

Analysis of the Factors Influencing Functional Outcomes in Patients with Spinal Cord Injury

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Abstract. [Purpose] The extent of functional independence ultimately achieved by an individual patient will be influenced by a variety of medical and non-medical factors. [Subjects and Methods] this study included 419 patients with spinal cord lesions treated in the Clinic for Rehabilitation "Dr M. Zotovic", Belgrade, Serbia, from January 2000 to December 2009. The patients were divided in two groups according to achievement of increase in Functional Independence Measure (FIM) score of more than 13 at discharge compared to admission. A variety of clinical variables were followed in both groups. [Results] one hundred twenty-one patients (28.9%) showed improvements in FIM score of ≤ 13 , while 298 (71.1%) patients showed an increases in FIM score of >13 at discharge compared to admission. Better functional recovery was observed in patients with non-traumatic spinal cord lesions, lower neurological levels of the lesion (OR = 6.07), and in patients treated surgically, but the level of the spinal cord lesion was the most influential factor affecting outcome. [Conclusion] the patients with spinal cord lesions should not only be grouped by traumatic and non-traumatic lesions only, but also sub-categorized, according to the etiology, level of injury and treatment method.

Key words: Spinal cord lesions, Rehabilitation, Functional outcomes

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INTRODUCTION

Patients with spinal cord injuries (SCI) are confronted with motor and sensory deficits and dysfunction of the bladder and bowel, resulting in disabilities in daily activities. Medical care of patients with SCI imposes a great burden on any health-care system. The causes of the SCI include trauma, vascular disorders, tumors of both malignant and benign etiology, infections, and developmental disorders¹. The incidence of SCI ranges globally from 10.4 to 83 cases per million per year^{1, 2}. The incidence of SCI in Serbia is unknown, because there is no registry of patients with these injuries in our country. The aim of rehabilitation is to treat patients with SCI in order to achieve optimal independence and a satisfactory quality of life in their own community². Fortunately, most patients return home after rehabilitation with significant degrees of functional independence^{3, 4}. The extent of the functional independence ultimately achieved

by an individual patient will also be influenced by a variety of medical and non-medical factors, such as age, body mass index, associated injuries, severity of spasticity, motivation, family support, living environment, pre-morbid lifestyle, vocation, educational background, financial status, etc⁵. This study deals only with medical factors: neurological deficit, level of a spinal cord injury, type and cause of injury, methods of treatment, secondary complications, associated injuries, age and gender.

The result of this study emphasize the great need for more precise knowledge about prognosis of functional outcomes and increased precision would enable better planning of a rehabilitation tailored to the needs of the patient.

SUBJECTS AND METHODS

This study was designed as a retrospective, case-control study. The patients included in the study had an SCI, and were admitted to the Clinic for Rehabilitation "Dr M. Zotovic", Belgrade, Serbia, from January 2000 to December 2009. The factors that were tested for their influence on the functional outcomes of the patients with spinal cord injury included: neurological deficit, i.e. neurological level of injury, type and cause of injury, methods of treatment, secondary complications, associated injuries, age and gender. The data were obtained from history and other available medical

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records of patients.

This study included 419 patients who were diagnosed with SCI at the institutions that were responsible for the primary care of these patients. The Patients with any kind of deterioration from the original condition that resulted in termination of rehabilitation, the those younger than 18 years, and those with an injury below the L₁ level the spinal cord were excluded from the study.

During hospitalization the patients were assessed using tests aimed at measuring the degree of their functional recovery and presence of neurological sequelae after spinal injury: the FIM test (Functional independence measure), the ASIA scale (American Spinal Injury Association impairment scale) used, and the MAS score (Modified Ashworth score).

The Functional status was assessed by the Functional Independence Measure (FIM). The FIM is one of the most widely used instruments for assessing the functional outcome of various rehabilitation programs^{6, 7}. Admission FIM scores (taken at the beginning of rehabilitation), discharge FIM scores (taken at the end of rehabilitation just before discharge) were noted and the differences of the two scores were calculated⁸. All patients received a comprehensive rehabilitation program, which included medical and nursing care, physical therapy and occupational therapy.

The subjects were retrospectively divided in two groups: the first group consisted of patients who had an increase in FIM scores of more than 13 at discharge compared to admission, and the second group was made up of subjects whose FIM score had not increases by 13 on discharge compared to admission².

The international standards of the American Spinal Injury Association (ASIA) were used to record motor and sensory levels of injury⁹. Completeness of the lesion was recorded according to the ASIA Impairment Scale (AIS). The AIS grades A is defined as complete motor lesions, and AIS grades B, C and D are defined as incomplete motor lesions¹⁰.

To determine the level of spasticity, we used the MAS test (Modified Ashworth Score)¹¹.

Recordings were made at the time of admission to the rehabilitation department as well as at discharge.

For the analysis of primary data descriptive statistical methods were used, as well as statistical hypothesis testing methods, and methods for analysis of the relationship between potential predictors and outcomes. Among the descriptive statistical methods, we have used the central tendency (arithmetic mean), measures of variability (standard deviation) and relative numbers. To test our hypothesis about the difference in frequency, χ^2 test was used. The t-test and Mann-Whitney test were used to testing the hypothesis about the difference of arithmetic means. Analysis of relations between binary outcomes and potential predictors was made using logistic regression.

Statistical hypotheses were tested the 0.05 level of statistical significance.

RESULTS

The study included 419 patients. The average value of

the difference of FIM scores on discharge compared to admission for all patients was 22.5 ± 13.07 . The minimum difference of FIM scores was to -1, the maximum was 55. Significant functional improvement was defined as a change in discharge-admission FIM score greater than 13, and we used it to divide patients into two groups: those with a FIM score increased of >13, or ≤ 13 . Out of the total number of patients during the rehabilitated, 121 (28.9%) had improvements in FIM score of ≤ 13 , and 298 (71.1%) patients had an increase in FIM score of >13 at discharge compared to admission.

The average age of the patients in the study was 45.5 ± 16.8 years. The youngest patient was 18 years old and the oldest 83 years. The mean age in the FIM ≤ 13 group was 45.3 ± 17.5 years, and that of the FIM >13 group, it was 45.6 ± 16.5 years. There was no statistically significant difference in age between the groups ($p = 0.85$).

Out of the total number of patients, 310 (74%) were males and 109 (26%) were females. Women were more likely to show increases in FIM scores of more than 13 at discharge compared to admission than men (73.4% vs. 70.3%), but this difference was not statistically significant ($p = 0.543$).

Based on the etiology of the injury, the patients were divided into two groups: 269 patients had traumatic and 150 patients had non-traumatic spinal cord injury. One hundred eighty-two (67.7%) patients with traumatic and 116 (77.3%) patients with non-traumatic causes of injury, showed an increases in FIM score of >13 at discharge compared to admission. Patients with non-traumatic spinal cord injuries tended to have more frequently show an improvement in of FIM score of more than 13 points ($p = 0.036$).

Associated injuries were present in 107 (25.5%) patients, while 312 (74.5%) patients did not have them. A FIM score improvement of >13 was recorded for 71 patients with associated injuries, and for 227 patients without them, but this difference was not statistically significant ($p = 0.207$).

Complications before rehabilitation were experienced by 84 (20%) patients, while none were experienced by 335 (80%) of them. For 242 patients without complications were not registered before the rehabilitation and 56 patients with complications the FIM score increased by more than 13 points during rehabilitation. There was no statistically significant difference in the frequency of occurrence of complications before rehabilitation between the groups ($p = 0.314$).

The Patients were treated surgically and conservatively: of the total number of patients, 260 (62.1%) was treated surgically and 159 (37.9%) conservatively. Two hundred four (78.5%) surgically treated patients and 94 (59.1%) conservatively treated patients showed improvements in FIM score of >13 during rehabilitation. Surgically treated patients were statistically more likely to show improvements in FIM score of >13 during rehabilitation ($p < 0.001$).

Of the total number of patients, 236 (56.3%) had an incomplete lesion, while 183 (43.7%) had a complete spinal cord lesion. In 163 patients with incomplete and in 135 patients with complete lesions there was an increase in FIM score of >13; however, this difference was not statistically significant ($p = 0.292$).

Among the patients on admission, according to the Com-

pleteness of the lesion on admission, the predominant lesion was determined as ASIA A lesions (43.2%), followed by ASIA C (36.3%) and ASIA B (20.5%). We recorded FIM score improvements of >13 for 134 (74%) patients with ASIA A, 63 (73.3%) ASIA B patients, and 101 (66.4%) patients with ASIA C lesions. There was no statistically significant difference in the frequency of the completeness of lesions in relation to the increase in FIM >13 at discharge compared to admission ($p = 0.279$).

Based on the level of lesion, the patients were divided into three groups: patients with cervical, thoracic and lumbar spinal cord injury. One hundred seventy-four (41.5%) patients had cervical injury, 182 (43.4%) had thoracic injury, and 63 (15%) patients had lumbar injury. Depending on the level of injury, the improvement of FIM score of >13 during rehabilitation was showed by 78 (44.8%) patients with cervical injuries, 161 (88.5%) patients with thoracic injuries and 59 (93.7%) patients with lumbar spinal cord injury, which a was statistically significant difference ($p < 0.001$). Functional recovery was better in patients with lower levels of neurological lesions (thoracic and lumbar).

On admission, the Ashworth median score of all patients was to 0 (range: 0–4). Ashworth median score on admission for patients who showed improved FIM scores of ≤ 13 was 0 (range: 0–3), and it was not significantly different from that of patients with improvements in FIM score of > 13 (median = 0, range: 0–4) ($p = 0.409$).

Spasticity as a complication during rehabilitation occurred in 249 (59.4%) patients, while 170 (40.6%) had no spasticity during the rehabilitation. Increase in FIM score of >13 at discharge compared to admission was showed by 160 (64.3%) patients with spasticity, and by 138 (81.2%) patients without spasticity. Spasticity during rehabilitation was associated with worse functional recovery of patients ($p < 0.001$).

The average value of FIM score at admission for all patients was 80.09 ± 11.85 . The minimum value of FIM score at admission was 43 and the maximum 114. The average value of FIM score at admission of patients who showed an increased in FIM score of ≤ 13 score was 76.01 ± 15.09 , while that of patients who showed an increased of FIM score of >13 was 81.74 ± 9.8 . There was a statistically significant difference in the value of FIM scores at admission between these groups of patients ($p < 0.001$).

The average value of FIM score at discharge for all patients was 102.59 ± 17.45 . The minimum value of FIM score at discharge was 43 and the maximum 126. The average value of FIM score at discharge of patients with increase of FIM scores of ≤ 13 was 82.23 ± 17.05 , while that of patients with increase of FIM score of >13 it was 110.86 ± 8.58 . There was a statistically significant difference in the value of FIM score at discharge between the groups ($p < 0.001$).

The average duration of rehabilitation for all patients was 162.22 ± 90.31 days. The average duration of rehabilitation for patients with increase of FIM score of ≤ 13 was 171.27 ± 101.81 days, and that of patients with increase of FIM score of >13 was 158.53 ± 85.08 days. However, this difference in duration of rehabilitation of patients was not statistically significant ($p = 0.315$).

In a simple logistic regression model statistically sig-

nificant predictors of FIM scores increase of more than 13 were: etiology (method of injury) ($B = 0.489$, $p = 0.037$), neurological level of lesion ($B = 1.939$, $p < 0.001$) and the value of FIM score on admission ($B = 0.044$, $p < 0.001$).

In the simple logistic regression model, as the statistically significant predictors that will not of in FIM scores increases over 13 were: method of treatment (conservative compared to the surgical treatment) ($B = -0.924$, $p < 0.001$), and spasticity as a complications during rehabilitation ($B = -0.875$, $p < 0.001$).

The multiple logistic regression model included those predictors that were statistically significant in the simple logistic regression model at the level of 0.1. The model contained five predictors listed in Table 2, which were compared among 419 patients. The whole model (all predictors) was statistically significant ($\chi^2=110.428$; $DF=5$; $p < 0.001$).

In the multiple logistic regression model, the statistically significant predictor of a FIM score increase of more than 13 was neurological level of injury ($B=1.804$; $p < 0.001$), and it's odds ratio was $OR = 6.07$. This suggests that patients with lower neurological level of lesion (thoracic and lumbar compared to cervical) are 6 times more likely, by category of the lesion level, to increase their FIM score by over 13, with control of all other factors in the model.

In the multiple logistic regression model, method of treatment (surgical or conservative) and FIM score on admission came very close to significance ($p = 0.054$ and $p = 0.064$ respectively). These two predictors should be checked and explored in the future primarily by increasing the sample to be tested.

DISCUSSION

All patients who participated in the study had been admitted to the branch hospitals where only physical therapy and rehabilitation patients are treated and followed. Acute treatments of these patients were completed and they were medically stabilized. Measurement of functional outcomes for patients with spinal cord injury is an integral part of any goal-orientated, multidisciplinary rehabilitation program and it requires suitable assessment tools. In our study the standard, validated assessment tools of functional outcomes have showed that more significant improvements could be expected in traumatic and paraplegic lesions. In addition, the mean FIM scores increased as the level of injury descended from the cervical to the thoracic and lumbar regions. In our study with an odds ratio of $OR = 6.07$, indicating the patients with lower neurological level of lesion (thoracic and lumbar compared to cervical) are 6 times more likely, by category of the lesion level, to show an increase FIM score of over 13, with control of all other factors in the model. Our results only partially agree with the results of the study conducted by Scivoletto et al. of 247 patients with spinal cord lesions. In their study the patients with traumatic and ischemic spinal cord lesions did not differ in the extent of neurological and functional recovery; however, the outcomes of these patients were better if the level of spinal injury was lower, as in our study¹². Another study by Scivoletto et al. have showed that patients with traumatic or inflammatory spinal cord lesions had similar

Table 1. Simple logistic regression model

	FIM change ≤13 (n=121)	FIM change >13 (n=298)
Age, $\bar{x} \pm SD$	45.3±17.5	45.6±16.5
Gender, n (%)		
male	92 (76%)	218 (73.2%)
female	29 (24%)	80 (26.8%)
Etiology of injury, n (%)		
traumatic	87 (71.9%)	182 (61.1%)
non-traumatic	34 (28.1%)	116 (38.9%)
Associated injuries, n (%)		
no	85 (70.2%)	227 (76.2%)
yes	36 (29.8%)	71 (23.8%)
Complications before rehabilitation, n (%)		
no	93 (76.9%)	242 (81.2%)
yes	28 (23.1%)	56 (18.8%)
Methods of treatment, n (%)		
operative	56 (46.3%)	204 (68.5%)
conservative	65 (53.7%)	94 (31.5%)
Completeness of lesion, n (%)		
incomplete	73 (60.3%)	163 (54.7)
complete	48 (39.7%)	135 (45.3%)
ASIA scale on admission, n (%)		
A	47 (38.8%)	134 (45%)
B	23 (19%)	63 (21.1%)
C	51 (42.1%)	101 (33.9%)
Level of injury, n (%)		
cervical	96 (79.3%)	78 (26.2%)
thoracic	21 (17.4%)	161 (54%)
lumbar	4 (3.3%)	59 (19.8%)
Modified Ashworth scale, median (range)	0 (0 to 3)	0 (0 to 4)
Complications during rehabilitation – spasticity, n (%)		
no	32 (26.4%)	138 (46.3%)
yes	89 (73.6%)	160 (53.7%)
FIM score on admission, $\bar{x} \pm SD$	76.01±15.09	81.74±9.8
Length of stay, $\bar{x} \pm SD$	171.27±101.81	158.53±85.08

Table 2. Multiple logistic regression with an increase of FIM score over 13 for rehabilitation as the dependent variable

Independent variable	B	p	OR	95% confidence interval	
				lower limit	upper limit
Etiology of injury	0.17	0.562	1.19	0.67	2.11
Methods of treatment	-0.486	0.054	0.61	0.37	1.01
Neurological level of lesion	1.804	<0.001	6.07	3.66	10.08
Complications during rehabilitation – spasticity	0.068	0.816	1.07	0.6	1.9
FIM score on admission	0.021	0.064	1.02	0.99	1.04

functional outcomes after recovery, stressing once more that the level and extent of spinal cord lesions are the most important predictors of functional recovery, rather than the etiology of the lesions¹³.

The length of stay in our study appeared to be much lon-

ger than in other studies. The length of stay was remarkably long in patients whose FIM scores increased by ≤13 (171.27 ± 101.81 days), and much longer that of patients whose FIM score increased by >13 (158.53 ± 85.08 days). This could be explained by there being a larger proportion of patients

with non-traumatic spinal cord lesions in the group with FIM score increase of >13, since it was previously shown that non-traumatic spinal cord lesions were associated with shorter rehabilitation length of stay¹⁴). However, the overall long length of stay in our study could be explained by the extensive time required in Serbian circumstances for three crucial processes of SCI rehabilitation: associated injury, secondary complication during the rehabilitation, and home modification.

Gender difference was not found between the groups, but overall there were more men in our study. Considering that there were more patients with traumatic than non-traumatic spinal cord lesions in our study, and that traumatic spinal cord lesions are more frequent among men, the predominance of males was not a surprise. The age of our patients did not influence functional outcome, and this is not in accordance with other studies, which have shown that patients with spinal cord lesions and advanced age are less active after recovery¹⁵). This disagreement may be partially explained by the fact that our patients were generally younger than those of other studies (Table 1).

In our study surgical treatment of spinal injuries was associated with better functional outcome, which was not the case with other series of patients^{16, 17}), where only lack of neurological deterioration after surgery was demonstrated. However, the majority of authors agree that the true efficacy of surgical treatment of spinal injuries in regard to neurological recovery can only be established by means of a large and well designed randomized controlled clinical trial¹⁷).

In conclusion, based on the associations of etiology, level and treatment method of spinal cord lesions with functional outcome observed in our study, the patients with spinal cord lesions should not be grouped by traumatic and non-traumatic lesions only, but also sub-categorized, according to etiology, level of injury and treatment method. This categorization would make the planning of the rehabilitation program, definition of targets of the therapy and the estimation of the results of the therapy more efficient.

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