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Functional Rehabilitation of Patients with Traumatic Spinal Cord Injuries

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ABSTRACT

Few large-scale studies of functional outcomes and effects of rehabilitation have been performed in patients with traumatic spinal cord injuries (SCIs). Therefore, I reviewed the effects of rehabilitation in 105 patients with SCI who had been admitted to the Tokyo Metropolitan Rehabilitation Hospital in the past 5 years. The neurologic deficits and activities of daily living (ADL) were evaluated using the American Spinal Injury Association (ASIA) Impairment Scale and Functional Independence Measure (FIM). The ASIA Impairment Scale was classified the degree of impairment as A, B, C, D or E (A : most sever, E : recovery of normal function). The average age of patients with paraplegia (thoracolumbar SCI) was lower than that in quadriplegia (cervical SCI) groups C and D. FIM motor gains in paraplegia groups A and B were more than 30 points and significantly larger than in quadriplegia groups A, B and C. Among patients with quadriplegia, no age-response was found in the change in FIM score, but among patients with paraplegia, improvement in ADL in young patients (<40 years) was significantly better than that in elderly patients (≥ 40 years). Rehabilitation for patients with paraplegia was very effective, and ADL improvement in young patients was significantly better than that in elderly patients.

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Key words : traumatic spinal cord injury, functional outcome, rehabilitation, functional independence measure

INTRODUCTION

Only a few large scale studies of functional outcome and effects of rehabilitation in patients with traumatic spinal cord injuries (SCIs) have been performed outside the United States, where data can be input to a nationwide database. The Spinal Cord Injury Prevention Committee of the Japan Medical Society of Paraplegia started a nationwide epidemiologic survey using a postal questionnaire in 1990[1].

The Tokyo Metropolitan Rehabilitation Hospital is a specialized rehabilitation hospital to which patients with injuries of the brain or spinal cord are referred for rehabilitation. The purpose of this study was to examine the functional outcome achieved by patients with SCI participating in comprehensive inpatient rehabilitation programs at the Tokyo Metropolitan Rehabilitation Hospital and to identify factors (age and type of SCI) associated with favorable rehabilitation outcomes.

SUBJECTS

The clinical records of 105 patients with SCI who had been admitted to the Tokyo Metropolitan Reha-

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bilitation Hospital and for rehabilitation from 1994 through 1999 were reviewed. The subjects were 79 males and 26 females with a mean age of 47.8 years (16–85 years).

Injuries were classified as quadriplegia (cervical SCI) or paraplegia (thoracic or lumbar SCI). Neurologic deficits were evaluated with the criteria established by the American Spinal Injury Association (ASIA)[2]. The ASIA Impairment Scale (modified from Frankel's classification) was used to assess the degree of impairment. In this scale, a complete injury (A) is defined as the absence of sensory or motor function in the lowest sacral segments, and incomplete injury (B, C, or D) is defined as preservation of motor function or sensation below the neurological level of injury (B: preservation of sensory but not of motor function; C: more than half of key muscles below the neurological level have a muscle grade less than 3; and D: at least half of the key muscles below the neurologic level have a muscle grade greater than or equal to 3). In this scale, E is defined as the recovery of normal motor and sensory function. Table 1 shows the distribution of patients with degrees of impairment according to the ASIA Impairment Scale. Among patients with quadriplegia, those in whom paralysis of the upper limbs was clearly more severe than that of the lower limbs were considered to have a central cord syndrome (CCS).

Methods

Groups of patients classified with the ASIA scale were compared with regard to average age, cause of injury, length of rehabilitation, and rehabilitation efficacy. Activities of daily living (ADL) were evaluated using the Functional Independence Measure (FIM)[3]. The FIM is an 18-item ordinal scale in which scores of individual items range from 1 to 7. An FIM item score of 7 indicates complete independence, and a score of 1 indicates the need for full assistance. Two separate domains of items were defined: a motor domain consisting of 13 items and a cognitive domain consisting of 5 items.

Rehabilitation efficacy was assessed by comparing the motor FIM scores on admission and at discharge. Patients with quadriplegia and those with paraplegia were further divided on the basis of age into two subgroups (<50 years and ≥ 50 years for quadriplegia and <40 years and ≥ 40 years for paraplegia) to compare the effect of age on the efficacy of rehabilitation. Rates of acquisition of walking ability and of self-catherization for urination at the time of discharge and rates of discharge to home and return to work were examined.

For comparison among several groups, one-way analysis of variance was used, and Bonferroni's post hoc test was then performed to identify significant differences between two groups. The Wilcoxon test was used to compare motor FIM scores at admission and at discharge. Age-related differences in changes in motor FIM scores were analyzed using the unpaired Student's t-test. Statistical significance was set at $p<0.05$.

Results

1. *Age and causes of injury*

The ratio of males to females was 4 : 1, and 67% of patients had quadriplegia. The average age of patients with paraplegia was approximately 40 years, which was lower than that of patients in quadriplegia groups C and D (Table 1). The most common causes of quadriplegia (in descending order) were fall from a height, traffic accident, and fall on level ground, and those of paraplegia were fall from a height, traffic accident, and injury caused by falling objects (Fig. 1).

Table 1 Subjects

ASIA Impairment Scale	Number	Mean Age (years)
Quadriplegia A, B	13	41.9±18.1
Quadriplegia C	14	56.0±21.0
Quadriplegia D (non-CCS)	24	53.1±14.4
Quadriplegia D (CCS)	19	55.4± 8.7
Paraplegia A, B	17	37.9±18.0
Paraplegia C, D	18	39.8±18.0
Total	105	47.8±17.7

CCS: central cord syndrome

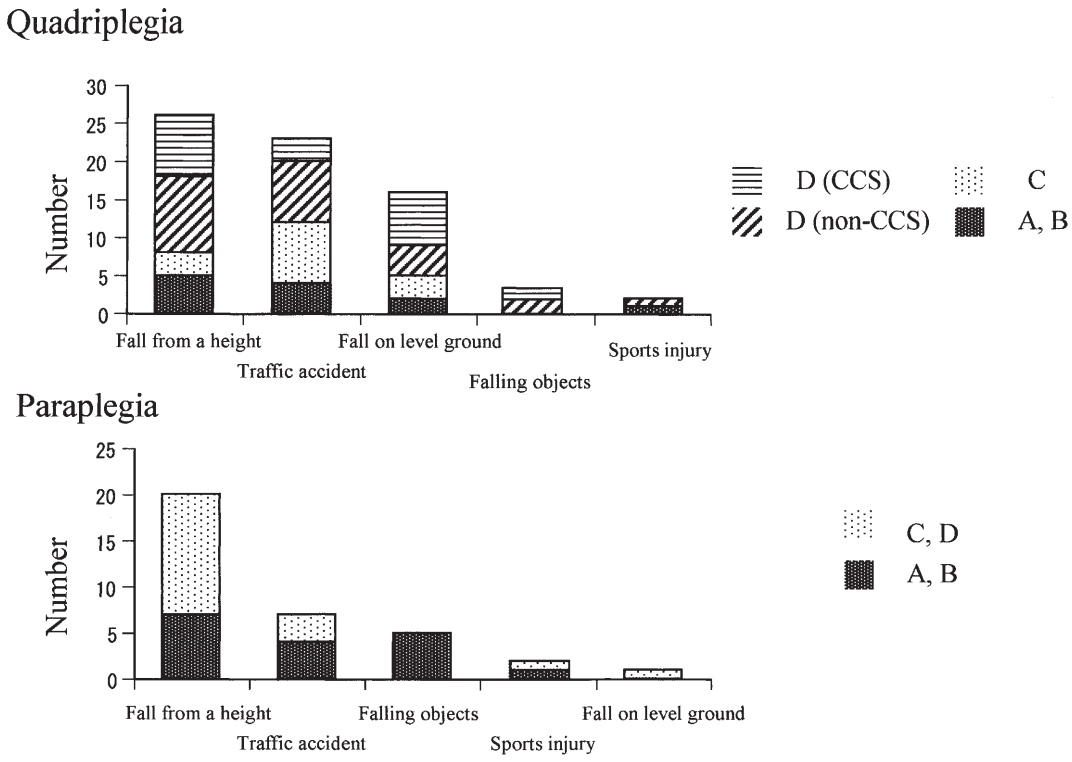

Fig. 1. Causes of injury in patients with SCI.

2. Length of stay

The length of stay at university or general hospitals for acute care of SCI averaged 148.5 days and did not differ significantly among the ASIA groups. The length of stay in the rehabilitation hospital for patients in quadriplegia groups A, B, and C was more than 200 days and was significantly longer than that for patients in quadriplegia group D or in paraplegia groups C and D (Fig. 2).

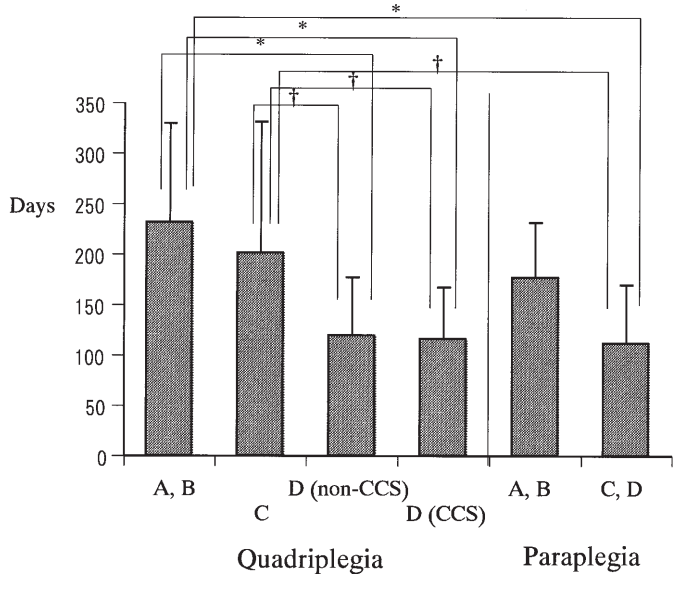

Fig. 2. Length of stay in rehabilitation hospital. $^{*}P<0.01$, $^{\dagger}P<0.05$

3. Improvement in total motor FIM scores

The total motor FIM scores improved in all groups, with patients of quadriplegia group D and patients with paraplegia showing improvements of 70 points or more (Table 2). Improvements in FIM motor scores in paraplegia groups A and B were more than 30 points and were significantly greater than those in quadriplegia groups A, B, and C and in patients with CCS.

4. Comparison between age subgroups in patients with quadriplegia and paraplegia

In patients with quadriplegia, the improvement in FIM scores did not differ with age (<50 years: 14.7±15.2, >50 years: 14.7±12.8), but in patients with paraplegia FIM improved significantly more in patients younger than 40 years (32.7±16.7) than in patients 40 years or older (18.6±15.3).

5. Status of patients at discharge

Many patients in paraplegia groups A and B could urinate by means of self-catheterization. Walking ability was acquired by patients in quadriplegia group D and paraplegia groups C and D. The rate of discharge to home was high (78.1%), and the rate of return to work was 7.6% overall (Table 3). The rate of return to work for patients who had been working before being injured was 10%.

Discussion

In Europe and the United States the risk of SCI is highest from age 20 to 40 years[4–6]. However, a characteristic of SCI in Japan is the presence of two peaks in the distribution curve at 20 and 50 years[1,7,8]. The percentage of cervical lesions (quadriplegia) is high in Japan and accounts for 75% of all SCIs[1,8]. In the present study 67% of patients with SCI had quadriplegia, and the average age of patients with incom-

Table 2 Total Motor FIM Scores

ASIA Impairment Scale	Motor FIM scores at admission	Motor FIM scores at discharge	Changes in motor FIM scores
Quadriplegia A, B	17.0± 7.1	27.8±15.9	10.8±12.6*
Quadriplegia C	31.2±17.5	42.1±22.1	10.9±12.8*
Quadriplegia D (non-CCS)	51.7±24.0	71.1±14.8	19.4±14.5
Quadriplegia D (CCS)	55.8±26.5	70.1±20.5	14.3±13.4*
Paraplegia A, B	40.6± 9.5	72.5±12.2	31.9±14.2
Paraplegia C, D	54.8±18.7	77.3±11.8	22.5±19.3

*$P<0.01$ versus Paraplegia A, B

Table 3 Status of Patients at the Time of Discharge

ASIA Impairment Scale	Self-catheterization	Acquisition of walking	Discharge to home	Return to work
Quadriplegia A, B	30.8%	0%	53.8%	0%
Quadriplegia C	21.4	0	64.3	0
Quadriplegia D (non-CCS)	4.2	79.2	87.5	4.2
Quadriplegia D (CCS)	0	89.5	78.9	10.5
Paraplegia A, B	82.4	5.9	82.4	5.9
Paraplegia C, D	33.3	66.7	88.9	22.2
Total		46.7	78.1	7.6

plete quadriplegia (groups C and D) was greater than 50 years. The percentage of females was 20% of the total SCI population, which is similar to the percentages in studies from other countries[4-6,9].

The high incidence of falls from a height and on level ground is another characteristic of SCI in Japan[1,8]. In the present study the most frequent cause of cervical SCI was fall from a height, followed by traffic accident and fall on level ground.

The length of hospitalization for patients in quadriplegia group A, B, and C was more than 200 days and was significantly longer than that for patients in quadriplegia group D or paraplegia groups C and D. Patients with quadriplegia usually stay longer in hospital than do patients with paraplegia, and patients with incomplete lesions have shorter stays in rehabilitation facilities[4,8]. The mean duration of hospitalization in the United States is much shorter (less than 100 days)[4]. The mean length of hospitalization (151 days) in the present study was similar to that in the Netherlands[9].

The rate of motor recovery in patients with SCI is high in the first 3 months. However, the rate of recovery decreases in the next 3 months and then approaches a plateau[10-12]. In the present study, none of the patients showed great recovery of motor and sensory functions, because the first neurologic assessment after admission was performed more than 3 months after injury.

Functional recovery is expressed in term of improvements in ADL. The modified Barthel index has been used to assess ADL in several studies[4,8,13,14]. At the recent studies, ADL was evaluated using the FIM[8,15,16]. The cognition items in FIM are not useful for detecting changes over time in SCI[16]. In this study, changes in the motor FIM items were investigated, because FIM cognition items do not differ among ASIA groups. The total motor FIM score increased in all groups.

Increases in the FIM motor score in paraplegia groups A and B were more than 30 points and were significantly greater than those in quadriplegia groups A, B, or C or in patients with CCS. Patients with paraplegia show the greatest gains in FIM[16]. Tominaga et al.[8] have reported that increases in the modified Barthel index in patients with complete quadriplegia were significant less than those in other patients. Mean FIM total scores at discharge were 61.0 in patients with complete quadriplegia, 102.1 in patients with incomplete quadriplegia, 105.8 in patients with complete paraplegia, and 118.0 in patients with incomplete paraplegia[8]. These FIM scores are nearly identical to those of patients with SCI in the present study.

In this study, the improvement in FIM scores did not differ with age in patients with quadriplegia, whereas that in patients with paraplegia was significantly greater for patients younger than 40 years than for patients 40 years or older. In general, ADL improve significantly more in young patients with SCI than in older patients[17-19]. However, Yarkony et al.[13] have found no relation between age and ADL function except in patients with complete paraplegia.

Eighty-two percent of patients in paraplegia groups A and B could urinate by means of self-catheterization. Many patients with paraplegia and in quadriplegia group D in this study were capable of independent bowel care. Many patients in quadriplegia group D and paraplegia groups C and D could walk, and 89.5% of patients with CCS could walk unaided at the time of discharge. This result was similar to that reported by Tow et al.[14]. The rate of discharge to home in the present study was higher than that in Rosai hospitals (hospitals for patients with labor injuries) in Japan[8]. The rate of employment of all patients with SCI for reentry into society was 7.6% ; this rate increased to 10% in patients who were employed at the time of injury. These rates were slightly lower than those for patients at Rosai hospitals[8,20]. Patients with SCI, except for those with incomplete paraplegia, have difficulty returning to work.

Conclusion

I analyzed 105 patients with SCI who had been admitted for rehabilitation treatment. On the basis of my results, I conclude that rehabilitation for patients with paraplegia is much more effective than that for patients with quadriplegia and that ADL

improves much more in younger patients than in older patients.

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