

Paraplegia

Follow-up Study on the Use of Leg Braces Issued to Spinal Cord Injury Patients*

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Summary

A letter questionnaire was sent to 250 spinal cord injury (SCI) patients with leg braces who were admitted to a VA Medical Centre from January 1978 to December 1984. There were 73 responses deemed to be complete and acceptable. Among these 73 patients, 61 were paraplegic at the thoracic level and 12 were paraplegic at the lumbar level. They were all male veterans with an average age of 53.4 years. We found only 16 patients (22%) who were still using their braces for ambulation at the time of the survey. All 16 had lesions below T9 level, and 13 had incomplete cord lesions. The remaining 57 (78%) patients were not ambulatory; 13 of these were occasionally using their braces for standing. Statistical analysis revealed that discontinued usage of braces for ambulation was not related to length of initial hospitalisation, years after injury, marital status, educational level, living arrangements, social activities, sports participation or length of initial hospitalisation; but was related to age, level and severity of injury, medical problems and dependency on activities of daily living. In view of similar experiences at other SCI centres, it is concluded that the above factors should be considered in prescribing lower extremity braces for SCI patients.

Key words: *Spinal cord injuries; Orthotic devices; Lower extremity braces.*

Spinal cord injury (SCI) patients have been reported to be successful in ambulation with leg braces (Abramson, 1949; Dinken, 1951; Edberg, 1967; Hussey and Stauffer, 1973; Kent, 1958; Long and Lawton, 1955; Munro, 1951, 1954; Nativig and McAdam, 1978). However, they also have a high frequency of non-usage of issued leg braces for ambulation after discharge from rehabilitation centres (Coghlan *et al.*, 1980; Hahn, 1970; Kaplan *et al.*, 1973; Mikelberg and Reid, 1981; Rosman and Spira, 1974; Sposito *et al.*, 1984). The non-usage rate was from 32% for 59% from previous studies (Coghlan *et al.*, 1980; Mikelberg and Reid, 1981; Rosman and Spira, 1974; Sposito, *et al.*, 1984).

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Age, level of injury and other physical factors are considered important variables in determining brace usage (Chantraine *et al.*, 1984; Coghlan *et al.*, 1980; Dinken, 1951; Fisher and Gullickson, 1978; Gordon, 1956; Hahn, 1970; Hussey and Stauffer, 1973; Rosman and Spira, 1974). However, the contribution of social factors has not been well addressed.

This study was planned to determine the use of braces in SCI in a veteran's population and the physical and social factors influencing it.

Methods

A list of 250 SCI patients admitted to the Long Beach SCI Service from January 1978 to December 1984 who have been issued leg braces was obtained from the Prosthetic Service. A letter questionnaire concerning demographic data, home situation, work status, social activities, sports participation, status in activities of daily living (ADL), medical status and ambulation was sent to these patients.

A follow-up telephone survey was also carried out in some cases in order to complete the required information. The medical records were additionally reviewed to obtain the medical information as necessary. At the time of this study, all patients had had their braces prescribed for more than 1 year.

The functional levels of ambulation were divided into four categories according to Rancho Los Amigos Hospital's criteria (Hoffer *et al.*, 1973; Hussey and Stauffer, 1973): community ambulation, household ambulation, non-functional ambulation (or exercise ambulation) and non-ambulation.

Results

Over 100 questionnaires were returned without responses due either to change of address or death of the patient. There were only 73 responses deemed to be complete and acceptable. This sample size was considered appropriately representative for all 250 patients, based on the analysis of demographic data, medical and social status. All were male veterans with an average age of 53.4 years. The average duration between onset of SCI and date of survey was 22 months

Table I Status of spinal cord injury vs type of brace

Level of injury	Degree	Knee-ankle-foot orthosis	Ankle-foot orthosis	Total
Thoracic level	Complete	39	0	39
	Incomplete	17	5	22
	Both	56	5	61
Lumbar level	Complete	1	1	2
	Incomplete	5	5	10
	Both	6	6	12
Total cases	Complete	40	1	41
	Incomplete	22	10	32
	Both	62	11	73

(range 13–74). Table I shows the level of SCI and the type of brace prescribed. Based on medical record reviews, all patients were found to have received

comprehensive rehabilitation programmes including ambulation training. One of the common reasons of brace prescription was high motivation. All 73 patients were able to walk with the brace, at least for exercise ambulation after completion of the rehabilitation programme (Table II).

Table II Status of ambulation

Walkers	At the time when rehabilitation programme completed	At the time of survey
Community ambulation	15	5
Household ambulation	38	6
Exercise ambulation	20	5
Subtotal	73	16

There were only 16 (22%) patients who were still using their braces for ambulation at the time of this survey. All of them were below the T9 level. The remaining 57 (78%) patients were completely wheelchair-dependent, and 13 occasionally used braces only for standing. Nine of the 16 ambulatory subjects had an injury at the thoracic level 2 with complete and 7 with incomplete lesions. The other 7 subjects had an injury at the lumbar level, 1 being complete and 6 incomplete. As is shown in Table II, among the 16 ambulators, 5 (7% of all) were community ambulators, 6 were household ambulators, and 5 were exercise ambulators. The average age of the ambulatory group was 48.5 (range 26–60) and for the non-ambulators was 54.8 (range 31–72). Based on the student t-test the average age of the non-ambulatory subjects was significantly higher than that of the ambulatory subjects. The average length of initial hospitalisation after injury was not significantly different between the ambulatory and non-ambulatory groups. The time between onset of injury and date of survey was also not significantly different between these two groups.

Eight (14%) of the 57 non-ambulators discontinued usage of the brace for ambulation within 6 months after complete rehabilitation training; 42 (74%) discontinued usage between 6 and 12 months, and the remaining 7 patients discontinued usage between 1 and 3 years.

As is shown in Table III, some other possible aetiological factors which might cause the inability to ambulate were analysed with the Chi-square test. The behaviour of discontinuing the use of the issued lower extremity braces was not related to marital status, educational level, employment status, living arrangements, social activities and sports participation ($p > 0.1$). It was, however, significantly related to the level of injury ($p < 0.001$), severity of injury ($p < 0.001$), medical complications ($p < 0.01$) and the level of dependence on ADL at the time of the survey ($p < 0.01$).

Further analysis of the subjective reasons that caused the non-walker to give up ambulation with the brace revealed that difficulty and inconvenience were the major reasons, followed by medical problems (Table IV).

Table III Correlation between status of ambulation and some etiological factors

Factors	Chi-square	Degrees of Freedom	P value
Level of injury (Thoracic vs lumbar)	11.13	1	< 0.001
Degree of injury (Complete vs incomplete)	11.65	1	< 0.001
Marital status (Married vs unmarried)	1.01	1	> 0.3
Educational level (College/high school/elementary)	0.60	2	> 0.8
Employment status (Employed vs unemployed)	1.58	1	> 0.2
Living arrangement (Alone vs with other/s)	1.29	1	> 0.2
Social activities (Frequent vs rare)	3.17	1	> 0.1
Sports participation (Yes vs no)	0.82	1	> 0.3
Medical problems (Yes vs no)	8.17	1	< 0.01
Dependency on ADL (Dependent vs independent)	7.73	1	< 0.01

Table IV Subjective reasons for non-usage of braces

Subjective reasons	Number of subjects
Too slow, too hard, too unsafe	20
Not practical	17
Too weak	12
Broken leg/hip	2
Leg amputations	3
Muscle spasms	3
Total	57

Discussion

From this retrospective follow-up study we found a higher frequency of non-usage of leg braces issued to SCI patients in a veteran's population than that reported in other studies (Coghlan *et al.*, 1980; Hahn, 1970; Kaplan *et al.*, 1973; Mikelberg and Reid, 1981; Rosman and Spira, 1974; Sposito *et al.*, 1984).

The level and severity of SCI are important factors which determine the ability of functional ambulation, and thus may affect the final outcome of brace usage. Long and Lawton (1955) suggested that only exceptional patients with levels of injury above T12 could obtain any form of functionally significant ambulation, and that independent ambulation even with equipment could be achieved only by patients with injuries below the L4 level. This had been further supported by the later studies (Coghlan *et al.*, 1980; Rosman and Spira, 1974; Sposito *et al.*, 1984). In our study, no patients with lesions at T9 or higher would use braces continuously

after discharge. The energy cost of ambulation for paraplegics is related to the level of the lesion, and is extremely high at the level higher than T12 (Chantraine *et al.*, 1984; Fisher and Gullickson, 1978; Gordon, 1956). This is probably the main reason why high level paraplegics cannot use braces for ambulation continuously.

Nativig and McAdam (1978) had successfully trained their patients with SCI at thoracic level to ambulate and climb stairs. From a 10-year follow-up study of 27 paraplegics with complete lesions (T1–T10), they found that 20 patients (74%) were able to climb 20 stairs with crutches and 19 patients (70%) were able to walk for 100 m. It appeared that their patients were relatively younger than other groups, and their training programmes were much more extensive and intensive.

As in previous studies (Coghlan *et al.*, 1980; Dinken, 1951; Gordon, 1956), we found that age, physical status (medical problems) and ADL level were related to the usage of braces. The high energy expenditure of paraplegic ambulation does not allow the aged and sick subjects to sustain this high cardiopulmonary stress. For patients needing assistance in ADL, the brace donning and undonning might depend on the help from another individual. It would not be practical for those who live alone to ambulate with braces if they are not independent in ADL.

From previous studies, the most common reason given by those non-users was that ambulation with braces is 'too slow, too difficult to too unsafe' (Coghlan *et al.*, 1980; Kaplan *et al.*, 1973; Mikelberg and Reid, 1981; Rosman and Spira, 1974). On the other hand, the two most common reasons stated for using and receiving benefit from the braces were 'means of physical exercise' and 'improved self-image by being upright' (Coghlan *et al.*, 1980). In our study, the reasons that made the non-walker abandon their braces were that the walking activity itself appeared to be perceived as laborious, slow and unsafe. This perception was compatible with previous studies on paraplegic energy expenditure during ambulation (Chantraine *et al.*, 1984; Fisher and Gullickson, 1978; Gordon, 1956).

The majority of non-users interviewed felt that the desire to be independently walking with braces during their initial rehabilitation stage was psychologically reinforcing. However, the motivation to continue using the braces appeared to wane between 6 months to 1 year. The more severely impaired patients who are not realistic candidates for brace ambulation may eventually have a more positive attitude toward wheelchair ambulation as they approach discharge status (Antler *et al.*, 1969).

It was suggested that the upright position was important to prevent complications including osteoporosis, pressure sores, spasticity, and urinary complications (Abramson, 1949; Dinken, 1951; Hahn, 1970; Nativig and McAdam, 1978). However, if the only purpose is to maintain an upright position (standing training), a pair of posterior splints would be preferred over expensive leg braces (Rosman and Spira, 1974).

Based on the results from our study, patients who are well motivated, less than 60 years old, with a level of injury at or below T9 or with incomplete injury at any level, without serious medical problems, and independent in ADL should be considered for ambulation training with braces. If braces are issued for ambulation, the patient's usage should be reinforced at least every 6 months after discharge from the Rehabilitation Centre.

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