

Research Article

Traumatic vs non-traumatic spinal cord injury: A comparison of primary rehabilitation outcomes and complications during hospitalization

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Objective: To compare outcome for patients with traumatic (TSCI) and non-traumatic spinal cord injuries (NTSCI) after primary rehabilitation regarding neurological improvement measured by the American Spinal Injury Association Impairment Scale (AIS), length of stay and complications.

Design: Retrospective comparative cohort study on patients with TSCI and NTSCI, hospitalized during a ten-year period at Haukeland University Hospital, Norway. Impairment, length of stay and complications during first in-patient rehabilitation period were analyzed. Uni- and multivariate analysis was performed.

Setting: Spinal Cord Rehabilitation Unit, Haukeland University Hospital, Norway

Participants: A total of 174 persons with a spinal cord injury (SCI) were included; 102 with TSCI and 72 with NTSCI.

Outcome measures: Neurological improvement measured by AIS from admission to discharge, number of weeks in the hospital, frequency and significance of complications were compared.

Results: Improvement in AIS after primary rehabilitation did not differ between TSCI and NTSCI. Length of stay was in average 3.4 weeks longer for TSCI. Urinary tract infections and pressure ulcers significantly influenced length of stay in both groups. Urinary tract infections were more frequent in TSCI (67%) vs NTSCI (42%). Pressure ulcers were more frequent among NTSCI (24%) vs TSCI (14%). Pneumonia and neuropathic pain did not depend on etiology and did not influence length of stay.

Conclusions: Patients with SCI have a rehabilitation potential regardless of etiology. Complications are frequent in both groups and often prolong hospitalization. Complication patterns differ in the two groups, and specific prevention and optimal treatment will shorten and optimize the length of primary rehabilitation.

Keywords: Non-traumatic spinal cord injury, Traumatic spinal cord injury, Complications, Length of stay, AIS impairment scale

Introduction

The main goals of rehabilitation of patients with spinal cord injuries (SCI) are to reduce disability and to minimize the limitations of the impairment.¹ The effect of rehabilitation on patients with traumatic spinal cord injuries (TSCI) is well-studied, as well as the impact and frequency of acute and chronic complications.² In

contrast, rehabilitation outcomes and complications in non-traumatic spinal cord injury (NTSCI) are less investigated. This may be due to its more complex nature and less abrupt onset, along with diversity in terms and study design.¹ The need for extensive rehabilitation after NTSCI has been questioned, since comorbidity and age are expected to influence the rehabilitation outcome negatively in this patient group.³ There are very few studies comparing the outcome of rehabilitation in patients with non-traumatic and traumatic SCI taking place in the same rehabilitation center.^{1,4}

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The complication rate is high in SCI compared to other patient groups during rehabilitation.⁵ Urinary tract infections, respiratory complications, neuropathic pain and pressure ulcers are frequently reported complications, and they may occur together.^{3,6–11} Such complications appear in patients with both NTSCI and TSCI, they increase morbidity, influence outcome and are determinants for the length of the primary rehabilitation period.^{3,5,8} There are few studies that correlate the incidence of such complications to the neurological outcome of rehabilitation, this being true both for TSCI and NTSCI.³ A comparison between these two major groups will reveal potential similarities and differences in the course after spinal cord injury and will consequently define any differences in the need for rehabilitation for these patients.

This study aims to compare TSCI and NTSCI during the primary rehabilitation period at the same hospital unit and with the same principles of care. We wanted to examine whether the etiology of SCI was important for the neurological outcome, and if the length of stay depended on SCI etiology. Furthermore, we aimed to investigate whether TSCI or NTSCI differed regarding the frequency and pattern of the complications relating to urinary tract infections, pneumonia, pressure ulcers and neuropathic pain.

Material and methods

Participants

In this study, we analyzed the full medical records of 178 patients in a 10-year period (January 1st 2004–December 31st 2013) admitted for primary rehabilitation at the Spinal Cord Rehabilitation Unit, Haukeland University Hospital. The unit provides multidisciplinary rehabilitation for patients with SCI aged 16 years or older in the Western Norway health region. In the specific time period, all admitted patients were considered for participation in the study. A life expectancy longer than the expected length of primary rehabilitation was necessary to be recommended for hospitalization at The Spinal Cord Unit. This evaluation was made by the neurologist head of the unit and the referring doctor, together. There are no national guidelines for such estimate and decisions. The unit does not offer rehabilitation for patients with progressive neurologic diseases such as multiple sclerosis or cancer with metastasis. Death during the primary rehabilitation period in the hospital (two patients) and lack of consent (two patients) were exclusion criteria. Two excluded patients were NTSCI and two were TSCI.

Methods

All medical records were systematically reviewed by two of the authors (MHG and HSL). In cases of disagreement, consensus was obtained by consulting a senior co-author (TR). All patients were grouped by their SCI; 102 had TSCI and 72 had NTSCI. This grouping was based on the principles of The International Classifications of External Causes of Injuries (ICECI).¹² The following demographic information was collected: age, sex and smoking habits. The clinical features studied were the length of stay, anatomical level of lesion, and completeness of injury as classified by the American Spinal Cord Injury Association Impairment Scale (AIS) at admission and discharge.¹³ Length of stay was defined as the time in weeks from admission to discharge. Anatomical level was classified as either cervical (C1–C7) or below cervical (T1–S5) based on results from MRI-scans and clinical examinations combined.

The AIS was used for assessing the severity of SCI. In 21 cases there was inconclusive information regarding AIS score at admission, discharge or both; 8 and 13 in the TSCI and NTSCI groups, respectively. These 21 were not included in the neurological outcome analysis. Improvement in AIS ≥ 1 was defined as improvement to a better AIS grade from admission to discharge.

The frequency of the complications urinary tract infection, pneumonia, pressure ulcers and neuropathic pain during the primary rehabilitation was recorded. Urinary tract infection was defined as an episode with symptomatic bacteriuria and significant growth of bacteria in accordance with present guidelines,^{14,15} and the need of antibiotic treatment. Pneumonia was defined as a clinical lung tissue inflammation with radiographic evidence of parenchymal disease and a need for treatment. Pressure ulcers detected visually by inspection at admission and during the hospital stay were registered. Neuropathic pain was defined as pain with typical characteristics and a need of specific drug treatment as noted in the medical records.

Data analysis

Descriptive methods were used to categorize the sample. Differences between the groups were tested by t-tests, Wilcoxon rank-sum tests or chi-squared tests. TSCI was compared to NTSCI using logistic regression for categorical dependent variables; AIS improvement and complications; urinary tract infection, pneumonia, pressure ulcers and neuropathic pain. Linear regression was conducted for the continuous dependent variable; length of stay. To reveal the association between etiology and length of stay as predictors, multivariate logistic regression models for each complication were carried out. Each regression model was estimated unadjusted,

one by one and together for sex, age, smoking and anatomical level of lesion. The adjustments which improved the model the most, were interpreted and presented. In the improved model, we applied all adjustments which changed the coefficient more than 10%. The results were considered significant with a P value <0.05 . STATA 15 was used for all statistical analysis.

Ethical considerations

Information concerning demographic characteristics and clinical features were extracted from medical records and entered into an approved and de-identified database to maintain patient privacy. All patients fitting the inclusion criteria were contacted and informed about the study. Patients gave written dissent if not willing to participate in the study. The study was approved by The Regional Committee for Medical and Health Research Ethics of South East Norway (reference number 2018/782).

Results

Mean age did not differ significantly between TSCI and NTSCI; being 49 and 52 years, respectively (Table 1). Both groups had a higher percentage of men, 72% and 58% respectively, a borderline significant difference between TSCI and NTSCI ($P = 0.069$). Length of stay was in average 3.4 weeks longer for patients with TSCI compared to NTSCI ($P = 0.007$).

At admission, there were significantly more patients graded AIS A among TSCI (Table 2). Approximately, one fourth of all patients experienced an improvement of AIS ≥ 1 during rehabilitation. Among TSCI 26% improved, compared to 18% for NTSCI (Table 2). Only 7% with TSCI and 4% with NTSCI experienced an improvement of more than one grade in AIS, this difference not being significant. 92% in TSCI and 86% in NTSCI with AIS A remained with a complete injury after primary rehabilitation.

Table 1. Demographic and clinical patients' characteristics.

	TSCI (n = 102)	NTSCI (n = 72)	P value
<i>Demographics</i>			
Sex (male)	73 (72%)	42 (58%)	0.069 ¹
Age	49 (19.8)	52 (18.6)	0.275 ²
Smoking	26 (26%)	20 (28%)	0.736 ¹
<i>Anatomical level of lesion</i>			
Cervical (C1-C7)	50 (49%)	29 (40%)	0.254 ¹
Below cervical (T1-S5)	52 (51%)	42 (58%)	
Unknown	0	1 (1%)	
<i>Length of stay</i>			
Weeks	15,2 (8.4)	11,8 (7.9)	0.007 ^{*3}

¹n (%), χ^2 -test. ²Mean (SD), t-test. ³Linear regression, unadjusted. *indicates significance.

Only 26 (15%) patients did not experience any complications during the rehabilitation. The proportion with complications was higher among persons with NTSCI. Urinary tract infection, pneumonia, pressure ulcers and neuropathic pain were frequent complications regardless of etiology (Table 3). The majority of patients experienced one or two complications.

Table 4 shows how the complications correlated with etiology and length of stay. TSCI had a significantly higher risk for developing urinary tract infection than NTSCI, 67% vs 42% ($P < 0.004$) (Tables 3 and 4). The difference between TSCI and NTSCI was even higher when adjusted for sex. The occurrence of urinary tract infection increased the length of stay. Pressure ulcers were significantly more common among NTSCI than TSCI (Table 3), significant also when adjusted for length of stay ($P = 0.017$) (Table 4). There was no significant relationship between etiology, length of stay and the complications neuropathic pain and pneumonia in the multivariate analysis (Table 4).

Discussion

The main finding of this study was that etiology for spinal cord injuries is not a predictor of AIS improvement during primary rehabilitation. Among our patients 22% experienced improvement in AIS grade ≥ 1 , similar for traumatic and non-traumatic injuries. An Italian study showed an overall higher improvement rate for AIS ≥ 1 both in patients with TSCI and NTSCI, but in line with our study did not find any significant difference between the two groups.⁷ A previous study comparing vascular NTSCI and TSCI noted that factors like age, length of stay and AIS at admission were better predictors for AIS improvement than etiology.¹⁶ Despite no shift in AIS grade from admission to discharge, many patients experienced a substantial improvement in functional outcome. AIS grading is not a very sensitive marker and allows considerable functional variation within the same grade.¹³ For NTSCI, New *et al.* showed a marked reduction in disability applying non-AIS scoring systems but with no change in AIS grade.¹ Our findings imply that patients prior to rehabilitation should be evaluated with more sensitive scales in addition to AIS, such as FIM.¹ In our study, AIS was used as the outcome measure as it was used consistently at the Spinal Cord Unit during the whole registration period, in contrast to other scales. The AIS score is an easy and robust assessment tool the doctor in daily routine.¹³ Similarly, there is consensus in using AIS improvement as a major outcome measure because this scale is robust and objective.¹⁷ Because of the similar rehabilitation outcome, etiology

Table 2. AIS score at admission and at discharge grouped by etiology, and AIS improvement from admission to discharge.

AIS score	TSCI (n = 102)		NTSCI (n = 72)		P value
	Admission	Discharge	Admission	Discharge	
A	36 (35%)	33 (32%)	7 (10%)	6 (8%)	0.0001* ¹
B	14 (14%)	7 (7%)	6 (8%)	2 (3%)	0.2734 ¹
C	23 (23%)	11 (11%)	15 (21%)	8 (11%)	0.7879 ¹
D	23 (23%)	41 (40%)	35 (47%)	46 (64%)	0.0003* ¹
E	1 (1%)	4 (4%)	0 (0%)	2 (3%)	0.4008 ¹
Unknown	5 (5%)	6 (6%)	9 (13%)	8 (11%)	0.0704 ¹
<i>Improvement</i>					
≥ 1	25 (26%)		13 (18%)		0.438 ²
> 1	7 (7%)		3 (4%)		–

¹Wilcoxon test comparing AIS score at admission in NTSCI vs TSCI.

²Logistic regression model unadjusted.

The information is presented as number of patients (percentage).*indicates significance.

Table 3. The number and percentage of TSCI and NTSCI patients with well-defined complications during primary rehabilitation, and the number and percentages of the same patients with none, some or all of these complications.

	TSCI (n = 102)	NTSCI (n = 72)
<i>Complication</i>		
Urinary tract infection	68 (67%)	30 (42%)
Pneumonia	22 (22%)	9 (13%)
Pressure ulcers	14 (14%)	18 (24%)
Neuropathic pain	58 (57%)	32 (43%)
<i>Number of complications</i>		
0	8 (8%)	18 (25%)
1	40 (39%)	31 (43%)
2	46 (45%)	19 (26%)
3	7 (7%)	3 (4%)
4	1 (1%)	1 (1%)

should not be a major determinant for whether or not patients are offered primary rehabilitation.¹⁸

There were significantly more TSCI patients graded AIS A at admission, implying that patients with TSCI are suffering from more severe neurologic impairment and disability. 92% of patients with AIS A in TSCI cases and 86% of such patients in NTSCI cases still

had a complete injury after primary rehabilitation. This shows a poor prognosis for neurologic outcome with complete SCI. The improvement in AIS grade during rehabilitation tended to be better with grade B and C at admission for both groups. Other studies have shown the same trend.^{1,4,7,19,20} AIS score at admission may be used as a predictive factor for neurological rehabilitation outcome. However, even if patients with complete SCI do not improve in AIS grade, they have a considerable benefit of specialized primary rehabilitation for survival and total functional outcome.^{1,13,18}

Complications were common for both patients with both TSCI and NTSCI. Patients with NTSCI developed pressure ulcers significantly more often compared to patients with TSCI. Yet, the incidence of pressure ulcers in this study was lower than previously reported.²¹ There are only a few studies comparing the prevalence of pressure ulcers among patients with NTSCI and TSCI in the same hospital unit, but the tendency is that TSCI are more prone to develop pressure ulcers than NTSCI.^{3,7,21,22} The development of pressure ulcers significantly increased the length of stay regardless of

Table 4. The relationship between etiology (TSCI vs NTSCI) and length of stay (LOS), and specific complications during rehabilitation.

		Univariate		Multivariate	
		OR (CI)	P value	OR (CI)	P value
Urinary tract infection	TSCI/NTSCI	3.47 (1.78–6.78)	0.000*	2.94 (1.42–6.09)	0.004* ¹
	LOS	1.13 (1.08–1.19)	0.000*	1.02 (1.01–1.02)	0.000* ¹
Pneumonia	TSCI/NTSCI	1.81 (0.77–4.25)	0.175	1.58 (0.66–3.78)	0.307 ²
	LOS	1.05 (1.00–1.10)	0.048*	1.04 (0.99–1.09)	0.078 ²
Pressure ulcer	TSCI/NTSCI	0.47 (0.22–1.04)	0.062	0.37 (0.16–0.84)	0.017* ³
	LOS	1.05 (1.00–1.10)	0.031*	1.07 (1.02–1.12)	0.009* ³
Neuropathic pain	TSCI/NTSCI	1.82 (0.98–3.41)	0.060	1.75 (0.93–3.31)	0.085 ¹
	LOS	1.02 (0.98–1.06)	0.290	1.01 (0.98–1.05)	0.468 ¹

¹Adjusted for sex.

²Adjusted for anatomical level of lesion.

³Not adjusted.

Results for both univariate and multivariate analyzes are shown. *indicates significance.

etiology, in line with previous studies.^{21,22} The way to reduce pressure ulcers during rehabilitation in all SCI is through active prevention and specific awareness amongst all health care professionals. Up until now, one has probably not been equally alert for NTSCI patients as for TSCI. Pressure ulcers dramatically decrease patients' quality of life and ability to participate in daily activities.²³ This illustrates the necessity of awareness of pressure ulcers also in patients with NTSCI, both during rehabilitation and in a community setting. Preventive actions are equally important in TSCI and NTSCI.¹⁰

In our data set, the frequency of urinary tract infections was high, and it was highest among patients with TSCI, in line with previous studies.^{3,5,24} Such infections appear as a result of urinary tract dysfunction.² This dysfunction contributes to chronic infections and was the main cause of mortality earlier, but this is not the case anymore.^{2,25} Length of stay was substantially increased for patients who developed urinary tract infections, also found in another recent study.⁸ Hearn *et al.* (2018) recently demonstrated the negative influence of chronic and recurrent urinary tract infections on quality of life after discharge from hospital.²⁶ Prevention of urinary tract infections is cost effective, and will improve patients' quality of life.⁵ Urinary tract infections should be treated and prevented in order to improve results of rehabilitation as well as shorten hospital stays.

The number of patients with pneumonia was slightly higher in the TSCI group, but not significantly. Pneumonia was not a predictor for prolonged hospitalization. In our unselected patient cohort, there were no differences in anatomical lesion level between TSCI and NTSCI. This probably explains the similar frequency of pneumonia in the two groups. TSCI has previously been found more often to be complete tetraplegic lesions, predisposing for respiratory complications and pneumonia.^{27,28} A major cause of death among TSCI is respiratory failure, which substantiates the importance of early interference and preventive measures.²⁵

Neuropathic pain was common in both groups, with no significant difference regarding SCI etiology. Neuropathic pain did not influence the length of hospitalization. Earlier studies on patients with TSCI show a prevalence of neuropathic pain ranging between 40 and 80%.^{11,29,30} There was no correlation with the level of the lesion, completeness or sex in line with a previous study.³⁰ In contrast, a Swedish study on NTSCI found female sex to be a predictor for neuropathic pain.³¹ Our study illustrates that clinicians should be aware of neuropathic pain in all patients with SCI.

Patients with TSCI were hospitalized in average 3.4 weeks longer than patients with NTSCI. This can be explained by more complete injuries and a higher frequency of complications. TSCI complications tended to co-occur, meaning that most patients experienced two or three complications during their hospitalization. This differs from a study conducted by New *et al.* (2002) where most patients experienced only one complication.³ Hospitalization length correlates with risk of complications and costs.^{5,7,32} Prevention of complications will therefore not only improve rehabilitation potential, but also reduce the length of stay and rehabilitation costs.

There were more men than women in both patient groups, consistent with previous studies.^{1,7,20} In our study, there was no significant difference in age between TSCI and NTSCI, whereas others have found patients with NTSCI to be older.^{7,16,20} At our unit, all patients with an expected rehabilitation potential, regardless of age, were offered treatment. This substantiates our findings, and should reflect the true composition of SCI patients. Our results suggest that neither sex nor age should be used as key indicators in screening for the benefit of rehabilitation.³³

Strength and limitations

The retrospective design over a ten-year period has made it possible to include a relatively large number of patients. The rehabilitation unit is publicly funded and the only one in Western Norway. Due to universal access to healthcare in a geographically well-defined area, our study provides a rare opportunity to investigate outcome and complications for SCI regardless of the etiology and individual socioeconomic status in a complete and unselected cohort. This provides minimal selection bias among patients. Even so, some NTSCI patients were not offered rehabilitation in a specialized department due to short expected lifetime, in contrast to TSCI.³⁴ The comparison of the two patient groups was possible because of similar and parallel management over the whole time period. Since progressive diseases were excluded, it is unlikely that the condition leading to NTSCI should worsen during the primary rehabilitation period.

The data was extracted from extensive and detailed medical records by two independent researchers, who had no influence on the course of treatment. The retrospective approach may have led to underestimating the frequency of complications in both groups. Some changes in treatment and rehabilitation practice may have taken place during the recording period, but we expect this to influence TSCI and NTSCI in the same way and to the same extent.

Conclusion

This study has shown the rehabilitation potential of patients with SCI regardless of etiology. The rate of complications was high in both TSCI and NTSCI, but the overall rate was higher among patients with TSCI. The complications show a different pattern in the two groups. Complications tended to cluster in some patients. Urinary tract infections and pressure ulcers were factors that prolonged the length of stay, delayed important rehabilitation, and impaired the overall functional improvement. All health workers in a rehabilitation unit should be aware of this mutual relationship to optimize the primary rehabilitation for all patients with SCI, independent of cause and comorbidities. Prospective studies comparing TSCI and NTSCI in the same rehabilitation setting are required to further determine what is the optimal pathway of rehabilitation for the two patient groups. Such, studies should focus on the impact of complications on patients' quality of life and rehabilitation outcome.

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