



Original Research Article

Predictors of neurological recovery after traumatic thoracolumbar spinal cord injury.

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Abstract: **Background:** Traumatic thoracolumbar spinal cord injury (SCI) can result in significant neurological disability, but has been shown to have a wide spectrum of recovery in patients who have seemingly similar injuries. A clinical, imaging, and treatment based prediction could enhance the prognosis and surgical planning and contribute to personalizing rehabilitation. **Aim:** To identify factors associated with neurological recovery after traumatic thoracolumbar spinal cord injury and to obtain independent predictors of neurological recovery at 6-months follow up. **Methods:** A retrospective observational cohort study of adult patients with traumatic thoracolumbar SCI treated at a tertiary-care hospital. Demographic data, mechanism and degree of injury, American Spinal Injury Association Impairment Scale (AIS) grade, MRI results, timing of surgical decompression, associated injuries, and neurological status at follow-up were assessed. The primary outcome of neurological recovery was improvement in at least one AIS grade at 6 months. Univariate analysis was carried out, and the independent predictors of recovery were identified using multivariable logistic regression. **Results:** A total of 112 patients were included, with a mean age of 38.4 ± 13.7 years; 82 (73.2%) were male. 51 patients (45.5%) showed an improvement of one or more AIS grade at 6 months. Neurological recovery was more prevalent in patients with incomplete baseline injury (AIS B-D), early decompression (≤ 24 hours) and no intramedullary hemorrhage, or in the patients with the shorter duration of spinal cord edema on initial MRI. Neurological improvement was independently predicted by incomplete baseline AIS grade (adjusted odds ratio [aOR] 4.62), decompression within 24 hours (aOR 2.48), and when the IH was absent (aOR 2.71), while increasing age had a negative association with probability of neurological improvement. **Conclusion:** Neurologic completeness at time of injury, time for decompression, MRI characteristics, and age seem to be significant factors in neurologic recovery for traumatic thoracolumbar SCI. A multimodal assessment, therefore, could contribute to the accuracy of prognosis and individual treatment and rehabilitation planning, especially at an early stage.

Keywords: Traumatic spinal cord injury, thoracolumbar injury, neurological recovery, ASIA Impairment Scale, surgical decompression, magnetic resonance imaging, prognostic factors.

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INTRODUCTION

TSCI is a leading cause of long-term neurologic disability, and causes significant physical, psychological and socio-economic burden for patients,

families and health care systems. A recent global systematic review and meta-analysis calculated the pooled incidence of TSCI at around 26.5 cases per million population with a significant geographical

variation [1]. Damage to the thoracolumbar (T10-L1) junction is of special significance as high-energy trauma at the mobile to rigid transition of the thoracolumbar junction may result in vertebral instability, spinal canal compromise, and injury to the distal spinal cord or conus medullaris. This causes various degrees of neurological dysfunction, from mild sensory dysfunction to a complete paraplegia, with variable recovery.

The neurological outcome of TSCI depends on both the initial mechanical injury as well as the secondary injury cascade that develops. Primary trauma can result in disruption of neural tissue, vascular damage and hemorrhage, while secondary mechanisms such as ischemia, edema, excitotoxicity, inflammation, oxidative stress, and cellular death can cause the damaged tissue to expand beyond the initial lesion. This natural evolution is the basis for early decompression of the spinal cord, ensuring proper perfusion, and early multidisciplinary treatment. Despite this, early and accurate prognosis is still of great clinical importance as neurological outcome is heterogeneous even in patients receiving similar treatment.

The International Standards for Neurological Classification of spinal cord injury and the American Spinal Injury Association Impairment Scale (AIS) continue to be the most widely used clinical tools to classify injury severity and to track neurological change. Baseline neurological status is always one of the most powerful prognosticators of subsequent recovery [2,3]. Generally patients with incomplete injuries (AIS C and D) have significantly higher likelihood of improvement in motor and functional outcomes than patients with complete AIS A injuries. The majority of spontaneous AIS conversion and motor recovery occur within the first 6–9 months and the most rapid neurological recovery is within the first 3 months following injury [3]. The age of the patient may also affect the recovery process, as older patients tend to have poorer neurological and functional outcomes, although not all studies confirm this.

Magnetic resonance imaging can also give further prognostic information as it shows the amount and type of damage to the spinal cord. A correlation between intramedullary hemorrhage and severe initial neurological impairment and poor neurologic outcome has been reported, while isolated or shorter-segment cord edema has been reported to have a more favorable recovery [4,5]. This may therefore mean that the combined clinical and MRI assessment may be more informative than either alone.

Another modifiable factor of outcome is the timing of surgical decompression. Recent literature suggests that early decompression (within 24 hours of acute SCI) is correlated with better neurologic recovery than later decompression. Accordingly, new guidance for clinical

practice guides suggests that decompressive surgery should be performed as soon as medically possible within 24 hours [6,7]. The effect of surgery should be weighed, however, in combination with the baseline AIS grade, age, injury morphology, MRI, associated trauma, and other clinical factors.

Even though progress has been made in the management of acute SCI, prognosis remains less than perfect and available prognostic models exhibit considerable variation in the types of predictors used, outcomes measured, and methodological quality [8]. Specific data on traumatic thoracolumbar injuries in a resource-limited clinical setting also is relatively limited. Identifiable predictors which are readily available during hospitalisation could have a beneficial impact on counselling, treatment prioritisation, rehabilitation planning and follow-up.

The purpose of the present study is to establish the clinical, radiological and treatment related predictors of neurological recovery after traumatic TTSCI and to identify factors that predict improvement in AIS grade at 6-month follow-up independently.

The Introduction contains the following references:

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MATERIALS AND METHODS

Design and settings of the study.

The main part of the study assessed factors associated with neurological recovery routinely available at the clinic, radiology, and treatment visit. Published evidence was also assessed to provide context for the observed predictors and a small additional survey of clinicians was completed to investigate current views of factors impacting neurological recovery. The survey results were not used to create the main multivariable prediction model, but were included in the descriptive information.

Study Population

Hospitalized adults (age 18) with acute traumatic spinal cord injuries in the thoracic and thoracolumbar area were included. All patients had to undergo a documented neurological examination at admission, radiological evaluation by computed tomography and/or magnetic resonance imaging (MRI) and neurological follow-up to ensure adequate determination of outcome. Patients were excluded from the analysis if they had non-traumatic spinal cord compression, pathological vertebral fracture, prior significant neurological disability that interfered with gait function, incomplete medical records, or insufficient follow-up data, or death prior to neurological evaluation. There were no patients with isolated vertebral fractures who had an objective neurological deficit.

Data Collection

A standardized data collection form was used to retrieve clinical information from the patients' medical records in a retrospective manner. Variables recorded were age, sex, mechanism of injury, level of injury, associated systemic injury, baseline neurological function, MRI characteristics, timing of surgical decompression and neurological function at follow-up.

Neurological impairment was determined by the American Spinal Injury Association Impairment Scale (AIS) from AIS A (complete injury) to AIS E (normal sensory and motor function). For predictor analysis, baseline injuries were further classified as complete or incomplete injuries.

Radiological factors were vertebral level of injury, spinal canal compromise, spinal cord edema, approximate longitudinal extent of signal abnormality and the absence or presence of intramedullary hemorrhage. The MRI results were assessed based on the formal radiology reports and, when available, confirmed with the original imaging reports.

Treatment Variables

Trauma and spinal injury protocols were followed for

the management of patients. Early treatment consisted of immobilization of the spine, hemodynamic stabilization, an assessment of associated injuries, and neurological evaluation. Surgical decompression with stabilization was performed as indicated clinically.

Decompression timing was split into 'early surgery' (within 24 h of injury) and 'later surgery' (after 24 h of injury), following current guidelines of decompression within 24 h of injury if medically possible [6]. Conservatively managed patients were analyzed separately, if applicable.

Outcome Assessment

Neurological recovery at 6 months, measured as at least one AIS grade improvement from the neurological grade obtained at admission was the main outcome. Secondary measures were the size of AIS conversion and where adequate documentation of motor function was present, its improvement.

Factors studied were parameters of age, sex, mechanism of trauma, initial AIS grade, completeness of neurological injury, injury level, spinal cord edema, intramedullary hemorrhage, associated injuries, and timing of surgical decompression.

Supplementary Clinician Survey

25 clinicians (neurosurgeons, orthopaedists, rehabilitation physicians and critical-care clinicians) participated in a short structured survey of their spinal trauma management. The participants were asked which clinical and radiological parameters they felt were most significant to predict neurological recovery. Frequencies and percentages were used to sum up the responses. The survey has only been used as additional background information and was not used to predict patient outcomes or included in the regression analysis.

Statistical Analysis

IBM SPSS Statistics version 27.0 was used to analyze the data. There were continuous variables that were summarized as mean $\pm$ standard deviation or median with interquartile range depending on the distribution of the data, and categorical variables that were summarized as frequencies and percentages.

Independent-samples t-test and Mann–Whitney U-test were used to compare continuous variables between patients who had and did not have neurological recovery, while the chi-square or Fisher's exact test was used for categorical variables. Variables that were clinically relevant and/or showed association ($p < 0.10$) in the univariate analysis were analysed for inclusion in the multivariable binary logistic regression model.

The odds ratios (ORs) were adjusted to determine the independent predictors of neurological recovery, and the results were presented with 95% confidence interval (CI). Prior to the construction of the final regression

model, the multicollinearity of the predictor variables was checked. The Hosmer–Lemeshow goodness of fit test was used for model calibration and overall goodness of fit. Two-sided p value < 0.05 was considered statistically significant.

Ethical Considerations

The patient-record component of this study was

retrospective, and the need for informed consent was waived by the institutional review board, with institutional policy. All clinicians who participated in the additional clinician survey provided informed consent, and the survey was voluntary. All patients' information was anonymized before the analysis and kept confidential throughout the study.

RESULTS

Patient Characteristics

During the study period, 137 patients with traumatic spinal injury of thoracic or thoracolumbar spine were screened. Twenty-five patients were excluded due to incomplete neurological documentation, inadequate follow-up, pathological or non-traumatic spinal lesions or lack of objective neurological deficit. Finally, 112 patients who had suffered traumatic TSCI were included in the final analysis. The mean age of the subjects was 38.4 ± 13.7 years, and ranged from 18 to 72 years. Eighty-two patients (73.2%) were male and 30 (26.8%) were female. The most common mechanism of injury was road traffic accidents in 52 patients (46.4%), falls from height in 43 patients (38.4%) and other mechanisms in 17 patients (15.2%). The 51 patients (45.5%) who improved by at least one AIS grade at 6 months follow-up had neurological recovery, while 61 patients (54.5%) did not have a change of AIS grade. Patients that showed neurological recovery were significantly younger than those that did not recover (34.1 ± 11.8 vs. 42.0 ± 14.2 years, $p = 0.002$). There was no statistically significant difference in recovery in relation to sex or mechanism of injury.

Table 1: Baseline characteristics according to neurological recovery

Characteristic	Total (n=112)	Recovery (n=51)	No recovery (n=61)	p value
Age, years, mean $\pm$ SD	38.4 ± 13.7	34.1 ± 11.8	42.0 ± 14.2	0.002
Male sex	82 (73.2%)	38 (74.5%)	44 (72.1%)	0.774
Female sex	30 (26.8%)	13 (25.5%)	17 (27.9%)	—
Road traffic accident	52 (46.4%)	25 (49.0%)	27 (44.3%)	0.781
Fall from height	43 (38.4%)	19 (37.3%)	24 (39.3%)	—
Other mechanism	17 (15.2%)	7 (13.7%)	10 (16.4%)	—
Thoracic injury	24 (21.4%)	9 (17.6%)	15 (24.6%)	0.371
T11–L2 injury	88 (78.6%)	42 (82.4%)	46 (75.4%)	—
Associated major injury	47 (42.0%)	17 (33.3%)	30 (49.2%)	0.090

Unless otherwise indicated, values are expressed as number (%).

Baseline Neurological Status and AIS Conversion

The complete neurological injury (AIS A) was seen in 39 (34.8%) patients at admission. The other 73 patients (65.2%) suffered incomplete injuries, with 20 suffering an AIS B and 31 an AIS C and 22 an AIS D injury.

Neurological improvement was highly variable with regard to the initial AIS grade. Of 39 patients with AIS A injury, only 7 (17.9%) showed an improvement in AIS grade of one or more. Compared, 10 of 20 patients (50.0%) with AIS B, 19 of 31 (61.3%) with AIS C and 15 of 22 (68.2%) with AIS D injuries recovered neurologically.

In total, 44 of 73 patients with incomplete injury were neurologically recovered while only 7 of 39 patients with complete injury were neurologically recovered ($p < 0.001$).

Table 2: Change in AIS grade from admission to six-month follow-up

Baseline AIS grade	n	AIS A at 6 months	AIS B	AIS C	AIS D	AIS E	≥ 1 -grade improvement
AIS A	39	32	3	2	2	0	7 (17.9%)
AIS B	20	0	10	6	4	0	10 (50.0%)
AIS C	31	0	0	12	15	4	19 (61.3%)
AIS D	22	0	0	0	7	15	15 (68.2%)
Total	112	32	13	20	28	19	51 (45.5%)

AIS = American Spinal Injury Association Impairment Scale.

MRI Findings and Neurological Recovery

In 31 patients (27.7%), MRI showed intramedullary hemorrhage and in 81 patients (72.3%), MRI showed no intramedullary hemorrhage. Of 31 patients with intramedullary hemorrhage, 8 (25.8%) recovered neurologically, while 43 of 81 patients without hemorrhage (53.1%) recovered neurologically ($p = 0.009$).

Length of cord edema was also associated with outcome. The edema was extensive (more than three vertebral segments) in 45 patients. Of these, 14 (31.1%) had neurological recovery. Recovery was seen in 37 of 67 patients (55.2%) who had

edema involving three or fewer vertebral segments ($p = 0.013$), compared to 15 of 29 patients (51.7%) who had edema involving four or more vertebral segments.

Spinal canal compromise was common but canal compromise was not independently associated with neurological recovery after adjustment for baseline neurological status and MRI cord characteristics.

Timing of Surgical Decompression

Thirty-nine patients (34.8%) had surgery for decompression performed within 24 hours of injury, and the rest were treated later or did not get them decompressed, depending on clinical and radiologic criteria.

The results showed that 25 of 39 (64.1%) of patients who underwent decompression within 24 hours had neurological recovery compared to 26 of 73 (35.6%) of those who were not decompressed within 24 hours ($p = 0.004$).

This association persisted after adjustment for baseline AIS grade, patient age, MRI findings and associated injuries.

Table 3: Clinical, radiological, and treatment-related factors associated with recovery

Predictor	Recovery n/N (%)	No recovery n/N (%)	p value
Incomplete baseline injury	44/73 (60.3%)	29/73 (39.7%)	<0.001
Complete AIS A injury	7/39 (17.9%)	32/39 (82.1%)	<0.001
Early decompression ≤ 24 h	25/39 (64.1%)	14/39 (35.9%)	0.004
No intramedullary hemorrhage	43/81 (53.1%)	38/81 (46.9%)	0.009
Intramedullary hemorrhage	8/31 (25.8%)	23/31 (74.2%)	0.009
Cord edema ≤ 3 segments	37/67 (55.2%)	30/67 (44.8%)	0.013
Cord edema > 3 segments	14/45 (31.1%)	31/45 (68.9%)	0.013
Associated major injury	17/47 (36.2%)	30/47 (63.8%)	0.090

Multivariable Analysis of Predictors of Neurological Recovery

Multivariable logistic regression was performed, with variables with $p < 0.10$ on univariate analysis and variables known to be clinically important included in the model. These were age, neurological completeness, timing of decompression, intramedullary haemorrhage, the degree of cord oedema and the presence of associated major injuries.

When adjusted, incomplete baseline neurological injury was the strongest independent predictor of recovery, with patients with incomplete injury having nearly 4.6 times the odds of improving by at least one AIS grade compared with those with complete injury (aOR 4.62; 95% CI 1.79–11.92; $p = 0.002$).

The independent predictors of a better neurologic outcome were surgical decompression within 24 hours (aOR 2.48; 95% CI 1.08–5.70; $p = 0.032$). Likewise, a lack of intramedullary hemorrhage on the primary MRI was associated with better recovery (aOR 2.71; 95% CI 1.05–7.01; $p = 0.039$).

Older age was a poor factor for neurological recovery. For every 10-year increase in age, the odds of recovery decreased by approximately 24% (aOR 0.76; 95% CI 0.59–0.98; $p = 0.034$).

In univariate analysis, shorter cord edema was found to be associated with recovery, but this was not statistically significant after adjustment for the other predictors.

Table 4: Multivariable logistic regression for neurological recovery

Predictor	Adjusted OR	95% CI	p value
Incomplete vs. complete injury	4.62	1.79–11.92	0.002
Decompression ≤ 24 hours	2.48	1.08–5.70	0.032
Absence of intramedullary hemorrhage	2.71	1.05–7.01	0.039
Age, per 10-year increase	0.76	0.59–0.98	0.034
Cord edema ≤ 3 segments	1.74	0.76–3.97	0.191
Associated major injury	0.71	0.31–1.65	0.430

OR = odds ratio, CI = confidence interval.

The Hosmer-Lemeshow goodness-of-fit test showed that the final regression model was well calibrated ($p = 0.61$). The Nagelkerke R^2 was 0.39 indicating that the clinical and radiological predictors included in the model accounted for about 39% of the variance seen in neurological recovery. The model had good discrimination, with an area under the receiver operating characteristic curve of 0.80 (95% CI 0.72–0.88) and correctly classified 73.2% of patients.

Supplementary Clinician Survey

The 25 clinicians, who were involved in the management of acute spinal trauma, participated in the supplementary survey. The most common neurological factor to be considered a baseline measure for recovery was selected by 23 clinicians (92.0%), and it was the neurological status. The following were associated with this: Intramedullary

hemorrhage on MRI (80.0%), timing of decompression (76.0%), patient age (60.0%), extent of cord edema (56.0%), and maintenance of adequate hemodynamic status (52.0%).

Table 5: Clinician perceptions of important predictors of neurological recovery

Predictor identified by clinicians	n (%)
Baseline AIS grade/injury completeness	23 (92.0%)
Intramedullary hemorrhage on MRI	20 (80.0%)
Timing of surgical decompression	19 (76.0%)
Patient age	15 (60.0%)
Extent of spinal cord edema	14 (56.0%)
Hemodynamic stability/perfusion	13 (52.0%)
Associated systemic injuries	9 (36.0%)

Several answers could be given. In general, the results showed that neurological completeness at baseline, early surgical decompression, intramedullary hemorrhage seen on the MRI and age were the main independent factors for neurological recovery at six months. Baseline neurological status was the strongest predictor of AIS-grade improvement, among these factors.

DISCUSSION

This study aimed to analyze clinical, radiological and treatment related risk factors for neurological recovery after traumatic thoracolumbar spinal cord injury. The main results reveal that neurological completeness at baseline, surgical decompression timing, intramedullary hemorrhage on MRI and patient age are critical factors for neurological recovery at 6 months. Of these, incomplete initial neurological injury was the most powerful independent predictor for recovery. The presence of intramedullary hemorrhage and decrease in age following initial decompression within 24 hours were also predictive factors for improved neurological outcome, while an increase in age was a negative factor. The long axis of spinal cord oedema on uni-variate analysis was associated with outcome but this was less influential after adjusting for other clinical and radiological parameters.

Baseline Neurological Status

The most important predictor found in the present analysis was baseline severity of neurologic signs. There was a significant difference between neurological recovery in patients with incomplete and those with complete AIS A injury. It can be concluded that about 60 percent of patients with incomplete injuries levelled at least one AIS grade, while less than 20 percent of patients with complete injuries levelled.

This observation is consistent with the natural history of traumatic SCI. In early prediction of subsequent neurological outcome, Mputu Mputu et al. found initial injury severity (AIS grade, motor score, and neurological level) to be the most important factors [2]. In the same way, Kirshblum, et al., showed that patients with AIS B and C injuries have significantly more potential for neurological improvement than patients with AIS A injuries [3]. Khorasanizadeh et al. also performed a systematic review and meta-analysis that showed the initial neurological severity was well correlated with final recovery [9].

The clinical explanation is biological and makes sense.

Complete injuries are more likely to be associated with widespread disruption of the ascending and descending tracts in the spinal cord and are more likely to be structurally permanent, while incomplete injuries are suggestive of the preservation of at least some ascending and descending tracts in the spinal cord. Spontaneous neurological recovery, neural plasticity, and rehabilitation-induced functional improvement are provided by these remaining neural pathways as an anatomical substrate. The new systematic review by Cao et al. also revealed that the best predictor of walking recovery following TSCI was AIS grade [11].

Initial neurological status is also stressed by the pattern of AIS observed in the present study. The proportion of patients with AIS D injuries who recovered was greater, and the rate of recovery increased, with increasing AIS grades among patients with AIS B, C, and D injuries. This gradient aligns with published natural history data that the prognosis for neurologic recovery is strongly dependent on the presence of motor and sensory function immediately after injury [3].

Timing of Surgical Decompression

Surgical decompression early in course was another important predictor of neurological improvement. Those patients who were operated for decompression within 24 hours showed a higher rate of recovery than those who were operated for later decompression or not operated at all due to early decompression. Other predictors were adjusted for and early surgery remained a significant predictor of neurological recovery.

There are a number of mechanisms that can account for this link. There may be increased ischemia, edema, microvascular dysfunction and secondary inflammatory cascade with persistent mechanical compression of the injured spinal cord. Early decompression can limit these processes by restoring space in and around the neural elements and enhance spinal cord perfusion prior to secondary injury.

The findings are in agreement with contemporary clinical recommendations. Based on the 2024 clinical practice guideline for acute SCI, if medically possible, decompressive surgery within 24 hours is recommended as the preferred treatment for adults [6]. It was determined from this systematic review that there were clinically significant neurological benefits reported with early decompression [7]. In a separate systematic review and meta-analysis of 1,188 patients, decompression also showed superior neurological recovery within 24 hours of surgery vs. delayed surgery [10].

But it is important not to think of timing of surgery in isolation. Patients who are severely polytraumatized, hemodynamically unstable, present late, have limited access to the operating room, or have other contraindications will require later surgery. Moreover, the last systematic reviews have still reported differences in terms of injury completeness and anatomical level. Thus, any possible link between early surgery and neurological recovery needs to be considered in conjunction with the nature of the injury, which varies from patient to patient rather than as a standalone reassurance of recovery.

MRI Predictors

Influence of Age

Neurological recovery was independently negatively associated with increasing age. In this current investigation, an increase of 10 years in age was found to be associated with decreased odds of improvement in AIS.

Past studies have typically revealed suboptimal neurological and functional outcomes in older patients, but the age at which there is a clinically relevant decrease in outcome is not well defined [2,3]. Theories for these hypotheses range from decreased neuroplasticity and decreased physiological reserve, to the possibility of pre-existing degenerative changes in the spine, increased burden of comorbidity, vascular disease, and decreased tolerance of secondary systemic complications.

However, age should not be the only factor in deciding treatment level. At the correct age, there is significant recovery possible in suitably selected elderly patients and neurological completeness, physiological condition, MRI characteristics and rehabilitation potential are important in individual prognostication.

Associated Injuries and Other Variables

Neurological improvement was associated with major injuries (univariate analysis) but not after adjustment. This is broadly consistent with a systematic review by Mputu Mputu et al. [2] who found that associated vertebral and systemic injuries were not as consistently associated with neurological outcomes as baseline injury severity.

In the same way, in the present study, no significant associations were found between recovery and sex and mechanism of injury. There are no consistent neurological recovery data published in the natural history literature [3] that show a major effect of sex. The results confirm that neurological completeness and direction of spinal cord features are more important than general demographic characteristics.

Clinician Perceptions

Clinician survey (supplementary) confirmed much of the patient-level results. Baseline AIS grade was deemed most important, followed by intramedullary hemorrhage, time of decompression, age, and cord edema. The synergy of clinical perception with empirical evidence is remarkable, but the findings need to be viewed with caution since this sample was a small convenience sample and the survey was designed to give only background information, not validation of the prediction model.

Clinical Implications

The study demonstrates the importance of integrating neurological examination, MRI findings and therapy-related factors in counseling patients and families. A patient with an incomplete injury, limited MR findings of injury, no intramedullary hemorrhage and prompt decompression, may reasonably be expected to have a more favorable neurological course than a patient with complete injury and large areas of hemorrhage in the cord.

However, prognosis should be stated in terms of probabilities not certainty. Patients with complete injury can have AIS conversion, and patients with seemingly good baseline characteristics can have limited recovery. This is because there was still good discrimination in the present model, although prediction models for TSCI are still methodologically challenging. An external validation of multivariable prediction models was conducted in 2024, which revealed a high degree of heterogeneity and high risk of bias of published prediction models, highlighting the need for external validation prior to use in routine decision-making [8].

Study Limitations

There are a number of caveats. Selection and information bias may have occurred in the retrospective design, especially in the incomplete documentation of neurological examinations and the time of injury. Relatively small sample size and a single-center design might reduce the generalizability of the results. The 6-month follow-up takes place when a significant amount of neurological recovery takes place, but not necessarily later recovery. Data extracted from the routine clinical MRI reports may also be less standardized than data collected in a structured imaging protocol.

Furthermore, there was no clear distinction about

causality because of the observational study design, as the timing of the surgery could have been determined by the severity of the injury, the presence of additional trauma or logistical requirements. The supplementary clinician survey was completed by a limited number of participants and should be considered exploratory. Further multicenter prospective studies with uniform ISNCSCI assessments, quantitative MRI parameters, and extended follow-up, as well as external validation of prediction models are warranted.

In spite of these constraints, the results of this study validate a clinically useful method of prognosis after traumatic thoracolumbar SCI. The neurologic baseline is the most important prognostic factor, whereas MRI features, age of the patient and early decompression are useful supplemental prognosticators.

CONCLUSION

The tendency towards neurological recovery was also statistically associated with early surgical decompression, within 24 hours of admission, further emphasising the need for prompt evaluation and definitive surgical treatment when clinically appropriate. Additionally, absence of intramedullary hemorrhage on MRI was correlated with better outcome which underscores the importance of prompt imaging in addition to neurological evaluation. Being older, was linked to lower chances of recovery, but age should not be a factor in determining the intensity of treatment or rehabilitation.

The results indicate that a single measure should not be used to predict neurologic outcome. Instead, a composite evaluation based on AIS grade, MRI features, time of surgery, age, and clinical status will more effectively predict recovery potential.

Knowing from the outset whether the patient has good or poor prognostic factors can help the clinician decide on treatment planning, counseling the patient and family, determining rehabilitation resources and realistic functional goals. However, the identification of negative predictors can help identify those in need of more intensive rehabilitation and extended support.

Additional prospective multicenter examinations with standardized neurological assessments, quantitative MRI and a longer follow-up period are necessary to confirm these predictors and develop more accurate prognostic models to help identify patients with traumatic thoracolumbar spinal cord injury.

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