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Research

The Effect of Smoking on the Functional Gain After Inpatient Rehabilitation in People with Spinal Cord Injury

Sigara İçmenin Omurilik Yaralanması Olan Kişilerde Yatan Hasta Rehabilitasyonu Sonrası Fonksiyonel Kazanca Etkisi

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ABSTRACT

Objective: This study aimed to investigate the effect of cigarette smoking on functional recovery during inpatient rehabilitation for spinal cord injury.

Methods: A total of 78 persons with spinal cord injury admitted to a rehabilitation hospital were included in this prospective observational study. The participants were divided into two groups: smokers and nonsmokers. Functional independence measurement (FIM) scores at baseline and discharge were recorded. The Hospital Anxiety and Depression scale (HADS) was used to assess emotional status.

Results: Thirty-four people (43%) participants were cigarette smokers. Mean ages were 41.29±14.03 and 41.39±16.79 years for the smokers and non-smokers, respectively. Mean disease durations were 5.82±4.13 and 5.20±4.42 months in the smokers and non-smokers, respectively. Baseline FIM scores were 29.97±14.49 and 36.00±15.48 in the smoker and non-smoker groups, respectively (p=0.84). A statistically significant improvement in FIM scores was observed in both groups at discharge (p=0.001). The increase in FIM scores were 10.94±9.58 and 17.52±11.05 in the smoker and nonsmoker groups, respectively (p=0.007). FIM gain was higher in the non-smoker group (p=0.007). The mean HADS anxiety scores were 5.91±4.03 and 7.41±4.3 in the smoker and non-smoker groups, respectively (p=0.12). The mean HADS depression scores were 5.59±3.9 and 6.20±3.70 in the smoker and non-smoker groups, respectively (p=0.47).

Conclusion: A significant functional improvement was observed in both smokers and nonsmokers with spinal cord injury after inpatient rehabilitation. Functional recovery was higher in the non-smoker group.

Keywords: Spinal cord injury, functional recovery, rehabilitation outcome, smoking

ÖZ

Amaç: Bu çalışmanın amacı omurilik yaralanmasında sigara içiminin yatarak rehabilitasyon sonrasında fonksiyonel iyileşmeye etkisini araştırmaktır.

Gereç ve Yöntem: Bu prospektif gözlemsel çalışmaya omurilik yaralanması nedeniyle rehabilitasyon hastanesine başvuran 78 kişi dahil edildi. Katılımcılar sigara içenler ve içmeyenler olarak iki gruba ayrıldı. Başlangıçta ve taburculuk öncesi fonksiyonel bağımsızlık ölçümü (FIM) skorları kaydedildi. Duygusal durumun değerlendirilmesinde Hastane Anksiyete ve Depresyon ölçeği (HADÖ) kullanıldı.

Bulgular: Otuz dört kişi (%43) sigara içiyordu. Sigara içen ve içmeyen grupların ortalama yaşları sırasıyla 41,29±14,03 ve 41,39±16,79 yıldı. Ortalama hastalık süreleri sigara içen ve içmeyen grupta sırasıyla 5,82±4,13 ve 5,20±4,42 ay idi. Başlangıç FIM skorları sigara içen ve içmeyen grupta sırasıyla 29,97±14,49 ve 36,00±15,48 idi (p=0,84). Taburculuk sırasında her iki grupta da FIM skorlarında istatistiksel olarak anlamlı iyileşme vardı (p=0,001). FIM puanlarındaki artış sigara içen ve içmeyen grupta sırasıyla 10,94±9,58 ve 17,52±11,05 idi (p=0,007). Sigara içmeyen grupta FIM kazancı daha yüksekti (p=0,007). Ortalama HADS anksiyete puanı sigara içen ve içmeyen grupta sırasıyla 5,91±4,03 ve 7,41±4,3 idi (p=0,12). Ortalama HADS depresyon puanı sigara içen ve içmeyen grupta sırasıyla 5,59±3,9 ve 6,20±3,70 idi (p=0,47).

Sonuç: Yatarak rehabilitasyon sonrasında omurilik yaralanması olan hem sigara içen hem de sigara içmeyen kişilerde önemli bir fonksiyonel iyileşme bulundu. Sigara içmeyen grupta fonksiyonel iyileşme daha yüksekti.

Anahtar Kelimeler: Omurilik yaralanması, fonksiyonel iyileşme, rehabilitasyon sonucu, sigara içme

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INTRODUCTION

There are approximately 20 million people who smoke cigarettes in Türkiye, and annually almost 100,000 individuals die due to smoking and smoking-associated factors. This ratio constitutes 1/3 of the total deaths due to other reasons (1). Within the South-East Anatolian Project, among people older than 15 years, the proportion of female smokers was 11.8% and that of male smokers was 49.7% in Türkiye. The cigarette smoking ratio was found to be higher among males, in middle ages, with higher education levels, and living in cities (2). In American adults, the smoking ratio decreased to 18.1% in the last 30 years as of 2012 (3). The prevalence of smokers were approximately 22% in the United States of America (4,5). The percentage was as high as 54% in a spinal cord injury (SCI) rehabilitation unit in Türkiye (6). Smokers usually have poorer general health. Smoking is associated with a worse health sense, more work day loss, and an increased burden on health systems (7).

SCI occurs suddenly due to a trauma to the spine. The severity of spinal cord damage varies in each case. Prognosis is poorer in patients with complete injuries (8). However, the level of injury is important in terms of functional recovery, and the strongest predictor of outcomes is injury severity in SCI (9). In addition to SCI severity and level, other factors affecting functional healing are age, education level, comorbidities, spasticity, and recovery of deep tendon reflexes or delayed plantar response (10,11). The current study aimed to investigate the effect of cigarette smoking on functional gain after inpatient rehabilitation for SCI.

METHODS

This is a prospective observational study. Seventy-eight patients aged >17 years with SCI who underwent inpatient rehabilitation were enrolled in this single-center study. Individuals with injury duration >12 months and those with accompanying traumatic brain injury were excluded. Patients were divided into two groups: currently smokers and non-smokers. Two individuals who quit smoking 15 or 30 years ago were evaluated in the non-smokers group due to the long cessation period. On the other hand, two individuals with a history of smoking 60 pack/year and 9 pack/year were evaluated in the currently smoker group because the smoking cessation period was <1 year.

Neurological severity was assessed using the American Spinal Cord Injury Association Impairment scale (AIS). Functional status was evaluated using functional independence measurement (FIM) at admission and discharge. The Hospital Anxiety and Depression scale (HADS) was used to assess the patients' anxiety and depression status at admission. All patients received rehabilitation 5 days a week.

Ethical approval Approved by the Clinical Research Ethics Committee of İstanbul Physical Medicine and Rehabilitation Training and Research Hospital with (protocol number 2024-3, date: 02.07.2024). All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (instutional and national) and with the Helsinki Declaration of 1964 and its later amendments. Informed consent was obtained from all patients prior to their inclusion in the study. This article does not contain any studies with animal subjects. All authors declare that there are no conflicts of interest.

American Spinal Cord Injury Association Impairment Scale

AIS helps classify neurological severity in 5 categories after SCI. AIS A refers to complete injury in which no sensory or motor function is preserved in sacral segments. AIS B indicates incomplete injury without motor function below the injury level. However, sensory function is preserved below the neurological level and extends through sacral segments. AIS C shows incomplete lesions in which motor function is preserved below the neurological level, and most key muscles below the neurological level have a muscle strength <3. AIS D indicates incomplete injury with preserved motor function below the neurologic level. Moreover, most key muscles below the neurological level have a muscle strength ≥3. AIS E indicates that sensory and motor functions are normal below this level (12).

Functional Independence Measurement

FIM is a widely used scale with 18 items that help assess disability. Self-care, sphincter control, locomotion, communication, and social communication were evaluated in the motor and cognition subscales. Each item was scored on a 7-point scale. Higher scores indicate a more independent function. FIM motor scores can be used to measure the functional status of patients with SCI (13). FIM scores are adapted for use in Türkiye (14).

Hospital Anxiety and Depression Scale

HADS is an easy and reliable test that can help screen anxiety and depression. The test is used for both hospitalized patients and outpatients (15). HADS can be completed in 2-5 minutes. The test has a two-factor structure with 14 items. Each item was scored on a four-point scale. Total score differed between 0 and 21. Scores between 0 and 7 indicate normal emotional status. However, scores >7 indicate anxiety or depression (16). The reliability of the

Turkish version of HADS in individuals with traumatic SCI has been studied (17).

Statistical Analysis

The Kolmogorov-Smirnov test with the Lilliefors significance correction or Shapiro-Wilk test was used to determine whether the data were normally distributed. Continuous variables were summarized as an arithmetic mean ± standard deviation or a median (interquatile range). Categorical data were summarized as frequency and analyzed using the Likelihood ratio test and Fisher's Exact test. The means of the two groups were compared using the Mann-Whitney U test or unpaired-sample t-test. Multivariate binary logistic regression analysis was performed to identify risk factors for polypharmacy. The p-value for a factor to be included in the regression model was 0.05 using the forward conditional method, and the p-value for exclusion was 0.1. The suitability of the regression model was reviewed using the Hosmer-Lemeshow test. The regression model was considered statistically suitable if the p-value determined using the Hosmer-Lemeshow test was <0.05. The 95% confidence intervals were calculated for the odds ratios [Exp(B)]. Wald statistical analysis was conducted to determine the significance of coefficient B. P<0.05 was considered significant. The software package used for data management was PASW Statistic 18.

RESULTS

There were no significant differences in age, body mass index, education level, injury duration, marital status, or gender distribution between the groups (p>0.05). The length of hospital stay was significantly longer in smokers than in non-smokers (Table 1). Clinical features related to the etiology, neurological severity, and associated problems are presented in Table 2. Frequencies of patients with traumatic SCI and motor complete patients were significantly higher in smokers. There were no statistically significant differences in emotional status scores between the groups upon admission (p>0.05).

The total number of smokers who quit smoking was 4 (5%). The cigarette consumption ratio was 27.76±18.50 (2-76) pack/year among smokers. FIM and HADS scores are summarized in Table 3. There was significant functional recovery after inpatient rehabilitation in both groups (p<0.0001). Gain in FIM scores in the currently smoker group was significantly lower than that in the non-smokers (p=0.004). The cut-off value (14.28) was calculated for the arithmetic mean (95%) upper confidence limit of the smoker group. If the FIM gain is below this cut-off value, functional recovery is insufficient; the gain above was considered sufficient. Accordingly, insufficient functional recovery was detected in 35 (44.9%) patients.

The binary logistics regression analysis revealed that neurologic severity, spinal cord lesion level, and smoking were risk factors for insufficient functional recovery after inpatient rehabilitation (Nagelkerke R^2=0.368, Hosmer-Lemeshow test p=0.975). The risk of insufficient functional recovery was 12.56 times higher in patients with tetraplegia than paraplegia; 3.34- times higher in smokers than non-smokers; and 3.28 times higher in patients with motor complete lesions (AIS A or B) (Table 4).

DISCUSSION

In this study, significant functional recovery was observed after inpatient rehabilitation in both non-smokers and smokers with SCI. However, functional gain was lower in the current smoker group at discharge (p=0.007). Although there was no significant difference between the groups in terms of functional independence at admission, functional status was better in the non-smoker group at discharge (p<0.05). Paraplegia, incomplete lesions, and/or non-smoking were indicators of better functional recovery.

There are injury- and patient-related factors that affect functional improvement in SCI. It was suggested that age and sex were patient-related predictors, whereas injury

Table 1. Demographic and clinical characteristics

	Non-smokers (n=44)	Smokers (n=34)	p-value
Age (years)	41.4±16.8	41.3±14.3	0.979*
BMI (kg/m²)	25.3 (22.9-27.8)	24.7 (21.8-26.2)	0.279$^{\pi}$
Sex (F/M) (n)	12/32	5/29	0.176§
Marital status (married/single) (n)	32/12	25/9	0.937§
Education duration (years)	5.0 (5.0-9.5)	5.0 (5.0-8.0)	0.935$^{\pi}$
Injury duration (mos)	4.0 (2.0-6.8)	5.0 (3.0-8.0)	0.205$^{\pi}$
Length of stay (days)	63.5 (59.0-78.3)	71.0 (61.0-85.5)	0.026$^{\pi}$

*Unpaired-sample t-test, §Likelihood ratio, $^{\pi}$Mann-Whitney U test, BMI: Body mass index, F: Female, M: Male

Table 2. Clinical characteristics

		Non-smokers (n=44)	Smokers (n=34)	p-value
Etiology	Falls	17	19	0.065*
	Traffic accidents	10	10	
	Violance and others	17	5	
Traumatic/non-traumatic ratio		33/11	32/2	**0.018§**
SCL level	(Tetraplegia/paraplegia)	5/39	9/25	0.085§
Neurologic severity (AIS)	Motor complete (AIS A, B)	13	23	**0.001§**
	Motor incomplete (AIS C, D)	31	11	
Associated problems	Pulmonary problems	4	4	0.723π
	Pain	31	27	0.366§
	Spasticity	17	20	0.076§
	Heterotopik ossification	0	3	0.079π
	Deep venous trombosis	1	1	0.999π
	Intestinal problems	5	5	0.740π
	Pressure ulcer	5	6	0.519π

Data are presented as case number. *Pearson's chi-square test, §Likelihood ratio test, πFisher Exact test
AIS: American Spinal Cord Injury Association Impairment scale

Table 3. Functional and emotional status

	Non-smokers (n=44)	Smokers (n=34)	p-value
Admission FIM	31.0 (27.3-43.3)	28.0 (20.8-35.5)	**0.032**
Discharge FIM	55.5 (44.3-68.5)	37.5 (29.8-53.5)	**0.002**
FIM gain	17.0 (8.5-23.5)	9.0 (4.0-13.5)	**0.004**
HADS-A	7.0 (4.0-10.0)	6.0 (2.0-9.3)	0.194
HADS-D	6.0 (4.0-8.0)	5.0 (2.8-7.3)	0.418

The Mann-Whitney U test was used in the statistical analysis. P<0.05 was considered significant.
FIM: Functional independence measurement, HADS-A: Hospital Anxiety and Depression scale- anxiety, HADS-D: Hospital Anxiety and Depression scale-depression

Table 4. Regression model for sufficiency of functional recovery

Independent variable	B	SE	Wald	df	p-value	Odds ratio	95% CI	
							Lower limit	Upper limit
Neurologic severity (1)	1.18	0.56	4.51	1	0.034	3.28	1.09	9.81
SCL level (1)	2.53	1.11	5.18	1	0.023	12.56	1.42	110.97
Smoking (1)	1.20	0.57	4.51	1	0.034	3.34	1.09	10.16
Constant	-1.10	0.40	7.65	1	0.006	0.33	-	-

Neurological severity (1): (1) AIS A or B, (0) AIS C or D; Spinal cord lesion (neurologic) level (1): (1) Tetraplegia, (0) paraplegia; Smoking (1): (1) Smoker, (0) Non-smoker.
SE: Standard error, df: Degrees of freedom, CI: Confidence interval

severity was a injury-related predictor of recovery after SCI (8,11,18). Aging has been reported as a factor that leads to poor neurological and functional healing in individuals with complete SCI due to blunt trauma (8). On the other hand, it is concluded that there was no relationship between advanced age and recovery in patients with incomplete SCI. The baseline AIS value was suggested as an indicator of functional status in the first year after injury in a previous study. The same study revealed that patients with baseline AIS motor scores >50 had better functional outcomes (18). Previously, better motor recovery was found in patients with incomplete traumatic cervical SCI who were non-smokers after injury (19).

In another study, factors related to functional recovery as measured by FIM were reported as baseline AIS motor scores assessed within 72 hours after injury, education level,

comorbidities, spasticity, and age in patients with central cord syndrome (11).

Smoking is one of the most common risk factors of lyfestyle in terms of morbidity, especially with the three important organ system damage, cardiovascular, respiratory, and urinary systems, in SCI (20). It was concluded that each smoking year increased cardiovascular morbidity by 3.1%, respiratory system morbidity by 3.5%, and urinary system morbidity by 6% in patients with complete injury. The same study revealed that smoking is a serious health threat among patients with SCI. Smoking may cause pulmonary system complications in patients with SCI (21). There was no difference between the groups in terms of pulmonary complications. Because of the relatively short injury duration, the effects of smoking on the other systems were not evaluated in this study.

Currently-smokers were 49% of people with SCI in this study. The prevalence of cigarette smoking differs between 22% and 35% in SCI (4,5,22). Demirel et al. (6) reported smoking frequencies of 54% and 42% in individuals with SCI and controls, respectively. Smoking ratio is higher among patients with SCI than in the normal population (23). Previously, it was reported that the cigarette smoking ratio among patients with SCI was similar to that of healthy adult males in Türkiye (2).

Weaver et al. (4) concluded that 22% of the participants were still smoking cigarettes, whereas 51% had quit smoking in a study performed on 1210 veterans with chronic SCI with a mean injury duration of 20.7 years. In another study, it was reported that 22.6% of the individuals were still smoking, 49.2% were not smoking, and 28.2% had quit smoking in a previous study involving 1076 adults suffering from traumatic SCI, with injury duration ≥1 year (14).

Patients who continue to smoke have higher lung problems, pain, depression, and alcohol consumption than those who never smoked, and for this reason, smoking is a risk factor for other health problems in SCI as in the normal population (4).

In our study, no relationship was found between smoking and neither the frequency of pain nor emotional status. Previously, it was reported that smoking increased the intensity of neuropathic pain in two individuals struggling with neuropathic pain due to SCI, and the pain decreased after they quit smoking. This condition can be explained by the effect of nicotinic receptors on pain perception (16).

There are some strengths and limitations to this study. The strength of this study is that it is the first to investigate the relationship between smoking and functional gain in patients with SCI after inpatient rehabilitation. The limitations of this study are the relatively small number of patients and the lack of long-term follow-up.

CONCLUSION

Smoking had negative effects on functional recovery after inpatient rehabilitation for SCI. Smoking cessation is beneficial for individuals with SCI.

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ETHICS

Ethics Committee Approval: Ethical approval Approved by the Clinical Research Ethics Committee of İstanbul Physical Medicine and Rehabilitation Training and Research Hospital with (protocol number 2024- 38, date: 02.07.2024).

Informed Consent: Informed consent was obtained from all patients prior to their inclusion in the study.

Conflict of Interest: No conflict of interest was declared by the authors.

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