of the above associations were statistically significant (chi-squared test, $p < 0.0001$).

After injury to the spinal cord, the preservation of sensation to pin prick in a motor segment with grade-0 power indicated an 85% chance of motor recovery to at least grade 3.

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Recovery of motor function after injury to the spinal cord depends on the degree and extent of the initial injury.¹⁻⁴ The preservation of sensation distal to the level of injury indicates a favourable prognosis in terms of motor recovery,⁵⁻⁸ and spinothalamic sensory sparing, as indicated by the perception of a pin prick, appears to have the closest correlation with motor recovery.^{5,9,10}

Zonal sensory sparing may also indicate the prognosis in patients with a complete (Frankel A) injury to the cord.¹¹ Motor segments in the zone of the injury which show MRC grade-0 power on admission are more likely to recover if the sensation in the corresponding dermatomes is intact.¹¹

Our aim was to evaluate patients with injury to the spinal cord to determine the prognostic significance of sparing of sensation to pin prick on segmental motor recovery.

PATIENTS AND METHODS

We reviewed 59 patients with injury to the spinal cord admitted to the National Spinal Injuries Unit at the Mater Misericordiae Hospital, Dublin, between June 1991 and December 1995. Patients with lesions of the nerve roots or cauda equina were not included. Of the 59 patients, 35 were tetraplegic (18 complete, 17 incomplete) and 24 were paraplegic (19 complete, 5 incomplete).

We performed neurological evaluation of each patient on admission, at 48 hours after injury before transfer for rehabilitation and at a mean follow-up of 29.6 months (13 to 57).

We used the American Spinal Injury Association (ASIA) scoring system;¹² this gives a numerical score of motor function and of sensation to light touch and pin prick. The motor score is calculated from the summation of the MRC grade of five key muscles in each limb. In the arm these are the elbow flexors (C5), the wrist extensors (C6), the elbow extensors (C7), the flexors of the middle finger (C8), and the abductors of the little finger (T1), and in the leg the hip flexors (L2), the knee extensors (L3), the dorsiflexors of the ankle (L4), the extensor of the great toe (L5) and the plantar flexors of the ankle (S1). The sensory scores are determined by the summation of the degree of sensation

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Fig. 1

Location of the key sensory points for each dermatome (reproduced with the permission of the American Spinal Injury Association).

(absent = 0, impaired = 1, normal = 2) at key sensory points, one for each dermatome (Fig. 1).

The number of key motor segments with MRC grade-0 power on admission was noted for each patient, considering right and left sides separately. The degree of sensation to pin prick at the key point in the corresponding dermatome was recorded. At follow-up each of these motor segments was carefully assessed and graded for return of power. For example, if a patient had MRC grade-0 power of the five key muscle groups of the right upper arm, segments supplied by C5 to T1, the sensation to pin prick at the key points of the C5 to T1 dermatomes was noted and at follow-up these muscle groups were assessed for return of power and MRC grade.

Operative treatment. Of the 35 tetraplegics, 14 had sur-

gery and 21 had closed skull traction. Of the 24 paraplegics 17 had operations. Corticosteroids were given to 21 tetraplegics and 15 paraplegics. Those patients who did not receive corticosteroids had been referred to our unit at over eight hours after injury.

Statistical analysis. We used the chi-squared test to test the hypothesis that sparing of sensation to pin prick and segmental motor recovery were significantly related.

RESULTS

Of the 59 patients on admission, 25 had one or more motor segments which had grade-0 power and sparing of sensation to pin prick in the corresponding dermatome; at follow-up, 24 had return of functional power ($\geq$ grade 3) in at least one

Table I. Segmental motor recovery in patients with sparing of sensation to pin prick

	Number	Patients with pp* + grade-0 power	Levels with pp* + grade-0 power	Levels with return of power	Levels with no return of power
Complete tetraplegia	18	7	26	20	6
Incomplete tetraplegia	17	12	63	58	5
Complete paraplegia	19	3	6	6	0
Incomplete paraplegia	5	3	19	13	6
Total	59	25	114	97	17

* sparing of sensation to pin prick

Table II. Segmental motor recovery in patients with no sparing of sensation to pin prick

	Levels with grade-0 power + no pp*	Levels with return of power	Levels with no return of power
Complete tetraplegia	235	3	232
Incomplete tetraplegia	51	2	49
Complete paraplegia	180	0	180
Incomplete paraplegia	13	1	12
Total	479	6	473

* sparing of sensation to pin prick

of these segments. In total there were 114 such segments and 97 (85%) had return of functional power at follow-up ($p < 0.0001$; Table I). By contrast, there were 479 segments which had grade-0 power and no sparing of sensation to pin prick on admission; only 6 (1.3%) had return of functional power at follow-up ($p < 0.0001$; Table II).

If a motor segment with grade-0 power on admission had sparing of sensation to pin prick in the corresponding dermatome there was an 85% chance of functional recovery, but if there was no sparing the chance was only 1.3%. Treatment had no apparent effect on these results.

DISCUSSION

The accurate prediction of motor recovery is difficult after injury to the spinal cord, but sensory sparing distal to the level of injury is an important prognostic indicator.⁵⁻⁸ Zonal sensory sparing improves the chance of zonal motor recovery in patients with complete (Frankel A) injuries to the cord,¹¹ and sparing of the spinothalamic tract (pin prick) is a better predictor of overall functional motor recovery than function of the posterior column.^{5,9,10} This is thought to be due to the close proximity of the lateral corticospinal (motor) and spinothalamic tracts.⁸

Previous studies which have shown the predictive value of sparing of sensation to pin prick in incomplete injury of the spinal cord have looked at the global recovery of motor function, as ability to walk or change in Frankel grade.^{5,9,10} The prediction of functional outcome is desirable but may be inaccurate because of many other factors; the assessment of pure motor recovery at the level of a single segment may be more accurate.

We have shown that after injury to the spinal cord preservation of sensation to pin prick in any given motor segment with grade-0 power indicates an 85% chance of

motor recovery to at least grade-3 power. A segment with no sparing of sensation to pin prick is very much less likely to regain any power. This difference was significant in all groups of injury to the cord.

Our findings have important clinical implications in improving the ability to predict motor recovery accurately whatever the degree of injury to the spinal cord.

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REFERENCES

1. Bohlman HH. Acute fractures and dislocations of the cervical spine: an analysis of three hundred hospitalized patients and review of the literature. *J Bone Joint Surg [Am]* 1979;61-A:1119-42.
2. Bohlman HH. Treatment of fractures and dislocations of the thoracic and lumbar spine. *J Bone Joint Surg [Am]* 1985;67-A:165-9.
3. Frankel HL, Hancock DO, Nyslop G, et al. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. *Paraplegia* 1989;27:163-72.
4. Chiles BW, Cooper PR. Acute spinal injury. *N Engl J Med* 1996;334:8:514-20.
5. Folman Y, El Masri W. Spinal cord injury: prognostic indicators. *Injury* 1989;20:92-3.
6. Donovan WH, Cifu DX, Schotte DE. Neurological and skeletal outcomes in 113 patients with closed injuries to the cervical spinal cord. *Paraplegia* 1992;30:533-42.
7. Waters RL, Adkins RH, Yakura JS, Sie I. Motor and sensory recovery following complete tetraplegia. *Arch Phys Med Rehabil* 1993;74:242-7.
8. Katoh S, El Masry WS. Motor recovery of patients presenting with motor paralysis and sensory sparing following cervical spinal cord injuries. *Paraplegia* 1995;33:506-9.
9. Foo D, Subrahmanyam TS, Rossier AB. Post-traumatic acute anterior spinal cord syndrome. *Paraplegia* 1981;19:201-5.
10. Bedbrook GM, Prince HG. A study of the influence of posterior column sensory sparing on the initial presentation of cervical injuries on the ultimate prognosis. *Paraplegia* 1987;25:441-5.
11. Katoh S, El Masry WS. Neurological recovery after conservative treatment of cervical cord injuries. *J Bone Joint Surg [Br]* 1994;76-B:225-8.
12. Donovan WH, Wilkerson MA, Rossi D, Mechoulam F, Frankowski RF. A test of the ASIA guidelines for classification of spinal cord injuries. *J Neuro Rehab* 1990;4:39-53.