ORIGINAL ARTICLE

UDC: 616.832-001-036.82/.86
DOI: 10.2298/VSP1212061M

Demographic characteristics and functional outcomes in patients with traumatic and nontraumatic spinal cord injuries

Demografske karateristike i funkcionalni oporavak kod bolesnika sa traumatskim i netraumatskim povredama kičmene moždine

Saša Milićević*, Zoran Bukumirić†, Aleksandra Karadžov Nikolić‡, Rade Babović*, Slobodan Janković§

***Clinic for Rehabilitation "Dr M. Zotović", Belgrade, Serbia; †Institute for Medical Statistics and Informatics, Faculty of Medicine, University of Priština, Kosovska Mitrovica, Serbia; ‡Special Hospital for Cerebral Palsy and Developmental Neurology, Belgrade, Serbia; §Institute of Pharmacology, Faculty of Medicine, University of Kragujevac, Kragujevac, Serbia**

Abstract

Background/Aim. Spinal cord injuries (SCI) could be associated with a significant functional impairment in the areas of mobility, self-care, bowel and bladder emptying and sexuality. The aim of this study was to compare demographic characteristics and functional outcomes of nontraumatic and traumatic spinal cord injury patients. **Methods.** This study was designed as retrospective case series study. A detailed medical history including sex, age, mode of trauma, and clinical and radiological examination was taken for all patients. Hospital records were used to classify the patients according to the following: mechanism of injury, neurological level of injury, functional outcomes, associated injuries, method of treatment, secondary complications and length of stay. The following clinical scores were measured in the patients: American Spinal Injury Association standards (CASTA), Functional Independence Measure (FIM), and Modified Aschworth score (MAS). **Results.** Out of totally 441 patients with spinal cord injury, 279 were traumatic patients (TSCI) and 162 nontraumatic patients (NTSCI); 322 men and 119 women. The mean age of the patients was 46.1 ± 19.9 years. Traumatic and nontraumatic populations showed several significant differences with regard to age, level and severity of lesion. When adjusted for these factors patients with traumatic injuries showed a significantly lower FIM score at admission and significantly better improvement in the FIM score at discharge. The two populations were discharged with similar functional outcome. **Conclusions.** The NTSCI patients in our study were younger, more frequently female, with less complications before rehabilitation and less frequently treated operatively than the TSCI patients. Hospital rehabilitation of the TSCI patients was longer than that of the NTSCI patients, but their functional gain from admission was also higher, so at discharge. Traumatic and nontraumatic spinal cord lesion patients achieved similar results in regard to neurological and functional status.

Key words:
spinal cord, injuries; diagnosis; demography; radiography; treatment outcome; rehabilitation.

Apstrakt

Uvod/Cilj. Povrede kičmene moždine dovode se u vezu sa velikim funkcionalnim poremećajima pokretnosti, samonege, pražnjenja i seksualnosti. Cilj ove studije bio je da se utvrdi korelacija demografskih karakteristika i funkcionalnog oporavka kod bolesnika sa netraumatskim i traumatskim lezijama kičmene moždine. **Metod.** Ova studija urađena je kao retrospektivna studija slučaja. Za podatke o polu, starosti, načinu lečenja, dijagnostičkim pretragama, načinu lečenja, neurološkom nivou lezije, udruženim povredama, sekundarnim komplikacijama, dužini boravka i funkcionalnom oporavku korišćene su istorije bolesti i druga dostupna medicinska dokumentacija. Tokom rehabilitacije bolesnici su bili podrvrgnuti sledećim testovima: *American Spinal Injury Association standards* (ASIA), *Functional Independence Measure* (FIM) i testu *Modified Aschworth score* (MAS). **Rezultati.** Od ukupno 441 bolesnika sa povredom kičmene moždine 279 je bilo sa traumatskim, a 162 sa netraumatskim lezijama. Bilo je 322 muškarca i 119 žena. Prosečna starost bolesnika bila je 46,1 ± 19,9 godina. Traumatske i netraumatske lezije pokazale su nekoliko značajnih razlika u odnosu na pol, nivo i učestalost povrede, udružene povrede, sekundarne komplikacije i funkcionalni

Correspondence to: Saša Milićević, Clinic for rehabilitation "Dr M. Zotović", Sokobanjska 13, 11 000, Belgrade, Serbia.
Phone.: +381 65 500 60 70, E-mail: rsmilicevic@gmail.com

oporavak. U zavisnosti od navedenih faktora bolesnici sa traumatskim lezijama pokazali su manji FIM skor na prijemu, ali značajno bolji oporavak u FIM skoru na otpustu. Obe grupe bolesnika otpušene su sa približno sličnom funkcionalnom osposobljenošću. **Zaključak.** Kod klinički stabilnih bolesnika tip povreda kičmene moždine ne utiče na prognozu funkcionalnog oporavka. Na prijemu bolesnici sa traumatskim povredama imaju lošiju autonomnost u obavljanju aktivnosti dnevnog života najverovatnije zbog udruženih povreda koje ovi bolesnici imaju. Na otpustu obe grupe bolesnika pokazuju sličan funkcionalni i neurološki oporavak.

Ključne reči:
kičmena moždina, povrede; dijagnoza; demografija; radiografija; lečenje, ishod; rehabilitacija.

Introduction

Spinal cord injuries (SCI) could be associated with a significant functional impairment in the areas of mobility, self-care, bowel and bladder emptying and sexuality [1]. All over the world the incidence of SCI varies between 10.4 and 83 cases per million, per year [2]. In Europe, the incidence is one to 32 per million [2]. The incidence of SCI in the United States is approximately 40 per million, which means around 11,000 new cases each year [3]. Spinal cord injuries can be divided into two subgroups on the basis of their etiology: traumatic (TSCI) and nontraumatic (NTSCI). Within the general population of patients with SCI, traumatic SCI account for the largest portion, and most of the studies on SCI have been conducted with this group of patients. Traumatic SCI occur primarily in young adults, who are in more than half of the cases between 16 and 30 years of age. Men account for about 80% of cases [4]. The percentage of nontraumatic SCI patients is also significant. A previous study on 3,000 patients has reported that one third of SCI patients had a nontraumatic SCI. The fractions of older, female and retired patients are higher in nontraumatic SCI than traumatic SCI group [5]. As nontraumatic SCI patients are usually older, they usually have diabetes, cardiovascular and pulmonary diseases and poor memory. These co-existing health problems could result in a decrease in the efficiency of rehabilitation and in hampering improvement of long-term functionality of the nontraumatic SCI patients [6]. Therefore, traumatic and nontraumatic SCI patients comprise two separate clinical entities, which deserve separate rehabilitation plans in order to improve their functional recovery.

Factors that influence functional outcomes in patients with SCI had been analyzed in considerable number of studies, but are difficult to interpret, since the studies were mostly uncontrolled, observational in character, with short follow-up, with heterogenous cohorts and underpowered. Besides, the complete SCI was variously defined in the last decade, and few studies acknowledged a difference between local neurologic improvement in the area of incomplete lesion and neurologic recovery distal to the injury [7, 8]. Some of the factors were proposed as beneficial for functional recovery after TSCI, like higher ASIA motor score at hospitalization, younger age, level of education, good general health prior to SCI, the absence of spasticity [8] and incompleteness of spinal cord injury [7, 9], but complete evidence is lacking. On the other hand, functional recovery in NTSCI patients was implied to be better with higher Frankel grades of neurologic deficit at first admission to rehabilitation, with younger age and female sex [10, 11], but the associations were weak. Therefore, factors affecting functional outcomes in patients with SCI still remain an unresolved issue.

The hypothesis of our study is that the patients with traumatic SCI, in comparison to the patients with nontraumatic SCI, will have better functional recovery after certain time spent at rehabilitation, regardless the functionality level at admission.

Methods

This study was a retrospective hospital-based analysis of 441 patients with the spinal cord injury admitted to the Clinic for Rehabilitation "Dr M. Zotovic", Belgrade, Serbia, from January 2000 to December 2009. The study sample was consecutive, inclusive of all patients present at the study site satisfying inclusion criteria (diagnosis of a spinal cord injury and signs of neurological lesions of spinal cord) not having exclusion criteria, and non-random. For all the patients, a detailed medical history including sex, age, mode of trauma and clinical and radiological examination was taken. Hospital records were used to classify the patients according to the following: mechanism of injury, neurological level of injury, functional outcomes, associated injuries, methods of treatment, secondary complications and length of stay.

All the enrolled patients satisfied the inclusion criteria. Criteria for exclusion from the study were: any kind of deterioration in the basic condition that resulted in termination of the rehabilitation process, age below 18 years and neurological injury below L3 level at the admission. In total 592 patients were screened, but only 441 enrolled. Of the screened patients, 151 were excluded, due to deterioration of the basic condition (n = 28), age below 18 years (n = 21) and injury below L3 (n = 102).

During rehabilitation the patients were subjected to a series of tests that assessed their functional status and the presence of neurological sequelae after spinal injury: FIM test (Functional Independence Measure), ASIA scale (American Association Impairment scale), MAS (Modified Aschworth Score).

The FIM was a primary functional outcome measure for SCI used in our facility, and its value was determined at admission (AFIM) and discharge (DFIM). The FIM gain is the difference between DFIM and AFIM scores, and it reflects functional improvement. The FIM efficiency is the FIM gain divided by the length of stay (LOS) and reflects the rate of functional improvement [12, 13].

The international standards of the ASIA were used to record motor and sensory levels of the injury. Completeness

of the lesion was recorded according to the AIS. The AIS grades A were defined as a complete motor lesions, and AIS grades B, C and D as incomplete motor lesions [14]. To determine the level of spasticity, we used the MAS.

Recordings were made at the time of admission in the rehabilitation department, as well as at discharge. The data were analyzed for frequency and presented in tables.

For the analysis of primary data descriptive statistical methods were used, as well as hypothesis testing methods. Among the used descriptive statistical methods were the central tendency (arithmetic mean, median), measures of variability (standard deviation) and relative numbers. To test hypothesis about the difference in frequency χ^2-test and Fisher test were used. Mann-Whitney test and *t*-test of exact probability were used for testing hypothesis about difference of arithmetic means. The level of statistical significance in our study was set to 0.05.

Table 1

Characteristics of the patients with spinal cord injuries (SCI)

Parameters	Nontraumatic SCI (n = 162)	Traumatic SCI (n = 279)	*p*
Age, $\bar{x} \pm SD$ (years)	55.5 ± 13.8	40.2 ± 16	< 0.001
Sex, n (%)			
male	92 (56.8)	230 (82.4)	< 0.001
female	70 (43.2)	49 (17.6)	
Polytrauma, n (%)			
no	162 (100)	270 (96.8)	0.03
yes	0(0)	9 (3.2)	
Associated injury, n (%)			
no	162 (100)	172 (61.6)	< 0.001
yes	0 (0)	110 (38.4)	
Complications before rehabilitation, n (%)			< 0.001
no	149 (92)	199 (71.3)	
yes	13 (8)	80 (28.7)	
Methods of treatment, n (%)			
operative	94 (58)	188 (67.4)	0.048
conservative	68 (42)	91 (32.6)	

Results

A total of 441 patients with SCI were included. In the present study, 162 (36.7%) of the SCI patients were in the nontraumatic and 279 (63.3%) were in the traumatic SCI group.

The mean age was found to be 40.2 ± 16 for the traumatic SCI group, and 55.5 ± 13.8 for the nontraumatic SCI group. There was a statistically significant difference between the two groups in terms of age ($p < 0.001$).

Of the total number of patients, 322 (73%) were male and 119 (27%) female. The men were more likely to have traumatic SCI than the women (71.4% *vs* 41.2%) which was statistically significant ($p < 0.001$). In the nontraumatic group of the patients 92 (56.8%) were males, and 70 (43.2%) were females. However, in the traumatic SCI group the proportion of male patients (82.4%, n = 230) was significantly higher than the proportion of female patients (17.6%, n = 49).

When the etiology was analyzed in the traumatic SCI group, it was found that injuries were caused by the following: in 121 (43.4%) patients – falling from a high place, in 114 (40.8%) patients – traffic accident, in 22 (7.9%) patients – gunshot wounding, in 22 (7.9) patients – jump in water headfirst. Etiology of the injury in the non-traumatic SCI group was as follows: tumors in 66 (40.7%) patients, myelopathy in 46 (28.4%) patients, infection in 22 (13.6%) patients, vascular origin in 22 (13.6%) patients, pathological fractures in 3 (1.9%) patients, myelitis in 3 (1.9%) patients and other in 1.8% of the patients. These and other characteristics of the patients with SCI are shown in Table 1.

Of the total number of patients, 255 (57.8%) had an incomplete and 186 (42.2%) a complete spinal cord lesion. Complete lesions were significantly more common in patients with traumatic than nontraumatic SCI (54.1% *vs* 21.6% respectively, $p < 0.001$).

At admission, in all the patients with SCI, the most common were a complete lesion, ASIA A (41.7%), followed by ASIA C (37.4%) and ASIA B (20.9%) type. In the patients with nontraumatic SCI the most common were ASIA C (56.2%), followed by ASIA B (24.1%) and ASIA A (19.8%). In the patients with traumatic SCI, the most frequently preposition occurred ASIA A (54.5%), followed by the ASIA C (26.5%) and ASIA B (19%). There was a statistically significant difference in frequency between complete and incomplete lesions in the groups ($p < 0.001$). Nontraumatic SCI usually had incomplete, and traumatic SCI usually had complete injury (Table 2).

On admission, in all the patients with SCI, the most common were thoracic injuries (42.4%), followed by cervical injuries (37%) and lumbar injuries (20.6%). In the nontraumatic group of the patients the most common were the thoracic injuries (49.4%) followed by cervical injuries (30.9%), and lumbar spine injuries (19.8%). In the traumatic group of the patients the most common were cervical injuries (40.5%), followed by thoracic injuries (38.4%) and lumbar injuries (21.1%). The difference between the groups was statistically insignificant ($p = 0.06$).

Table 2

ASIA score on admission and the type of the lesion

Characteristics of the lesion	Nontraumatic (n = 162)	Traumatic (n = 279)	*p*
Completeness of lesion, n (%)			
incomplete	127 (78.4)	128 (45.9)	< 0.001
complete	35 (21.6)	151 (54.1)	
ASIA on admission, n (%)			
A	32 (19.8)	152 (54.5)	< 0.001
B	39 (24.1)	53 (19)	
C	91 (56.2)	74 (26.5)	
Level of injury, n (%)			
cervical	50 (30.9)	113 (40.5)	0.06
thoracic	80 (49.4)	107 (38.4)	
lumbar	32 (19.8)	59 (21.1)	

ASIA – American Spinal Injury Association

The average duration of rehabilitation for all the patients was 153.7 ± 86.2 days. The minimum duration of rehabilitation was 16, while the maximum was 380 days. The average duration of rehabilitation in the patients with nontraumatic SCI was 126 ± 80.13 days and in the patients with traumatic SCI 169 ± 85.72 days, which was a statistically significant difference ($p < 0.001$).

The mean admission total FIM score was 81.01 ± 12.16 and the mean discharge total FIM score was 104.16 ± 16.37. The mean FIM gain was 23.15 ± 12.68 and the FIM efficiency was 0.21 ± 0.18 points/day.

Comparison of the admission FIM scores between the two groups showed that the traumatic SCI group (77.63 ± 11.31) had significantly lower scores than the nontraumatic SCI group (86.82 ± 11.38) ($p < 0.001$). However, the difference in the discharge FIM scores between traumatic SCI (101.32 ± 18.12) and non-traumatic SCI (109.06 ± 11.27) groups was also statistically significant ($p < 0.001$). The comparison of the FIM gain between the two groups showed that the traumatic SCI group (23.69 ± 13.66) had higher gain than the non-traumatic SCI group (22.24 ± 10.75), but the difference was statistically insignificant ($p = 0{,}208$).

The mean FIM efficiency was 0.19 ± 0.18 for the traumatic and 0.25 ± 0.18 points/day in the NTSCI patients. There was a statistically significant difference between the FIM efficiency in the nontraumatic and traumatic patients ($p < 0.001$; Table 3).

The mean age in the nontraumatic SCI group was higher than the mean age in the traumatic SCI group, yet we could not say that the patients in the nontraumatic SCI group were very old. The mean age of the nontraumatic SCI group was only 55.5 ± 13.8 years. Etiological factors such as traffic accidents, falling from a high place, jump in water headfirst, which were the most common in the traumatic SCI group, are usually seen in younger people. Therefore, the mean age of traumatic SCI group was lower, only 40.2 ± 16 years.

The proportion of female and male patients was almost the same in the nontraumatic SCI group. However, the number of male patients in the traumatic SCI group was approximately five times higher than the number of females [15, 16]. It is possible that this difference is due to the fact that men take more active part in social and occupational settings, and therefore are in a higher risk for injuries caused by factors like motor vehicle accidents and falling from a high place [16]. In a previously published study, it has been reported that nontraumatic SCI were more common among women and traumatic SCI were more common among men. In our study both nontraumatic SCI and traumatic SCI were more common among men.

Reported lengths of stay (LOS) in the literature show wide ranges. LOS in this study was longer than those reported in studies from the United States (mean 60.8 days), Australia (median 83 days) and Italy (mean 143.1 for traumatic and 91.7 days for nontraumatic injuries). Another

Table 3

Functional outcomes: nontraumatic *versus* traumatic spinal cord injuries (SCI)

Parameters of functional outcomes	Nontraumatic SCI $\bar{x} \pm SD$	Traumatic SCI $\bar{x} \pm SD$	*p*
Duration of stay (days)	126.5 ± 80.1	169.5 ± 85.7	< 0.001
FIM on admission	86.82 ± 11.38	77.63 ± 11.31	< 0.001
FIM at discharge	109.06 ± 11.27	101.32 ± 18.12	< 0.001
FIM gain	22.24 ± 10.75	23.68 ± 13.66	0.208
FIM efficiency (points/day)	0.25 ± 0.18	0.19 ± 0.18	< 0.001

FIM – Functional Independence Measure

Discussion

In this study, demographic characteristics and functional outcomes of the patients were compared and evaluated between the nontraumatic and traumatic SCI patients.

Dutch study reported much longer mean and median LOS (272.9 for traumatic and 240 days for nontraumatic). In addition, different healthcare systems and cultural differences might explain some of the variation in LOS found in the literature [17, 18].

In our study, the leading etiologic factor in the traumatic SCI group was falling from a high place (43.4%), followed by traffic accidents (40.9%), jump in water head first (7.9%) and gunshot wounding (7.9%). In most of the studies on traumatic SCI, the leading cause of injuries were motor vehicle accidents. Kirshblum and O'Connor [19] have reported violent events as the second most common cause of traumatic SCI, as well as the other authors [20, 21]. However, in our study, traffic accident was the second most common cause.

In our study, 57.8% of the patients with SCI had nontraumatic lesions and 42.2% had traumatic lesions. Lower percentages of nontraumatic patients were found in studies from Turkey (32.5%), Italy (25%) and the United States (39%) [21–23].

Etiologic factors in the nontraumatic SCI group in our study were tumor compression (40.7%), myelopathy (28.4%), infection (13.6%) and vascular lesion (13.6%). In a study by McKinley et al. [22, 24, 25] the most common etiologic factors in nontraumatic SCI were found to be spinal stenosis and tumor invasion into the spinal cord. New et al. [26] reported that tumor compression (20.1%) was the first, multiple sclerosis (19.4%) was the second, and degeneration was the third (17.9%) most common cause in nontraumatic SCI patients. In our study, tumor compression was the first and cervical and lumbar myelopathy was the second most common etiologic factor in nontraumatic SCI. The differences in etiological factors of nontraumatic SCI between different countries may be due to social, cultural, and genetic differences [24].

The level of neurological injury in nontraumatic SCI patients was lower than in the traumatic SCI patients. Severity of paraplegia of the patients in the nontraumatic SCI group was significantly higher and they had more incomplete lesions than the patients in the traumatic SCI group. The higher frequency of paraplegia may be due to the differences in the etiologic factors of the two groups. The spinal cord tumor compression, which was the most common cause of nontraumatic SCI, affects mostly the thoracic region and degenerative problems affect mostly the lumbosacral region [26, 27]. Complete lesions and tetraplegia were more frequent in the TSCI group. This finding is in accordance with the results of other studies [1, 19, 20]. A high percentage of complete lesions in our study might be caused by the type of prehospital care, mode of transfer, and whether a trained person does primary medical care and accompanies patients during transportation.

Functionality of nontraumatic SCI patients was better than functionality of the traumatic SCI patients at the time of hospitalization. In general, functional statuses of nontraumatic SCI patients were better than the traumatic SCI patients. Although neurological status was mostly paraplegic and incomplete, functional status was better at the time of the hospitalization in the nontraumatic SCI group; functional gain and functional efficiency were found to be low in this patient group. In other words, the patients with traumatic SCI showed higher improvement of functional status during rehabilitation. This finding is in accordance with the results of other studies [5, 16, 28–31].

The SCI patients should not be grouped only as traumatic and nontraumatic ones, but they should be subcategorized based on etiologic factors, clinic and demographic features and functional results. This categorization should be used for planning of rehabilitation program, definition of targets of the therapy and estimation of the results of the therapy easier, if it were to be based on the etiologic factors (gunshot wounds, traffic accidents, infections, tumors, etc.).

The main limitation of this study lies in the non-random and consecutive sample of patients from only one rehabilitation center. Such design precludes investigation of a variety of rehabilitation methods, since practices in only one center tend to be uniform, and make generalizations difficult since the sample is not representative of wider population of SCI patients.

Conclusion

Although hospital rehabilitation of the traumatic SCI patients was longer than that of the nontraumatic SCI patients, functional recovery of the traumatic SCI patients after rehabilitation was better, regardless the functionality level at admission.

REFERENCES

1. *McKinley WO, Huang ME, Tewksbury MA.* Neoplastic vs. traumatic spinal cord injury: an inpatient rehabilitation comparison. Am J Phys Med Rehabil 2000; 79(2): 138−44.
2. *Wyndaele M, Wyndaele JJ.* Incidence, prevalence and epidemiology of spinal cord injury: what learns a worldwide literature survey? Spinal Cord 2006; 44(9): 523−9.
3. *National Spinal Cord Injury Statistical Center.* Spinal cord injury. Facts and figures at a glance. J Spinal Cord Med 2005; 28(4): 379−80.
4. *Osterthun R, Post MW, van Asbeck FW.* Characteristics, length of stay and functional outcome of patients with spinal cord injury in Dutch and Flemish rehabilitation centres. Spinal Cord 2009; 47(4): 339−44.
5. *Scivoletto G, Farchi S, Laurenza L, Molinari M.* Traumatic and non-traumatic spinal cord lesions: an Italian comparison of neurological and functional outcomes. Spinal Cord 2011; 49(3): 391−6.
6. *New PW, Sundararajan V.* Incidence of non-traumatic spinal cord injury in Victoria, Australia: a population-based study and literature review. Spinal Cord 2008; 46(6): 406−11.
7. *Fisher CG, Noonan VK, Smith DE, Wing PC, Dvorak MF, Kwon BK.* Motor recovery, functional status, and health-related quality of life in patients with complete spinal cord injuries. Spine (Phila Pa 1976) 2005; 30(19): 2200−7.
8. *Dvorak MF, Fisher CG, Hoekema J, Boyd M, Noonan V, Wing PC,* et al. Factors predicting motor recovery and functional outcome after traumatic central cord syndrome: a long-term follow-up. Spine (Phila Pa 1976) 2005; 30(20): 2303−11.
9. *Pollard ME, Apple DF.* Factors associated with improved neurologic outcomes in patients with incomplete tetraplegia. Spine (Phila Pa 1976) 2003; 28(1): 33−9.
10. *Catz A, Goldin D, Fishel B, Ronen J, Bluvshtein V, Gelernter I.* Recovery of neurologic function following nontraumatic spinal cord lesions in Israel. Spine (Phila Pa 1976) 2004; 29(20): 2278−82; discussion 2283.
11. *Gupta A, Taly AB, Srivastava A, Murali T.* Non-traumatic spinal cord lesions: epidemiology, complications, neurological and functional outcome of rehabilitation. Spinal Cord 2009; 47(4): 307−11.

12. *Uniform Data System for Medical Rehabilitation*. Guide for the Uniform Data Set for Medical Rehabilitation (including the FIM instrument), version 5.1. Buffalo, NY: State University of New York at Buffalo; 1997.
13. *Ng YS, Jung H, Tay SS, Bok CW, Chiong Y, Lim PA*. Results from a prospective acute inpatient rehabilitation database: clinical characteristics and functional outcomes using the Functional Independence Measure. Ann Acad Med Singapore 2007; 36(1): 3−10.
14. *American Spinal Injury Association*. Reference Manual for the International Standards for Neurological Classification of Spinal Cord Injury. Chicago, IL: American Spinal Injury Association; 2003.
15. *Catz A, Thaleisnik M, Fishel B, Ronen J, Spasser R, Folman Y,* et al. Recovery of neurologic function after spinal cord injury in Israel. Spine (Phila Pa 1976) 2002; 27(16): 1733−5.
16. *Post MW, Dallmeijer AJ, Angenot EL, van Asbeck FW, van der Woude LH*. Duration and functional outcome of spinal cord injury rehabilitation in the Netherlands. J Rehabil Res Dev 2005; 42(3 Suppl 1): 75−85.
17. *Tooth L, McKenna K, Geraghty T*. Rehabilitation outcomes in traumatic spinal cord injury in Australia: functional status, length of stay and discharge setting. Spinal Cord 2003; 41(4): 220−30.
18. *Eastwood EA, Hagglund KJ, Ragnarsson KT, Gordon WA, Marino RJ*. Medical rehabilitation length of stay and outcomes for persons with traumatic spinal cord injury-1990-1997. Arch Phys Med Rehabil 1999; 80(11): 1457−63.
19. *Kirshblum SC, O'Connor KC*. Levels of spinal cord injury and predictors of neurologic recovery. Phys Med Rehabil Clin N Am 2000; 11(1): 1−27, vii.
20. *Ones K, Yilmaz E, Beydogan A, Gultekin O, Caglar N*. Comparison of functional results in non-traumatic and traumatic spinal cord injury. Disabil Rehabil 2007; 29(15): 1185−91.
21. *Celani MG, Spizzichino L, Ricci S, Zampolini M, Franceschini M*. Spinal cord injury in Italy: A multicenter retrospective study. Arch Phys Med Rehabil 2001; 82(5): 589−96.
22. *McKinley WO, Seel RT, Hardman JT*. Nontraumatic spinal cord injury: incidence, epidemiology, and functional outcome. Arch Phys Med Rehabil 1999; 80(6): 619−23.
23. *Pickett GE, Campos-Benitez M, Keller JL, Duggal N*. Epidemiology of traumatic spinal cord injury in Canada. Spine (Phila Pa 1976) 2006; 31(7): 799−805.
24. *McKinley WO, Kolakowsky SA, Kreutzer JS*. Substance abuse, violence, and outcome after traumatic spinal cord injury. Am J Phys Med Rehabil 1999; 78(4): 306−12.
25. *McKinley WO, Tellis AA, Cifu DX, Johnson MA, Kubal WS, Keyser-Marcus L,* et al. Rehabilitation outcome of individuals with nontraumatic myelopathy resulting from spinal stenosis. J Spinal Cord Med 1998; 21(2): 131−6.
26. *New PW, Rawicki HB, Bailey MJ*. Nontraumatic spinal cord injury: demographic characteristics and complications. Arch Phys Med Rehabil 2002; 83(7): 996−1001.
27. *McKinley WO, Tewksbury MA, Godbout CJ*. Comparison of medical complications following nontraumatic and traumatic spinal cord injury. J Spinal Cord Med 2002; 25(2): 88−93.
28. *van der Putten JJ, Stevenson VL, Playford ED, Thompson AJ*. Factors affecting functional outcome in patients with nontraumatic spinal cord lesions after inpatient rehabilitation. Neurorehabil Neural Repair 2001; 15(2): 99−104.
29. *Chapman J*. Comparing medical complications from nontraumatic and traumatic spinal cord injury. Arch Phys Med Rehabil 2000; 81: 1264.
30. *Osterthun R, Post MW, van Asbeck FW*. Characteristics, length of stay and functional outcome of patients with spinal cord injury in Dutch and Flemish rehabilitation centres. Spinal Cord 2009; 47(4): 339−44.
31. *Gupta A, Taly AB, Srivastava A, Vishal S, Murali T*. Traumatic vs non-traumatic spinal cord lesions: comparison of neurological and functional outcome after in-patient rehabilitation. Spinal Cord 2008; 46(7): 482−7.

Received on November 7, 2011.
Revised on January 19, 2012.
Accepted on January 23, 2012.