

Research Article

Inpatient rehabilitation outcomes in neoplastic spinal cord compression vs. traumatic spinal cord injury

Sevgi Ikbali Afsar , Sacide Nur Saraçgil Cosar , Oya Umit Yemişçi ,
Hüma Bölük 

Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Baskent University, Ankara, Turkey

Objective: To compare neurological and functional outcomes, and complications of patients with neoplastic vs traumatic spinal cord injury (SCI) after in-patient rehabilitation.

Design: This study is a retrospective analysis.

Setting: In-patient rehabilitation unit of a tertiary research hospital.

Participants: A total of 252 patients with a SCI were included; 43 with neoplastic SCI (mean age: 60.9 ± 15.7 years, 60.5% were males) and 209 with traumatic SCI (mean age: 43.1 ± 16.8 years, 71.3% were males).

Outcome measures: Comparisons were made of demographic characteristics, etiology, American Spinal Injury Association (ASIA) impairment scale, functional independence measurement (FIM) and Functional Ambulation Categories (FAC) scores, length of stay (LOS), bladder independence, medical comorbidities and complications in both groups.

Results: Patients with neoplastic SCI were significantly older than those with traumatic SCI ($P < 0.01$). No difference was present between the groups in terms of sex and lesion level ($P > 0.05$). Incomplete SCI was significantly higher in the neoplastic group when compared with the traumatic group ($P < 0.01$). The LOS was significantly shorter in the neoplastic group than traumatic group (34.8 ± 41.03 vs. 60.02 ± 53.1 , $P < 0.01$). There were no differences in the admission FIM scores (69.3 ± 24.7 vs. 58.7 ± 18.9 , $P > 0.05$), discharge FIM scores (82.1 ± 25.1 vs. 74.02 ± 23.3 , $P > 0.05$) and FIM efficiencies (0.43 ± 0.72 vs. 0.36 ± 0.51 , $P > 0.05$) for the neoplastic and traumatic groups, respectively. However, neoplastic SCI patients demonstrated lower FIM gains compared to traumatic patients (12.9 ± 11.9 vs. 15.4 ± 15.2 , $P < 0.05$). During rehabilitation, urinary tract infection (48.4% vs. 69.4%) and decubitus ulcer (11.6% vs. 35.9%) were significantly more common in the traumatic group than the neoplastic group ($P < 0.05$).

Conclusion: Neoplastic SCI patients who commonly present at rehabilitation units exhibit different characteristics from traumatic SCI patients but the rehabilitation results are similar. Similar functional development can be achieved in a shorter period of time with inpatient rehabilitation in the neoplastic SCI group.

Keywords: Neoplastic spinal cord compression, Traumatic spinal cord injury, Rehabilitation

Introduction

Spinal cord injury (SCI) developing due to neoplasia is particularly difficult for both the patients and the health-care providers with the resultant neurological and functional deficiency, increased comorbidity in addition to the decreased life expectancy due to cancer. Spinal cord injury due to neoplastic spinal cord compression has been reported to constitute 10% of all new SCIs and

26% of non-traumatic SCIs.¹ The incidence of neoplastic SCI is expected to increase dramatically in the coming decades, with the aging population and an increase in the incidence of lung, prostate and breast cancers, which are the main causes of spinal metastasis and spinal cord compression.² In addition, improvements in early cancer diagnosis and treatments providing increased survival will also increase the number of neoplastic SCI patients benefiting from rehabilitation. Teams dealing with SCI will, therefore, encounter increasing numbers of SCI patients in the future.^{3,4}

Correspondence to: Sevgi Ikbali Afsar, Faculty of Medicine, Physical Medicine and Rehabilitation Department, Baskent University, Mareşal Fevzi Çakmak Avenue, 53rd Street, No:48 Bahçelievler, Ankara, Turkey; Ph: +90 312 203 05 22; +90 312 2030524. E-mail: ikbali@baskent.edu.tr

Although the rehabilitation of neoplastic SCI patients is similar to that of traumatic SCI cases in most respects, patients with neoplastic SCI have different rehabilitation problems due to the spinal cord involvement, neoplasia-related complications, and short life expectancy.⁴ In addition, the demographic profiles and medical comorbidities of neoplastic SCI patients may differ from those of patients with traumatic injuries. Traumatic SCI usually affects males more than females, with a reported male-to-female ratio of 2:1. The age distribution is bimodal, with a first peak involving young adults and a second peak involving adults over the age of 60 years. In traumatic lesions, tetraplegia/paraplegia and complete/incomplete injuries occur at almost equal percentages.^{5–8} Patients with neoplastic SCI, however, have a relatively even sex distribution, with a peak incidence between the ages of 50 and 70 years. In addition, paraplegia and incomplete injuries have been reported to be more frequent. Considering these differences, patients with neoplastic SCI require different methods for symptom management and rehabilitation.^{8–10}

The number of articles on the rehabilitation of neoplastic SCI patients has therefore been increasing in recent years.^{1,11–19} In most of these studies, SCI patients with tumors have been reported to provide significant functional improvement between hospitalization and discharge, and have demonstrated the benefits of rehabilitation in terms of independence, prevention of complications, and survival. However, in these studies, only neoplastic SCI patients have been investigated and no comparison have been made with a traumatic group. Only a few studies have compared this group with traumatic SCI patients,^{3,8} and the results of those studies have shown that the functional recovery of neoplastic SCI patients was less than that of traumatic patients.

The aim of this study was to compare the demographic data, injury-related characteristics, medical comorbidities and functional outcomes of neoplastic and traumatic SCI patients who were accepted into the rehabilitation program in our clinic. The hypothesis of this study was that neoplastic SCI patients have different demographic characteristics than patients with traumatic SCI. Neoplastic SCI patients can obtain significant functional gains from inpatient rehabilitation program, but this gain is expected to be less than in traumatic patients due to tumor effects, advanced age and medical comorbidities.

Materials and methods

A retrospective review was made of the medical charts of 338 patients with SCI who were included in the rehabilitation program between 2005 and 2019 at the tertiary

rehabilitation center affiliated with the Başkent University Hospital. A total of 209 traumatic SCI and 43 neoplastic SCI patients were finally included in the study. The admission criteria for our rehabilitation unit were that the patient was medically stable to be able to actively participate in the rehabilitation program, was able to tolerate the rehabilitation program for 2 h or more per day, and did not need a mechanical ventilator. If necessary, vital parameters were monitored. In the event of life-threatening complications, patients were transferred to an acute care facility. All patients were included in an inpatient rehabilitation program for the first time for more than 7 days. Patients were excluded if they had an additional injury such as traumatic brain injury and non-vertebral fracture or were rehospitalized for late complications. All patients had been treated for the primary disease causing compression of the spinal cord before coming to the rehabilitation center. The patients did not receive radiotherapy or chemotherapy during rehabilitation. All patients underwent an inpatient rehabilitation program two hours per day and 6 days a week including range of motion and progressive resistance exercises, balance and coordination exercises, ambulation training, and occupational therapy. Effective pain control, bladder and bowel management, and treatment of pressure sores were also implemented. Psychological counseling was provided when necessary.

The medical records of the patients included in the study were retrospectively evaluated and the age, sex, cause of injury, level of neurological injury, the completeness/incompleteness of injury based on the American Spinal Injury Association (ASIA) Impairment Scale, time since injury, length of stay (LOS) in the hospital during the rehabilitation period, functional status, and complications that occurred during hospitalization were recorded. The patients were classified according to the ASIA Impairment Scale (AIS) adapted to the 2011 revision of the International Standards for Neurological Classification of Spinal Cord Injury.²⁰ The time of onset of the neurological symptoms was used for the “time since injury” for patients with neoplastic SCI.

The outcome measures included the following: the Functional Independence Measurement (FIM) scores, FIM gain and FIM efficiency scores, Functional Ambulation Categories (FAC) scores and independence of bladder management.

The FIM is a functional assessment tool commonly used in the inpatient rehabilitation setting. It has been designed to assess physical, cognitive, and social function and contains 18 items aimed at focusing on the

disability. The motor subscale includes items on self-care, sphincter control, locomotion and transfer information. The cognitive subscale collects information on communication and social functioning.^{21,22} Each item is scored on a 7-point ordinal scale ranging from 1 (total dependence) to a score of 7 (total independence). Possible scores range from 18 to 126 with lower scores indicating more dependence. The inter-rater reliability, validity, and responsiveness of the FIM are well established.^{23,24} FIM is regarded as a reliable and valid measure in the functional assessment of SCI patients.²⁵ The reliability and validity of the Turkish version of the FIM has also been documented.²⁶ The total FIM score was recorded on admission and at discharge for each case. All FIM evaluations were performed by Physical Therapy and Rehabilitation specialists. The FIM gain and FIM efficiency scores were also assessed. FIM gain scores were calculated based on the difference between rehabilitation discharge and rehabilitation admission scores. FIM efficiency scores were calculated based on dividing the change in the scores by the corresponding rehabilitation LOS (in days).²⁷

Walking ability was assessed with the FAC scale. The FAC is a scale designed to provide information about the level of physical support that patients need to safely stand and walk. It is a reliable and valid assessment in patients with neurological impairment.^{28,29} The FAC score ranges from 0 to 5 – nonambulatory (0), ambulatory, dependent on physical assistance (patient requires continuous manual contact for support body weight) (1), ambulatory, dependent on physical assistance (patient requires intermittent or continuous light touch to assist walking) (2), ambulatory

with supervision (patient requires stand-by guarding, or the need for verbal cues to complete the task) (3), ambulatory independent (patient can walk independently on a flat surface but requires supervision on non-flat surface or stairs) (4), normal independent ambulation (5).³⁰ In this study, FAC was categorized as dependent (non-ambulatory or ambulatory with physical assistance) (FAC score: 0–2) or independent (FAC score 3–5) ambulation.

Independence of bladder management was defined as the presence of bladder control or ability to perform clean intermittent self-catheterization.

Finally, the presence of hypertension, diabetes mellitus and coronary artery disease and medical complications such as pressure sores, deep vein thrombosis, pulmonary embolism and urinary tract infection developing during rehabilitation were recorded. Approval for the study was granted by the Ethics Committee of Baskent University.

Statistical analysis

Data obtained in the study were analyzed statistically using SPSS vn.22.0 software. The presence or absence of a normal distribution of the variables was investigated with analytical methods (Kolmogorov–Smirnov). Descriptive analyses were presented using means and standard deviations for normally distributed variables, medians for the non-normally distributed data, and frequency tables for the ordinal variables. The Mann–Whitney U test was used to compare parametric variables without normal distribution between the groups. The Chi-square test or Fisher’s exact test was used to compare the percentages in different groups. A value of $P < 0.05$ was accepted as statistically significant.

Results

The medical records of a total of 338 patients consisting of 209 (61.8%) traumatic SCI patients and 129 (38.2%) non-traumatic SCI patients were reviewed. Neoplastic causes were found in 43 (33.3%) of the non-traumatic SCI patients. Low-grade malignant tumors (schwannoma, astrocytoma, ependymoma and meningioma) of the spine or spinal cord were present in 22 (51.2%) patients in the neoplastic group. A metastatic spinal cord lesion was found in 16 (37.2%) patients and other rare causes included multiple myeloma (3 patients), plasmacytoma (1 patient) and lymphoma (1 patient) (Table 1). Metastatic spinal cord compression was due to lung cancer in 5 (11.6%) patients, prostate in 5 (11.6%) patients, breast cancer 2 (4.7%) patients, colon cancer in 2 (4.7%) patients, and renal cell carcinoma

Table 1 Etiology of neoplastic and traumatic SCI patients.

Diagnosis	N	%
Neoplastic	43	
Metastatic	16	37.2
Lymphoma (primary malignant)	1	2.3
Multiple Myeloma (primary malignant)	3	7.0
Plasmacytoma (primary malignant)	1	2.3
Astrocytoma (spinal intramedullary)	6	14
Ependymoma (spinal intramedullary)	4	9.3
Schwannoma (intradural extramedullary)	9	20.9
Meningioma (intradural extramedullary)	3	7.0
Traumatic	209	
Motor vehicle accident	95	45.4%
Fall from height	88	42.1%
Firearms injury	11	5.3%
Cutting tool injury	2	1.0%
Diving	8	3.8%
Other	5	2.4%

Abbreviation: SCI, spinal cord injury.

in 2 (4.7%) patients. The cause of traumatic SCI was primarily motor vehicle accident (45.4%) followed by fall from height (42.1%) (Table 1).

Table 2 presents the demographic characteristics observed in the neoplastic and traumatic SCI patients. The neoplastic group comprised 17 (39.5%) females and 26 (60.5%) males with a mean age of 60.9 ± 15.7 (median 62) years. The traumatic group comprised 60 (28.7%) females and 149 (71.3%) males with a mean age of 43.1 ± 16.8 (median 39) years. The patients in the neoplastic group were significantly older ($P < 0.01$). There was no statistically significant difference between the two groups in terms of sex ($P > 0.05$) (Table 2). The lesion level in the neoplastic group was thoracic in 32 (74.4%) patients, cervical in 6 (14%) patients, and the lumbosacral region in 5 (11.6%) patients while the respective numbers were 107 (51.2%), 67 (32.1%) and 35 (16.7%) in the traumatic group. No significant difference was found between the two groups in terms of lesion level ($P > 0.05$). There was a significant difference between the neoplastic and traumatic groups in respect of the completeness of the injury ($P < 0.01$). Patients in the neoplastic SCI group presented more commonly with AIS D (37.2% vs. 13.9%) while the number of patients with AIS A was higher in the traumatic SCI group (52.6% vs. 20.9%) (Table 3).

The mean LOS in the hospital was 34.8 ± 41.03 (median 22) and 60.2 ± 53.1 (median 49.5) days, respectively, in the neoplastic and traumatic SCI patient groups. This value was significantly longer in

the traumatic SCI patients ($P < 0.01$). The mean FIM score was 69.3 ± 24.7 (median 62) on admission and 82.1 ± 25.1 (median 76.5) at discharge in the neoplastic group while the same values were 58.7 ± 18.9 (median 57) and 74.02 ± 23.3 (median 74) respectively, in the traumatic group. There was no significant difference between the two groups in respect of admission and discharge FIM scores and the FIM efficiency ($P > 0.05$). The neoplastic SCI patients had significantly lower FIM gain scores than those with traumatic SCI ($P < 0.05$). The percentage of patients with bladder management independence at discharge was significantly higher in the neoplastic SCI group compared to the traumatic group (51.2% vs. 26.8%) ($P < 0.05$) (Table 4). There was a significant difference between the groups in respect of admission FAC scores ($P = 0.000$). The percentage of non-ambulatory patients on admission was higher in the traumatic SCI group than in the neoplastic group (96.2% vs. 69.8%). At discharge, there was no statistically significant difference between the two groups in terms of ambulation (77.5% vs. 65.1%) ($P > 0.05$) (Table 4).

There was no statistically significant correlation between FIM and FAS scores and diabetes mellitus, hypertension and coronary artery disease in traumatic and neoplastic groups ($P > 0.05$). Urinary tract infection was the most common complication during the rehabilitation period in both the neoplastic and traumatic groups (48.8% and 69.4%, respectively). Only

Table 2 Demographic characteristics of the patients.

	Neoplastic <i>n</i> = 43	Traumatic <i>n</i> = 206	P-value
Age (years), mean $\pm$ s.d.	60.9 ± 15.7	43.1 ± 16.8	0.000*
Median (IQR)	62 (19)	39 (25)	
Sex, <i>n</i> (%)			
Male	26 (60.5%)	149 (71.3%)	0.160***
Female	17 (39.5%)	60 (28.7%)	
Presence of systemic disease, <i>n</i> (%)			
Hypertension	23 (53.5%)	30 (14.4%)	0.000*
Diabetes mellitus	11 (25.6%)	14 (6.7%)	0.000*
Coronary artery disease	9 (20.9%)	5 (2.4%)	0.000*
Education status, <i>n</i> (%)			
Illiterate	7 (16.3%)	18 (8.6%)	0.184***
Secondary school	29 (67.4%)	148 (70.8%)	
High school	7 (16.3%)	43 (20.6%)	

* $P < 0.01$.

** $P < 0.05$.

*** $P > 0.05$.

Table 3 Comparisons of the clinical characteristics of the neoplastic and traumatic SCI patients.

	Neoplastic <i>N</i> (%)	Traumatic <i>N</i> (%)	P
Impairment			0.513*
Tetraplegia	16 (37.2)	67 (32.1)	
Paraplegia	27 (62.8)	142 (67.9)	
AIS level on admission			0.000*
A	9 (20.9)	110 (52.6)	
B	12 (27.9)	29 (13.9)	
C	6 (14)	41 (19.6)	
D	16 (37.2)	29 (13.9)	
Level of injury			0.239***
Cervical	6 (14)	67 (32.1)	
Thoracic	32 (74.4)	107 (51.2)	
Lumbosacral	5 (11.6)	35 (16.7)	
Time to admission (days)			
Mean $\pm$ s.d.	161.2 ± 329.7	448.6 ± 1489.9	0.477***
Median (IQR)	97.5 (111.3)	73 (146.3)	

Abbreviations: SCI: Spinal cord injury; AIS: American Spinal Cord Injury Association Impairment Scale.

* $P < 0.01$.

** $P < 0.05$.

*** $P > 0.05$.

Table 4 Comparisons of the functional outcomes of the neoplastic and traumatic SCI patients.

	Neoplastic <i>n</i> = 43	Traumatic <i>n</i> = 209	P-value
Admission FIM, mean $\pm$ s.d.	69.3 $\pm$ 24.7	58.7 $\pm$ 18.9	0.059***
Median (IQR)	62 (31)	57 (19)	
Discharge FIM, mean $\pm$ s.d.	82.1 $\pm$ 25.1	74.02 $\pm$ 23.3	0.662***
Median (IQR)	76.5 (37.8)	74 (29.8)	
FIM gain, mean $\pm$ s.d.	12.9 $\pm$ 11.9	15.4 $\pm$ 15.2	0.017**
Median (IQR)	7 (11)	11 (20)	
FIM efficiency, mean $\pm$ s.d.	0.43 $\pm$ 0.72	0.36 $\pm$ 0.51	0.447***
Median (IQR)	0.23 (0.5)	0.21 (0.4)	
Rehabilitation LOS (days), mean $\pm$ s.d.	34.8 $\pm$ 41.03	60.2 $\pm$ 53.1	0.000*
Median (IQR)	22 (29)	49.5 (58.3)	
Bladder management independence, <i>n</i> (%)	22 (51.2%)	56 (26.8%)	0.002**
Admission FAC, <i>n</i> (%)	0–2 30 (69.8%) 3–5 13 (30.2%)	201 (96.2%) 8 (3.8%)	0.000*
Discharge FAC, <i>n</i> (%)	0–2 28 (65.1%) 3–5 15 (34.9%)	162 (77.5%) 47 (22.5%)	0.085***

Abbreviation: FIM, functional impedance measurement; SCI, spinal cord injury; LOS, length of stay.

**P* < 0.01.

***P* < 0.05.

****P* > 0.05.

symptomatic urinary tract infections with clinical symptoms such as fever or spasticity were included as data. Urinary tract infection and decubitus ulcer complications were significantly more common in the traumatic SCI group than the neoplastic group (*P* < 0.05). No statistically significant difference was found between the groups in terms of other complications (*P* > 0.05) (Table 5).

Table 5 Medical complications in neoplastic and traumatic SCI.

	Neoplastic <i>N</i> (%)	Traumatic <i>N</i> (%)	P-value
Heterotopic ossification	0	11 (5.3%)	0.124***
Joint contracture	0	12 (5.7%)	0.107***
Urinary tract infection	21 (48.8%)	145 (69.4%)	0.010**
Spasticity	16 (37.2%)	90 (43.1%)	0.479***
Deep vein thrombosis	3 (7%)	14 (6.7%)	0.947***
Pressure ulcers	5 (11.6%)	75 (35.9%)	0.002***

Abbreviation: SCI, spinal cord injury.

**P* < 0.01.

***P* < 0.05.

****P* > 0.05.

Discussion

The demographic characteristics, lesion features, functional results and complications of traumatic SCI and neoplastic SCI patients participating in the inpatient treatment program were evaluated and compared in this retrospective study. Neoplastic SCI patients formed 12.7% of the total SCIs and 33% of non-traumatic lesions in this study. In previous studies, neoplastic SCIs have been reported to constitute 10–26% of patients presenting at spinal rehabilitation units.

Traumatic SCI is more common in young adults while neoplastic SCI patients tend to be older with an age range of 50–70 years reported in the literature.^{10,31} In the current study, the mean age of the neoplastic group was 61 years, which was significantly higher than that of the traumatic group, which was consistent with the findings of other studies.^{3,8} While traumatic injuries are seen predominantly seen in males, cancer is less sex-specific with usually no sex distribution difference reported.³² The male ratio in neoplastic SCI has been reported as 56% by McKinley *et al.*³³ and 62% by Tan *et al.*¹⁰ In the current study, the neoplastic SCI group comprised 60.5% males and 39.5% females, with no significant difference between the neoplastic and traumatic groups in terms of sex.

Neoplastic SCI has been reported to be in general more commonly associated with incomplete injuries. The most common presentation for spinal cord tumors is epidural compression. Most patients present at the onset of weakness or bladder/bowel symptoms, and treatment with either radiation or surgery as well as chemotherapy may allow them to maintain incomplete injury status at presentation to the rehabilitation unit.⁸ Consistent with these findings in literature, incomplete injury was determined to be more common in the neoplastic group than in the traumatic group in the current study.^{3,8} There were more paraplegic patients than tetraplegic patients in both groups in our study. The thoracic region was injured in 74.4% of neoplastic SCI patients, which was consistent with the literature where spinal cord tumors typically appear in the thoracic region.^{32,34}

Ambulation is a very important functional parameter for quality of life and has a positive effect on survival in cancer patients.¹⁷ The FIM score on presentation has been suggested to be the most reliable predictive variable for survival.¹¹ Therefore, the FIM scale was used in the current study to evaluate the functional results of the patients. Several studies have reported consistent evidence of functional recovery with the implementation of a rehabilitation program in neoplastic SCI

patients.^{3,4,9,10} Most of these studies have been conducted on patients with metastatic compression. Parsch *et al.* reported that significant improvements have been made in terms of inpatient rehabilitation and personal care and ambulation of SCI patients with metastatic spinal cord compression.¹¹ In that study, the mean FIM score increased from 62 to 84 with an average of 50 days of rehabilitation. Another study of 26 patients (24 paraplegia, 2 tetraplegia cases) with metastatic SCI reported that functional improvement was determined in 17 patients while 9 showed no improvement or only minor improvement.¹⁵ In the current study, the mean FIM score in the neoplastic SCI group was 69.3 on admission and increased to 82.1 at discharge, again similar to findings in literature. A few studies have compared the functional results of neoplastic SCI patients after rehabilitation with traumatic SCI patients.^{3,8} These studies have differed regarding the etiology distribution in the neoplastic group. Primary spinal cord tumors with a low degree of malignancy such as primary ependymoma and schwannoma made up the majority with 76% of the patients in the neoplastic group in the study by Scivoletto *et al.*³ McKinley *et al.* reported that 85% of the neoplastic SCI lesions involved compression due to metastatic tumors.⁸ In the current study, 51.2% of the neoplastic group patients had low-grade malignant tumors (schwannoma, astrocytoma, ependymoma and meningioma) of the spine or spinal cord and 48.8% had primary malignant tumors such as metastases and multiple myeloma. The differences between the studies are probably due to different criteria used for admission to the rehabilitation unit.

Scivoletto *et al.* reported that the baseline functional and neurological values of the neoplastic SCI group were better than those of the traumatic group but the functional status of the two groups was similar at discharge, although the traumatic SCI patients had a higher Barthel Index efficiency score than the neoplastic patients.³ This was attributed to the better recovery rate of the traumatic group as they started with lower scores. McKinley *et al.* found similar FIM scores in traumatic and neoplastic SCI groups both on admission and at discharge.⁸ There was a significant increase in the FIM score in both groups. The FIM gain scores of the neoplastic group were significantly lower than those of the traumatic group but the FIM efficiency was similar in both groups. The current study results were similar to those of the McKinley *et al.* study.⁸ There was no difference between the groups in terms of admission FIM, discharge FIM and FIM efficiency but the FIM gain was lower in the neoplastic group. The similarity

between the lesion level and FIM scores on admission shows that these patients were admitted with similar functional deficiencies, which is an important factor when comparing two different populations undergoing rehabilitation. The similarity of the FIM discharge scores of the two groups shows that the groups gained similar benefits from rehabilitation. The lower FIM gain scores in the neoplastic group seem to be the result of the shorter LOS in this group, which is supported by the fact that there was no significant difference in FIM efficiency between the groups. In other words, there was no difference between FIM gain per unit time between the groups. Considering that life expectancy may be shorter in the neoplastic group, low FIM gain scores are an acceptable result. The important point is that the neoplastic SCI patients achieved the targeted functional gain in a shorter time.

The mean LOS in the hospital was significantly shorter in the neoplastic SCI patients than the traumatic group in the current study. Previous studies have also shown that patients with neoplastic SCI had a significantly shorter rehabilitation LOS than those with traumatic SCI.^{8,35} McKinley *et al.* based this result on the need to discharge neoplastic patients early due to their short life expectancy.⁸ Similar opinions have been given by other authors who have examined the outcome of patients with metastatic spinal cord lesions.¹⁵ In a study with non-traumatic SCI patients, LOS was found to be associated with etiology, and neoplastic SCI patients had shorter LOS than others.³⁶ The short hospital LOS of neoplastic SCI patients may be related to the higher rates of paraplegia cases with a thoracic location, the higher rates of incomplete lesions, and perhaps the lower life expectancy from the patients of the rehabilitation team in this group. The shorter life expectancy of patients with neoplastic SCI probably leads to different policies for these patients. Rehabilitation goals are mainly focused on functional independence and management of the bladder and bowels and less on social reintegration and occupational therapy.³⁷ On the other hand, the longer LOS of traumatic SCI patients may be due to other factors, such as the presence of complications or the need to wear an orthotic device affecting the time it takes to achieve functional independence. The LOS of traumatic SCI patients may be extended due to problems caused by the trauma itself and other medical complications. In the current study, a higher proportion of complete injury and higher frequency of pressure ulcers might have prolonged the LOS in the traumatic group.

In the study by Scivoletto *et al.* study, neoplastic and traumatic SCI groups had the same results for bladder

and bowel management.³ In the current study, the number of patients with independent bladder management at discharge was significantly higher in the neoplastic SCI group than in the traumatic group. The reason for this result seems to be higher AIS levels in patients in the neoplastic group. Nevertheless, these results show that a comprehensive bladder rehabilitation program can be used successfully as in traumatic SCI patients. Methods for bladder management in this patient population include timed voiding, intermittent catheterization, and indwelling catheters. Caution is required in patients with neutropenia and severe thrombocytopenia, and patients with neoplastic spine involvement may lack the ability to perform intermittent catheterization due to pain.¹⁸ Fattal *et al.* suggested that for some patients with an altered general state, a well-managed indwelling catheter might be a better solution than problematic self-catheterization.¹⁵ In the current study, there were no patients with neutropenia or thrombocytopenia. In addition, because this was a retrospective study, it was not possible to evaluate the effect of pain. In the future studies, bladder management can be evaluated in more detail with these aspects.

Independent of the etiology, the most common complications of SCI during the patients' lifetime are urinary tract problems, followed by pressure ulcers.³⁸ In accordance with the literature, the most common complications recorded in both groups were urinary tract problems. Urinary tract infections and decubitus ulcers were found to be more common in the traumatic SCI group during the rehabilitation process, but there was no difference between the groups in terms of other complications. The higher rate of complications in the traumatic SCI group could be attributed to the higher percentage of patients with complete injuries in this group, whereas most patients in the neoplastic group had incomplete injuries. Although incomplete injuries are predominant, approximately half of patients with metastatic spinal compression have been reported to die from SCI-related complications (such as pressure sores and pneumonia) rather than progression of neoplastic disease.¹³ Mobilization, special emphasis on skin care, and bowel and bladder management can be effective in preventing SCI complications and improving the survival of these patients.

In a study which compared traumatic and nontraumatic SCI patients, no statistically significant relationship was found between the Cumulative Illness Rating Scale (CIRS) scores of the patients and the FIM and Spinal Cord Independence Measurement (SCIM) scores.³⁹

In a study by Santos *et al.*, no significant correlation was found between the presence of medical comorbid

disease and the functional gain of patients with metastatic spinal cord compression.¹⁹ Similarly, in the current study, no statistically significant correlation was found between the FIM and FAS scores and comorbid diseases of hypertension, diabetes mellitus and coronary artery disease in the traumatic and neoplastic groups. In addition to systemic comorbid diseases, it is important to distinguish medical comorbidities associated with cancer diagnosis. Cancer-related fatigue is the most prevalent symptom experienced by individuals with cancer. With evaluation and appropriate treatment of organic factors, such as anemia and infection, are often easily correctable. However, other causes of fatigue must be considered, such as depression, and sedation caused by centrally acting drugs and pain medications.¹⁶ These patients may require supportive care and modifications of the rehabilitation care plan.¹⁸

This study had certain limitations, primarily that the population size of the two groups was different since fewer neoplastic SCI patients were admitted to the rehabilitation unit during the study period. Patients with primary tumors and metastatic compression were included to obtain a sufficiently large sample but it is possible that these two populations differed in the functional results obtained. Another limitation was that the study was retrospective. The admission of patients who meet certain criteria to the rehabilitation clinic may have caused bias. Including neoplastic SCI patients who had not been admitted to the rehabilitation unit in other studies may reveal more information about the results in these populations. Moreover, disease-specific outcome measures (SCIM, etc.) for SCI could have been used for functional assessment instead of FIM. Finally, the long-term functionality of the patients was not evaluated after discharge. Future studies investigating the outcome of these individuals are suggested and should include a larger sample size, documentation of associated comorbidities and long-term follow-up. Furthermore, studies examining whether re-hospitalization rate is higher in neoplastic SCI patients with shorter rehabilitation LOS can be planned.

In conclusion, neoplastic SCI patients who commonly present at rehabilitation units exhibit characteristics that are different from traumatic SCI patients. Despite the differences in demographic and lesion-related characteristics, neoplastic SCI patients achieve functional gains similar to those of traumatic patients in a shorter time. Rehabilitation should not be ignored when SCI symptoms are detected in these patients and the rehabilitation team should try to provide an effective rehabilitation service to neoplastic SCI patients despite the expected short survival.

Disclaimer statements

Funding This research received no specific funding from any agency in the public, commercial, or not-for-profit sectors.

Conflicts of interest The authors have no conflict of interest to declare.

ORCID

Sevgi İkbalı Afsar  <http://orcid.org/0000-0002-4003-3646>

Sacide Nur Saraçgil Cosar  <http://orcid.org/0000-0001-8306-463X>

Oya Umit Yemişçi  <http://orcid.org/0000-0002-0501-5127>

Hüma Bölük  <http://orcid.org/0000-0001-6771-3265>

References

- Ge L, Arul K, Mesfin A. Spinal cord injury from spinal tumors: prevalence, management, and outcomes. *World Neurosurg* 2019; 122:e1551–6. doi:10.1016/j.wneu.2018.11.099. PMID: 30471447.
- New PW, Sundararajan V. Incidence of non-traumatic spinal cord injury in Victoria, Australia: a population-based study and literature review. *Spinal Cord* 2008;46(6):406–11. doi:10.1038/sj.sc.3102152. PMID: 18071356.
- Scivoletto G, Lapenna LM, Di Donna V, Laurenza L, Sterzi S, Foti C, Molinari M. Neoplastic myelopathies and traumatic spinal cord lesions: an Italian comparison of functional and neurological outcomes. *Spinal Cord* 2011;49(7):799–805. doi:10.1038/sc.2011.6. PMID: 21321577.
- New PW, Reeves RK, Smith É, Eriks-Hoogland I, Gupta A, Scivoletto G, et al. International retrospective comparison of inpatient rehabilitation for patients with spinal cord dysfunction: differences according to etiology. *Arch Phys Med Rehabil* 2016;97(3): 380–5. doi:10.1016/j.apmr.2015.10.107. PMID: 26615143.
- Alizadeh A, Dyck SM, Karimi-Abdolrezaee S. Traumatic spinal cord injury: an overview of pathophysiology, models and acute injury mechanisms. *Front Neurol* 2019;10:282. doi:10.3389/fneur.2019.00282. PMID: 30967837; PMCID: PMC6439316.
- National Spinal Cord Injury Statistical Center. Spinal cord injury facts and figures at a glance. *J Spinal Cord Med* 2013;36(1):1–2. doi:10.1179/1079026813Z.000000000136. PMID: 23433327; PMCID: PMC3555099.
- Singh A, Tetreault L, Kalsi-Ryan S, Nouri A, Fehlings MG. Global prevalence and incidence of traumatic spinal cord injury. *Clin Epidemiol* 2014;6:309–31. doi:10.2147/CLEP.S68889. PMID: 25278785; PMCID: PMC4179833.
- McKinley WO, Huang ME, Tewksbury MA. Neoplastic vs. traumatic spinal cord injury: an inpatient rehabilitation comparison. *Am J Phys Med Rehabil* 2000;79(2):138–44. doi:10.1097/00002060-200003000-00005. PMID: 10744187.
- New PW, Marshall R, Stubblefield MD, Scivoletto G. Rehabilitation of people with spinal cord damage due to tumor: literature review, international survey and practical recommendations for optimizing their rehabilitation. *J Spinal Cord Med* 2017;40(2): 213–21. doi:10.1080/10790268.2016.1173321. PMID: 27088581; PMCID: PMC5430479.
- Tan M, New PW. Retrospective study of rehabilitation outcomes following spinal cord injury due to tumour. *Spinal Cord* 2012;50 (2):127–31. doi:10.1038/sc.2011.103. PMID: 21987063.
- Parsch D, Mikut R, Abel R. Postacute management of patients with spinal cord injury due to metastatic tumour disease: survival and efficacy of rehabilitation. *Spinal Cord* 2003;41(4):205–10. doi: 10.1038/sj.sc.3101426. PMID:12669084.
- Eriks I, Angenot E, Lankhorst G. Epidural metastatic spinal cord compression: functional outcome and survival after inpatient rehabilitation. *Spinal Cord* 2004;42(4):235–9. doi:10.1038/sj.sc.3101555. PMID:15060521.
- Ruff RL, Ruff SS, Wang X. Persistent benefits of rehabilitation on pain and life quality for nonambulatory patients with spinal epidural metastasis. *J Rehabil Res Dev* 2007;44(2):271–8. doi:10.1682/jrrd.2007.01.0006. PMID: 17551878.
- Tang V, Harvey D, Park Dorsay J, Jiang S, Rathbone MP. Prognostic indicators in metastatic spinal cord compression: using functional independence measure and Tokuhashi scale to optimize rehabilitation planning. *Spinal Cord* 2007;45(10):671–7. doi:10.1038/sj.sc.3102024. PMID:17228353.
- Fattal C, Gault D, Leblond C, Gossens D, Schindler F, Rouays-Mabit H, et al. Metastatic paraplegia: care management characteristics within a rehabilitation center. *Spinal Cord* 2009;47(2): 115–21. doi:10.1038/sc.2008.75. PMID:18542085.
- Raj VS, Lofton L. Rehabilitation and treatment of spinal cord tumors. *J Spinal Cord Med* 2013 Jan;36(1):4–11. doi:10.1179/2045772312Y.0000000015. PMID: 23433329; PMCID: PMC3555105.
- Fortin CD, Voth J, Jaglal SB, Craven BC. Inpatient rehabilitation outcomes in patients with malignant spinal cord compression compared to other non-traumatic spinal cord injury: a population based study. *J Spinal Cord Med* 2015;38(6):754–64. doi:10.1179/2045772314Y.0000000278. PMID: 25615237; PMCID: PMC4725809.
- Ruppert LM. Malignant spinal cord compression: adapting conventional rehabilitation approaches. *Phys Med Rehabil Clin N Am* 2017;28(1):101–14. doi:10.1016/j.pmr.2016.08.007. PMID: 27912991; PMCID: PMC5604850.
- Santos DZ, Leite ICG, Guerra MR. Functional status of patients with metastatic spinal cord compression. *Support Care Cancer* 2018;26(9):3225–31. doi:10.1007/s00520-018-4182-5. PMID: 29626262.
- Kirshblum SC, Waring W, Biering-Sorensen F, Burns SP, Johansen M, Schmidt-Read M, et al. Reference for the 2011 revision of the International Standards for Neurological Classification of spinal cord injury. *J Spinal Cord Med* 2011;34(6):547–54. doi:10.1179/107902611X13186000420242. PMID: 22330109; PMCID: PMC3232637.
- Hamilton BB, Granger CV, Sherwin FS, Zielezny M, Tashman JS. A uniform national data system for medical rehabilitation. In: Fuhrer MJ, (ed.) *Rehabilitation Outcomes: Analysis and Measurement*. Baltimore, MD: Brookes; 1987. p. 137–47.
- Ottensbacher KJ, Hsu Y, Granger CV, Fiedler RC. The reliability of the functional independence measure: a quantitative review. *Arch Phys Med Rehabil* 1996;77(12):1226–32. doi:10.1016/s0003-9993(96)90184-7. PMID: 8976303.
- Dodds TA, Martin DP, Stolov WC, Deyo RA. A validation of the functional independence measurement and its performance among rehabilitation inpatients. *Arch Phys Med Rehabil* 1993; 74(5):531–6. doi:10.1016/0003-9993(93)90119-u. PMID: 8489365.
- Hamilton BB, Laughlin JA, Fiedler RC, Granger CV. Interrater reliability of the 7-level functional independence measure (FIM). *Scand J Rehabil Med* 1994;26(3):115–19. PMID: 7801060.
- Alexander MS, Anderson KD, Biering-Sorensen F, Blight AR, Brannon R, Bryce TN, et al. Outcome measures in spinal cord injury: recent assessments and recommendations for future directions. *Spinal Cord* 2009;47(8):582–91. doi:10.1038/sc.2009.18. PMID: 19381157; PMCID: PMC2722687.
- Küçükdeveci AA, Yavuzer G, Elhan AH, Sonel B, Tennant A. Adaptation of the functional independence measure for use in Turkey. *Clin Rehabil* 2001;15(3):311–19. doi:10.1191/026921501676877265. PMID: 11386402.
- Stineman MG, Goin JE, Hamilton BB, Granger CV. Efficiency pattern analysis for medical rehabilitation. *Am J Med Qual* 1995;10(4):190–8. doi:10.1177/0885713X9501000405. PMID: 8547798.
- Holden MK, Gill KM, Magliozzi MR, Nathan J, Piehl-Baker L. Clinical gait assessment in the neurologically impaired: reliability and meaningfulness. *Phys Ther* 1984;64(1):35–40. doi:10.1093/ptj/64.1.35. PMID: 6691052.
- Holden MK, Gill KM, Magliozzi MR. Gait assessment for neurologically impaired patients. *Standards for outcome assessment*.

- Phys Ther 1986;66(10):1530–9. doi:10.1093/ptj/66.10.1530. PMID: 3763704.
- 30 Viosca E, Martínez JL, Almagro PL, Gracia A, González C. Proposal and validation of a new functional ambulation classification scale for clinical use. Arch Phys Med Rehabil 2005;86(6):1234–8. doi:10.1016/j.apmr.2004.11.016. PMID: 15954065.
- 31 Helweg-Larsen S. Clinical outcome in metastatic spinal cord compression. A prospective study of 153 patients. Acta Neurol Scand 1996;94(4):269–75. doi:10.1111/j.1600-0404.1996.tb07064.x. PMID: 8937539.
- 32 Sørensen S, Børgesen SE, Rohde K, Rasmusson B, Bach F, Bøge-Rasmussen T, et al. Metastatic epidural spinal cord compression. results of treatment and survival. Cancer 1990;65(7):1502–8. doi:10.1002/1097-0142(19900401)65:7<1502::AID-CNCR2820650709>3.0.CO;2-D. PMID: 2311062.
- 33 McKinley WO, Conti-Wyken AR, Vokac CW, Cifu DX. Rehabilitative functional outcome of patients with neoplastic spinal cord compressions. Arch Phys Med Rehabil 1996;77(9):892–5. doi:10.1016/s0003-9993(96)90276-2. PMID: 8822680.
- 34 Chaichana KL, Woodworth GF, Sciubba DM, McGirt MJ, Witham TJ, Bydon A, et al. Predictors of ambulatory function after decompressive surgery for metastatic epidural spinal cord compression. Neurosurgery 2008;62(3):683–92; discussion 683–92. doi: 10.1227/01.neu.0000317317.33365.15. PMID: 18425015.
- 35 Guo Y, Young B, Palmer JL, Mun Y, Bruera E. Prognostic factors for survival in metastatic spinal cord compression: a retrospective study in a rehabilitation setting. Am J Phys Med Rehabil 2003;82(9):665–8. doi:10.1097/01.PHM.0000083662.85497.1F. PMID: 12960907.
- 36 Vervoordeldonk JJ, Post MW, New P, Clin Epi M, Van Asbeck FW. Rehabilitation of patients with nontraumatic spinal cord injury in the Netherlands: etiology, length of stay, and functional outcome. Top Spinal Cord Inj Rehabil 2013;19(3):195–201. doi:10.1310/sci1903-195. PMID: 23960703; PMCID: PMC3743969.
- 37 Pataria A, Crevenna R. Challenges in rehabilitation of patients with nontraumatic spinal cord dysfunction due to tumors: a narrative review. Wien Klin Wochenschr 2019;131(23-24):608–13. doi:10.1007/s00508-019-1528-z. PMID: 31312916; PMCID: PMC6908546.
- 38 Güneş S, Kurtaiş Aytür Y, Gök H, Kutlay Ş, Güneş N, Sonel Tur B, Küçükdeveci AA. Demographic and clinical profile and functional outcomes of patients with spinal cord injury after rehabilitation. Turk J Phys Med Rehab 2017;63(1):66–71. doi: 10.5606/tftrd.2017.877.
- 39 Sarı A, Paker N. Is comorbidity related to the independence of patients with spinal cord injury? J Surg Med 2020;4(4):301–4. doi: 10.28982/josam.717855.