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ORIGINAL ARTICLE

Wheelchair appropriateness in patients with spinal cord injury: a Turkish experience

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Study design: Descriptive.
Objective: To determine the wheelchair appropriateness in patients with spinal cord injury (SCI).
Setting: National Rehabilitation Center in Ankara, Turkey.
Methods: Twenty-seven (25 male, 2 female) SCI patients were included. Demographic and clinical characteristics of the patients were noted. All wheelchairs were evaluated considering each part (seat length, seat depth, seat height, back height, armrest, headrest, wheels and seat belt) by a physiatrist who had attended the wheelchair-training course. The wheelchair was declared as inappropriate if at least three parts of wheelchair were not appropriate.
Results: The mean age of the patients was 32.9 ± 9.3 years and mean duration of wheelchair use was 19.63 ± 23.02 months. Among the patients, 21 (77.8%) were American Spinal Injury Association Impairment Scale (AIS) A, 4 (3.7%) AIS B, 1 (3.7%) AIS C and 1 (3.7%) AIS D. Five (18.5%) wheelchairs were motorized and 22 (81.5%) were manual. Overall, 15 (55.6%) wheelchairs were inappropriate. Seat height, cushion and back height were the most common inappropriate parts.
Conclusion: In light of our first and preliminary results, we can argue that 55% of the patients with SCI use inappropriate wheelchairs. In order to achieve better mobility; personally designed wheelchairs should be prescribed by the clinicians.
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INTRODUCTION

Wheelchair satisfaction and ergonomics are crucial for providing appropriate mobility and preventing complications such as fall, contracture and pressure ulcer. In this regard, appropriate wheelchair prescription for disabled individuals is becoming more and more desirable.[1] In the hitherto literature, wheelchair appropriateness has been evaluated in general wheelchair users and 88% of the wheelchairs have been found as inappropriate.[2] On the other hand, spinal cord injury (SCI) is one of the main causes of disability and SCI patients can require strict rehabilitation strategies and some different assistive device modifications to achieve better quality of life.[3] The ideal wheelchair biomechanics and set-up in SCI have been studied before.[4–6] However, to the best of our knowledge, wheelchair appropriateness has not been described in patients with SCI yet.

Previous studies found strong links between the upper extremity problems (carpal tunnel syndrome, ulnar neuropathy, shoulder disorders, impingements and pain) and quality of life in patients with SCI.[4,7,8] With respect to the patients' queries and expectancy, some ergonomic analysis and modifications have been proven to reduce the incidence of the aforementioned problems.[4] From this point of view, we believe that describing the inappropriate parts of the wheelchairs—the most missed parts in daily clinical practice—will guide clinicians to provide the patients with appropriate wheelchairs regarding their clinical features, homes/environments and works so that wheelchair-related complications can be reduced. Therefore, the purpose of this study was to describe the wheelchair appropriateness in patients with SCI by providing an insight into the wheelchair experience in Turkey.

MATERIALS AND METHODS

Twenty-seven (25 male, 2 female) SCI patients were included in this study. Demographic and clinical characteristics of the patients were noted. Functional outcome was measured using the Functional Independence Measure motor scale and American Spinal Injury Association Impairment Scale. All wheelchairs were evaluated considering each part (seat length, seat depth, seat height, back height, armrest, headrest, wheels and seat belt) (Figure 1) by a physiatrist who had attended the wheelchair-training course. Overall, the wheelchair was accepted as inappropriate if at least three parts of wheelchair were not appropriate.

The local ethics committee approved the study protocol. The wheelchair evaluation procedure was explained to each patient and informed consent was obtained from the patients.

Statistical analysis

SPSS version 16.0 was used for statistical analysis (SPSS Inc., Chicago, IL, USA). Data were expressed as mean ± s.d. Pearson coefficients were used for correlation analyses. Statistical significance was set at $P<0.05$.

RESULTS

A total of 27 patients with SCI (mean age 32.9 ± 9.3 years) were included. Clinical and demographic features of the patients are given in Table 1. The mean Functional Independence Measure motor score of the patients was 39.11 ± 16.06 and mean duration of wheelchair use was 19.63 ± 23.02 months. Five (18.5%) wheelchairs were motorized

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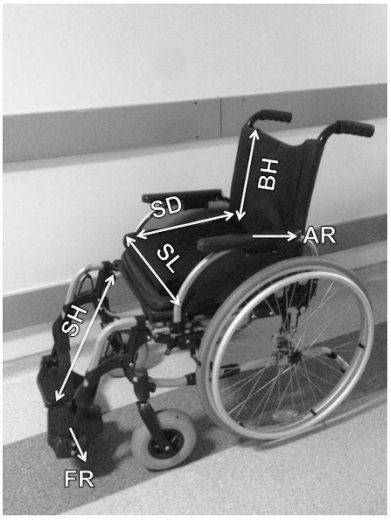

Figure 1 Picture illustrating wheelchair parts. AR, armrest; BH, back height; FR, footrest; SD, seat depth; SH, seat height; SL, seat length.

Table 1 Clinical and demographic features of the patients ($n=27$)

Mean age (years)	32.9 ± 9.3
Gender	
Male	25 (92.6)
Female	2 (7.4)
Complete	
AIS A	21 (77.8)
Incomplete	
AIS B	4 (14.8)
AIS C	1 (3.7)
AIS D	1 (3.7)
Lesion level	
Cervical	6 (22.2)
Thoracic	18 (66.7)
Lumbar	3 (11.1)
Time after injury (months)	42 ± 73
Etiology	
Motor vehicle accidents	10 (37.0)
Falls from height	9 (33.3)
Gunshot injuries	2 (7.4)
Spinal mass	2 (7.4)
Disaster injury	1 (3.7)
Infection	1 (3.7)
Other	2 (7.4)

Abbreviation: AIS, American Spinal Injury Association Impairment Scale.
The data are given as mean ± s.d. or *n*, (%).

and 22 (81.5%) were manual. Patients spent a mean of 3.52 ± 1.94 h on wheelchair in a day.

The appropriateness of each part of the wheelchair is shown in Table 2. Overall, 15 (55.6%) wheelchairs were inappropriate. Whereas

Table 2 Appropriateness regarding the each part of the wheelchair (*n*, %)

Wheelchair part	*Appropriate*	*Inappropriate*
Seat length	21 (77.8)	6 (22.2)
Seat depth	18 (66.7)	9 (33.3)
Seat height	9 (33.3)	18 (66.7)
Armrest	21 (77.8)	6 (22.2)
Back height	14 (51.9)	13 (48.1)
Belt	21 (77.8)	6 (22.2)
Wheels	22 (81.5)	5 (18.5)
Cushion	11 (40.7)	16 (59.3)
Headrest	26 (96.3)	1 (3.7)

15 (55.6%) patients had taken the wheelchair owing to the doctor's prescription, 12 (44.4%) patients had taken it without prescription. Eleven of them were prescribed by a physiatrist, 3 by a neurosurgeon and 1 by an orthopedist. In addition, 5 (18.5%) patients had the history of at least one fall while using wheelchair. Seven patients (25.9%) used their wheelchair inside the house, 7 outside of their houses and 13 (48.2%) both inside and outside their houses. There was no correlation between the Functional Independence Measure motor scores and time spent on wheelchair in a day ($P>0.05$).

DISCUSSION

In this study, we aimed to evaluate the wheelchair appropriateness in patients with SCI. According to our results, the most significant finding was that overall 55% of the patients use inappropriate wheelchairs. Seat height, cushion and back height were the most common inappropriate parts.

Neutral sitting posture providing lumbar lordosis is essential for preventing musculoskeletal complications in healthy populations. Prolonged sitting in inappropriate position has been found to be associated with fatigue, discomfort and strains. Maintaining a neutral position requires a high level of muscle activation as well.[9–12] On the other hand, since SCI patients have weakness, sensory deficits and abnormal spinal stability when compared to a healthy individual, sitting posture is becoming more noteworthy in SCI patients.[13] In this context, sitting configurations in SCI patients can differ from those in healthy subjects regarding the level of injury and balance. First the pelvis should be stabilized, and thereafter the lower extremities and trunk. Unless the patient has fixed deformities, a neutral and midline position of pelvis can be provided. However, a neutral position is not always the best position for patients. Seat dump—a small amount of flexion in the hips—can allow patients to sit more securely.[4] In addition, appropriate seating is also important for the upper extremity stabilization. Seat length should be 2–3 cm wider than the distance between the widest points of the hips in order not to cause pressure.[2] According to our results, seat height was inappropriate in 66.7% of the patients. Seat length and depth were inappropriate in 22.2% and 33.3% of the patients, respectively. If the appropriate sitting position is not maintained, SCI patients will tend to have contractures and musculoskeletal deformities. For instance, if the seat height is shorter than normal, the hips will be in flexed position, and thus cause the risk of hip flexors becoming contracted. The tuber of ischium will bear much more weight and patients will tend to have pressure ulcers (Figure 2). On the contrary, if the seat height is higher than normal, the ankle will be in flexed position and Achilles tendon will be susceptible to be contracted. If the seat length is lesser than

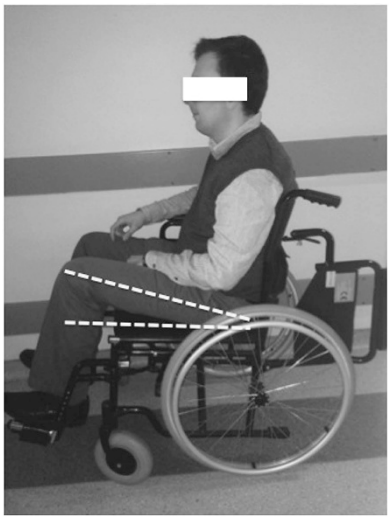

Figure 2 Picture designating the sitting position if the seat height is shorter than normal. The hips are in flexed position and the tuber of ischium is bearing much more weight.

normal, the widest points of the hip, probably the trochanter majors, will be under pressure. In addition, contractures, deformities and heterotopic ossification in hip or knee joints can affect wheelchair mobility. Special trunk and pelvis posture systems can be required if there are spine deformities or hip deformities.[2]

Previous studies have shown that appropriate cushions, soft and flexible, are effective in relieving pressure and preventing pressure sores in patients with SCI.[14–16] Cushions are also important for stabilizing the pelvis and providing postural support.[4] Therefore, patients with SCI should use an appropriate cushion for their wheelchairs. In addition, cushions should be cleaned regularly. According to our results, approximately two-third of the patients do not use cushions or use an inappropriate cushion.

Seat belts are crucial for providing trunk control for patients who do not have sitting balance, particularly for patients with an upper level of SCI.[2,4] In our study, despite the lack of sitting balance, six patients did not have seat belts. This inappropriateness might lead to falls in patients with SCI. Nelson *et al.*[17] have determined wheelchair-related falls. According to their results, the incidence of falls was 31% and that of injurious falls was 14%. Likewise, 5 patients (18.5%) reported at least one fall while using wheelchair in our study. Study of wheelchair features can help address the issue of wheelchair-related falls in patients with SCI.[17] Adjustable armrests are important to prevent falls during transfer from wheelchair to the bed. However, some patients do not require armrests since they can push up and transfer themselves, and so the armrests can be removed.[2,4] Armrests were not appropriate for six patients in our study. Besides, armrest is not the only factor suggested as affecting the upper extremity position, but also seat height and axles. Although we have evaluated the seat height, lack of evaluation of axles is a limitation of our study. As for the patients with cervical level of SCI, wheelchairs can require strict configurations such as higher back height and headrest. The lower the injury level and the better the trunk control that patients have, the lower the backrest can be. Lower backrests allow for greater freedom of upper extremity movement.[18,19] Further, headrest is necessary if the patient does not have enough neck control and has an upper level of cervical SCI.[2] Although it was required, only one patient did not have headrest in our study. Also, back height was found inappropriate in 13 (48.1%) patients.

Motorized wheelchairs can be recommended for patients who have upper limb problems, upper level of injury and who use wheelchairs over a long distance. However, using a motorized wheelchair has certain disadvantages, such as causing weight gain, deconditioning and being expensive.[4,20] Motorized wheelchairs are also associated with decreased transportability and increased maintenance. In our study, while 5 (18.5%) patients used motorized wheelchairs, 22 (81.5%) used manual wheelchairs.

Another important issue in our study was that approximately half of the patients had obtained wheelchairs without any physician prescription. We believe that this condition is directly related to the challenges in the insurance and refunding system. The insurance system in our country does not provide funding for both walking devices and wheelchairs at the same time. Therefore, patients prefer being funded for the walking devices, which are more expensive. Among 15 prescribed wheelchairs, 11 were prescribed by the physiatrists, 3 by a neurosurgeon and 1 by an orthopedist. On the basis of the above, we can argue that physiatrists are the main physicians who closely monitor and follow up SCI patients.

Cherubini and Melchiorri[2] have evaluated 15 parameters of wheelchairs for general wheelchair users. Furthermore, in Cherubini's study 25% of the patients had SCI. We believe that it is not convenient to evaluate patients with and without SCI according to the same criteria. Wheelchair parts, dimensions, durability and all other factors can vary individually, which can overall affect the patient's satisfaction with their wheelchairs. Therefore, we have included only patients with SCI. Since our patients did not have trunk or hip deformities, we did not consider the trunk/pelvis posture systems and the seat splay wedge while evaluating the wheelchair. In the study by Cherubini and Melchiorri the most common inappropriate part was the seat cushion, followed by the trunk/pelvis posture system and seat splay wedges. In our study, seat cushion was the second most inappropriate part. While 88% of the wheelchairs were inappropriate in their study, 55% of the wheelchairs were inappropriate in our study. We could attribute this difference to the different clinical features of the patients and lack of evaluation of posture systems. While Cherubini and Melchiorri[2] have used certain standards in their study, we highlight that some dimensions and needs can change based on the individual. Therefore we did not present the standards of a wheelchair.

As for the limitations of the current study, aside from the small sample size, wheelchairs could be evaluated by more physicians rather than one physician, and a common decision could be rendered, in order to be more objective. The motorized and standard wheelchair samples could be similar and compared. Association between the comorbidities and wheelchair appropriateness could be determined as well. We have evaluated only the dimensions of the wheelchairs in our study. Further studies should consider satisfaction of the patients with their wheelchairs. Therefore, apart from the dimensions, weights, easiness in adjusting, safety, comfort and effectiveness could also be considered for future studies.

CONCLUSION

In light of our first and preliminary results, we can argue that 55% of the patients with SCI use inappropriate wheelchairs. In order to achieve better mobility, personally designed wheelchairs should be prescribed by the clinicians. After getting the wheelchair, patients should be trained in its use and maintenance. Concerning the association between the comorbidities, complications and wheelchair

appropriateness, long-term follow-up studies with large sample sizes are awaited.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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