FUNCTIONAL INDEPENDENCE AND REHABILITATION OUTCOME IN TRAUMATIC SPINAL CORD INJURY

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Abstract. The purpose of this study was to investigation functional independence and rehabilitation outcomes of traumatic spinal cord patients. The data were obtained for 38 patients with traumatic spinal cord lesions admitted to the physical therapy unit from 1997 to 2001. The mean age was 32±6.48 years. Functional improvement was presented in terms of progress in independence in six daily activities. Independence was rated on a four-point scale. From admission to six months, significant increases in functional independence were made in self-care, sphincter control, mobility and locomotion. Differences were found in the extent of functional improvement between subgroups of patients with different levels and extents of lesions. Contrary to expectations based on theoretical models, patients with complete paraplegia did not achieve maximal independence in self-care activities. Regarding the outcome of bladder management, poor results were found. Interestingly, independence in bowel management, independent mobility and locomotion were only attained by patients with incomplete lesions. This study provides insight into the functional outcomes of a group of patients with traumatic spinal cord injury. More research is needed to determine the optimal rehabilitation program for these patients.

INTRODUCTION

Following the definitions set down by the World Health Organization in 1980, the philosophy of rehabilitation is to reduce disabilities and handicaps resulting from impairments caused by trauma or disease (WHO, 1980). Patients with spinal cord injuries (SCI) are confronted with motor and sensory deficits and dysfunction of the bladder and bowel, leading to disabilities in daily activities (Ditunno *et al*, 1994). The aim of rehabilitation is to treat patients with SCI in order to achieve optimal independence and a satisfying lifestyle in their own community. Fortunately, most patients return home after rehabilitation with a significant achievement in functional independence (Yarkony *et al*, 1987; Weingarden and Graham, 1992; Schonherr *et al*, 1996). In recent years, much attention has been paid to the neurological outcomes after SCI. In several studies, motor and sensory recovery following traumatic SCI has been quantified, based on the initial level of injury (Waters *et al*, 1992; 1993; 1994). Most motor recovery occurs within the first six months after injury (Water *et al*, 1993). It is generally accepted that the more distal the spinal cord lesion, the greater the degree of functional independence. Functional goals and expected outcomes are based on knowledge of the sequential organization of spinal segments and the capacity of spared muscle groups to perform specific activities of daily living (ADL) (Yarkony *et al*, 1990; Staas *et al*, 1988). Therefore, the level of functional independence ultimately achieved by an individual will also be influenced by a variety of medical and non-medical factors, such as age, body size and weight, associated injuries, severity of spasticity, motivation, family support, living environment, pre-morbid lifestyle, vocation, educational background and financial status (Yarkony *et al*, 1990; Staas *et al*, 1988). Little research is available concerning the number of patients who actually achieve the expected level of independence.

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The American Spinal Injury Association (ASIA) has recommended the Barthel Index be adopted as a universal functional measure for spinal cord injury (SCI) because of its well-defined guidelines, simplicity and ability to measure relevant functional aspects (Ditunno *et al*, 1994). Many articles focus on self-care of patients with tetraplegia (Welch *et al*, 1986; Yarkony *et al*, 1988a). ASIS, however, has acknowledged some limitations of the Barthel Index, noting that its validity in subpopulations with SCI has not yet been demonstrated (Maynard *et al*, 1997). Most authors agree that patients with paraplegia can be more independent in self-care skills. Ambulation is the subject of several studies with a variety of results (Hussey and Stauffer, 1973; Lazar *et al*, 1989; Mizukami *et al*, 1995; Nene *et al*, 1996). The outcome of bladder and bowel management in patients with spinal cord injuries is comparatively undocumented.

The purpose of this study was to provide a description of the recovery from impairments and disabilities of a group of traumatic spinal cord injury patients during 6 months of follow-up. The functional improvement of these patients is presented in terms of progress in independence in daily activities. Subgroups with different levels and extents of lesions were analyzed regarding independence in self-care activities, sphincter control, and ambulation.

MATERIALS AND METHODS

This study gathered information on admission, and at 6 months. The data were obtained from 38 patients enrolled in this study (18 males and 20 females). Their ages ranged from 18 to 57 years with a mean age of 32±6.48 years, who were consecutively admitted to the physical therapy unit, Ramathibodi Hospital, Bangkok, Thailand, from 1997 to 2001. In order to describe the study group, they were divided into four subgroups with different levels of lesion, using the standards for neurological and functional classification modified by the American Spinal Injury Association (ASIA Impairment Scale) in 1992 (Water *et al*, 1991; ASIA/IMSOP, 1992; Maynard *et al*, 1997). According to these standards, the neurological level of injury was defined as the most caudal segment of the spinal cord with normal motor function. Patients without function in the lowest sacral segment (complete lesions) at discharge form subgroups A and B. Subgroup A consisted of 12 patients with complete lesions at level C4 to T1 (tetraplegia), subgroup B consisted of 11 patients with complete lesions at levels below T1 (paraplegia). The patients with any motor or sensory function below the neurological level which included the lowest sacral segment (incomplete lesions) formed subgroup C (7 patients with lesions at C4 to T1) and subgroup D (8 patients with lesions below T1). This descriptive method has been shown to be reliable and valid (Collin *et al*, 1988; Wade and Collin, 1988). The self-care activities skills were eating and dressing, either in bed or in a chair. Sphincter control involved skills regarding bladder voiding and defecation. Continence of urine and bowels, with or without the use of collection devices, was assessed separately. Incontinence was defined as the unpredictable loss or spill of urine or feces. Motility consisted of bed, manual wheelchair propulsion, and toilet transfers. Locomotion consisted of functional walking and stair climbing. Independent walking was defined as the ability to walk about 10 meters with or without assistance devices, and stair climbing, 10 steps. Independent stair climbing was graded. Sample sizes are included in each table. The number of cases decreased with each follow-up evaluation because individuals could no longer be reached at their former addresses or phone numbers. The motor items of the Barthel Index were used to measure the degree of independence and assistance needed in ADL (with or without an appliance or orthosis relevant to daily activities selected from the Barthel Index. This index has 10 items). Higher scores indicate more independence in ADL functioning. For all skills, the degree of independence was rated on a four-point scale.

These scores were calculated on admission and followed up at 6 months. The differences were examined by paired *t*-tests. Data analysis was carried out using SPSS/PC for Microsoft Windows release 6.0 Kolmogorov Smirov Goodness of Fit test program.

RESULTS

All 38 patients had traumatic spinal cord lesions, which occurred from 1997 to 2000. Nine-

teen injuries (50%) were caused by industrial accidents, 15 (40%) by traffic accidents, 4 (10%) were sports accidents. Of the patients who were admitted to a university or general hospital, 20 (53%) of them underwent surgical interventions. Eight patients (21%) were treated with traction or immobilization. The mean length of stay in the hospital was 28.05 days (range 6-102 days) for the study group. Patients in subgroup A stayed an average 37.05 days; those in subgroup B 27 days; those in subgroup C 22.24 days; and those in subgroup D 24.12 days.

Functional improvement

The results of the independence rates in the study group regarding the eight daily activities are presented in Table 1. Comparison between admission and at six months follow-up, in independence rates, showed a significant increase in independence for all skills.

Table 2 shows changes in the independence rates of the four different subgroups regarding self-care, sphincter control, mobility and locomotion. All subgroups showed significant progress in independence.

Functional independence at 6 months follow-up

The independence rate of the four subgroups regarding self-care, sphinctor control, mobility, and locomotion at follow-up are presented in Table 3. On follow-up, eating meals and dressing the upper and lower body were carried out independently by patients in subgroups B, C, and D, showing reasonably good results. Dressing had the least independence, especially in subgroup A.

Regarding bladder and bowel care, the majority of patients needed assistance with voiding at follow-up. Most patients in subgroups B, C and D achieved independence in bladder voiding techniques. The scores for independence in bowel management were low in subgroup A. For toilet transfer, there was more need for assistance than transfer from bed to wheelchair, which is shown in Table 3. Independent walking and stair climbing over 10 meters with or without assistance devices was achieved by 15 patients (approximately 39% of the study groups). All were patients with incomplete lesions.

DISCUSSION

The aim of this study was to describe the functional independence and rehabilitation outcomes of a group of patients with traumatic spinal cord lesions. Although it was realized that the sample size was small, this study provides information about patients with traumatic spinal cord lesions in Thailand. There were some interesting trends which could have an influence on the contents of a rehabilitation program.

Table 1
Independence rates of study groups regarding eight activities of daily living at admission and at 6 months follow-up.

Barthel Index (n=38)	Admission		Follow-up		p-value
	Mean	(SD)	Mean	(SD)	
Eating	2.24	(1.17)	2.87	(1.24)	0.001[a]
Dressing	1.23	(1.43)	1.48	(0.82)	0.020[b]
Bladder management	0.59	(0.48)	1.02	(1.16)	0.000[a]
Bowel management	0.52	(1.04)	0.84	(1.37)	0.001[a]
Bed, wheelchair transfer	1.34	(1.10)	2.01	(1.42)	0.025[b]
Toilet	1.54	(0.18)	1.98	(1.59)	0.011[b]
Walking	0.62	(0.62)	0.98	(0.95)	0.001[a]
Stairs	0.01	(0.94)	0.81	(1.43)	0.000[a]

[a] $p<0.01$, [b] $p<0.05$ (Differences were examined by paired *t*-tests).

Table 2
Independence rates of four subgroups regarding self-care activities, sphincter control, mobility and locomotion on admission and 6 months follow-up.

		Admission		Follow-up		
	N	Mean	(SD)	Mean	(SD)	p-value
Self-care						
A	12	4.54	(2.13)	9.02	(4.01)	0.001[a]
B	11	10.21	(1.84)	12.54	(7.19)	0.000[a]
C	7	7.97	(1.63)	12.17	(3.44)	0.001[a]
D	8	8.25	(1.90)	13.10	(2.10)	0.001[a]
Sphincter control						
A	12	1.65	(2.26)	5.18	(4.08)	0.006[a]
B	11	1.48	(1.83)	8.19	(5.14)	0.001[a]
C	7	2.47	(1.63)	11.48	(3.85)	0.000[a]
D	8	1.25	(2.49)	11.29	(7.89)	0.005[a]
Mobility						
A	12	2.86	(1.75)	7.09	(8.06)	0.000[a]
B	11	4.81	(2.46)	6.43	(4.17)	0.000[a]
C	7	6.49	(2.27)	10.79	(3.40)	0.050[b]
D	8	6.10	(1.89)	11.01	(7.89)	0.001[a]
Locomotion						
A	12	1.89	(1.21)	2.39	(8.60)	0.050[b]
B	11	3.00	(2.09)	3.50	(3.67)	0.025[b]
C	7	3.44	(2.36)	11.47	(4.06)	0.000[a]
D	8	2.98	(1.58)	9.93	(9.81)	0.001[a]

[a] $p<0.01$, [b] $p<0.05$ (Difference were examined by paired *t*-tests)

Table 3
Independence rates of four subgroups regarding self-care, sphinctor control, and ambulation at 6 months follow-up.

	A (n=12)		B (n=11)		C (n=7)		D (n=8)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Self-care								
Eating	5.24	(0.81)	5.54	(0.62)	6.70	(1.92)	6.81	(0.91)
Dressing	3.78	(1.04)	6.00	(1.25)	5.47	(0.83)	6.29	(0.99)
Sphincter control								
Bladder and bowel	1.42	(1.24)	2.42	(1.98)	2.39	(1.91)	2.64	(0.77)
Toilet	0.85	(1.43)	1.03	(1.86)	2.36	(1.83)	1.98	(0.96)
Ambulation								
Bed, wheelchair transfer	2.01	(0.41)	2.27	(0.96)	2.91	(1.44)	2.68	(0.87)
Walking	0.22	(1.64)	0.41	(1.75)	2.42	(1.11)	1.94	(0.89)

Measurement of functional outcomes is an integral part of any goal-orientated, multidisciplinary rehabilitation program and requires suitable assessment tools. The motor items of the FIM, consisting of self-care activities, sphincter control, and locomotion have been described. Although the FIM is a suitable tool for many impaired groups, various authors have questioned whether it is suitable for particular impairments, including spinal cord injuries and traumatic brain

injuries (Maynard *et al*, 1997).

Functional recovery was expressed in terms of progress in independence in activities of daily living. Yarkony *et al* (1987, 1988) reported that functional improvement after SCI is expected to occur most rapidly during inpatient rehabilitation due to spontaneous neurological recovery, intensity of training and a multidisciplinary approach to problems. We found that the study group became significantly more independent in self-care activities, sphincter control, mobility, and locomotion. To what extent the rehabilitation program was responsible for the changes cannot be demonstrated with this study design. However, we found that patients with permanent complete lesions (subgroups A and B) showed substantial functional improvement.

The functional outcome of tetraplegia has received considerable attention in the literature. Functional motor recovery of the upper extremities in tetraplegia determines final independence in daily activities (Welch *et al*, 1986; Wuolle *et al*, 2003). Regarding the results of patients with complete tetraplegia in subgroup A, we found that the patients had a higher independence score for wheelchair transfer at followed-up. All subgroups could eat independently. These skills should be an important item in a rehabilitation program. Most patients in subgroup A remained dependent on assistance for dressing, sphincter control, and mobility.

Most authors agree that patients with lesion levels lower than C_7 should be able to accomplish most daily activities independently, except walking (Welch *et al*, 1986; Schonherr *et al*, 1999). The functional performance of those patients also depends on other factors, like co-morbidity, age, spasticity, motivation and coping (Lazar *et al*, 1989; DeVivo *et al*, 1990; Maynard *et al*, 1997). Patients in subgroup B (with a complete lesion below T1) did not achieve maximal independence in dressing, bladder and bowel management, mobility and locomotion. The results for defecation and toilet transfers were poor. Even some patients with lesions at lumbar levels did not achieve full independence. Although the results of rehabilitation were encouraging, the functional outcomes of this group were not as good as expected, based on previous reports (Lazar *et al*, 1986; Stineman *et al*, 1996). This is an important finding if we want to be realistic about the prognosis of patients with complete paraplegia.

Patients with incomplete lesions in subgroups C and D showed reasonably high scores overall. However, it was noted that patients with incomplete paraplegia showed more disabilities in self-care activities and sphincter control than indicated by all subgroups. Impaired hand function might have played a role in some patients with incomplete tetraplegia.

The results suggest that bed transfers are easier to perform than toilet or tub transfers. This confirms previous findings (Wade and Collin, 1988). This probably reflects the greater difficulty in performing transfers combining vertical as well as horizontal movements.

Mobility and locomotion have been extensively studied in patients with spinal cord injuries. Nene *et al* (1996) reviewed reports concerning locomotion. There are considerable differences in opinion regarding a patient's ability to walk and the use of orthoses. In this study, patients with complete paraplegia were not able to walk independently over 10 meters. Although the level of the lesion does not seem to be very important in most studies, it is generally accepted that patients with complete lesions above T10 cannot achieve successful independent locomotion. This study found poor results, which means that most patients remained dependent. Such factors as motivation, physique, psychosocial consequences, and the complications of spinal cord injury, play an important role in determining actual functional outcomes. These factors may explain the varied outcomes in these patients.

Functional independence and rehabilitation outcomes of patients with spinal cord injuries have been assessed in order to design more successful rehabilitation programs based on realistic goals.

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