It is Never Too Late to Start: Functional Outcomes Following a Delayed Comprehensive Rehabilitation Program for Traumatic Spinal Cord Injury Patients

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ABSTRACT

Background: The incidence of spinal cord injury (SCI) varies but is estimated at 10–83 per million per year with most injured under the age of 25 years. Rehabilitation constitutes an important element of management of traumatic SCIs. However, due to lack of resources and awareness, this aspect is often neglected in developing countries. This results in poor functional outcome.

Objectives: The study was conducted to assess functional improvement, in the form of self-care, transfer, and mobility pre and post a multipronged rehabilitation program in patients with SCI. The study also evaluated the impact of rehabilitation program in achieving different levels of independence, in SCI patients.

Materials and methods: A prospective observational study carried out over the period of 1 year at a tertiary teaching hospital. Twenty patients with traumatic SCIs were included in the study and underwent a multipronged rehabilitation program. The program was specifically designed and tailored to ensure bedside mobility initially and then progressing to transfer and ambulatory training, and activity of daily livings (ADLs).

Results: All patients showed improvements in functional outcome. The spinal cord independence measure (SCIM) showed a significant improvement in all areas of self-care, sphincter management, indoor and outdoor mobility. Ambulation status improved as a result of the program.

Conclusion: A well-designed rehabilitation program has a significant impact on the functional outcome of patients with SCI. Rehabilitation should be promoted even if delayed in such patients.

Keywords: Neglected, Rehabilitation, Spinal cord injury.

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INTRODUCTION

Spinal cord injuries (SCIs) are getting increasingly common in society, with road traffic accidents being the most common cause.[1,2] With improving trauma care and newer spinal fixation techniques becoming more accessible, the picture is changing in term of neurological outcome, but still SCIs are associated with a high mortality and morbidity. The term "spinal cord injury" refers to damage to the spinal cord resulting from trauma or from disease or degeneration.[3] According to National Spinal Cord Injury Statistical Center (NSCISC), incidence of SCI in the United States is 54 cases per one million people.[4] It varies globally but is estimated at 10–83 per million per year with most injured under the age of 25 years.[5] The peak incidence of SCI is among young adults, who are most at risk of having motor vehicle accidents. This is followed by fall from height as the second most common cause of SCI.[1,5] It causes variable level of functional disability in patients, and has significant physical, psychological, social, and economical debility. Spinal cord injury is classified by American Spinal Cord Injury Association into four grades; grade I being complete type of injury with no sensory or motor function preserved below neurological level. Grade II is defined as preserved sensory function below neurological level including S4 to S5. Grade III and Grade IV are incomplete motor type of injury, where partial motor function is preserved in key group muscles.[6] Incidence of complete SCI is reported to be nearly 45%.[4]

Comprehensive inpatient rehabilitation program is required for patients with SCI immediately after injury for optimal recovery and for integration of such patients back into society and to ensure return to preinjury work status.[7] Many technological advances

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including robotic locomotor training have been propagated; however, the cost is prohibitive. Also, a recent Cochrane review did not find any significant advantage of robotic locomotor training over other techniques for walking improvement in SCI patient.[8] In this study, we have focused on using conventional training techniques for gaining maximal functional independence in patient with SCIs. In the current scenario in a developing country

like India, many patients with SCI are unable to access spinal rehabilitation promptly because of lack of availability of such facility or lack of awareness on the part of the care providers regarding the need for providing such rehabilitation programs. Others also have their rehabilitation delayed in hope of spontaneous neurological recovery. With increasing awareness, the need for such comprehensive rehabilitation programs is being recognized; however, rehabilitation centers equipped to cater to the needs of patients with SCI are still few in number and prompt and proper rehabilitation is not universally available and accessible to all in society especially in peripheral areas. With these issues in mind, the study was designed to study the effect of a structured and comprehensive rehabilitation program on the functional outcome of patients with SCIs. To our knowledge, not many studies have been reported in India, which assess the improvement following rehabilitation in functional status of patients with chronic SCIs.

This study is relevant as SCI leads to significant neurological deficit that ultimately affects and limits the functional activities including activity of daily living (ADL), transfer, and locomotive capabilities. A systematic review performed by Simpson et al. in 2012 had identified motor function (arm and hand in tetraplegic and mobility in paraplegic cases), bladder and bowel function, and sexual function as top functional priorities in patients with SCIs.[9] Locomotive training becomes an essential goal for rehabilitation if the patient reports it as their primary complaint. Promotion of patient to fulfil his/her appropriate role in community is an essential part of rehabilitation.[10]

Specific Objectives

- To study functional improvement, in the form of self-care, transfer, and mobility following rehabilitation in patients of SCI.
- To study the impact of rehabilitation program, in achieving different levels of independence, in SCI patients.

MATERIALS AND METHODS

This study has been conducted in the Department of Physical Medicine and Rehabilitation and Orthopaedics at AIIMS, Jodhpur. The study was conducted over the period of 1 year in 2016 to 2017.

The study design was prospective observational case series. The primary aim of the study was to assess the functional improvement in patients with SCI undergoing rehabilitation. The primary outcome score used for this was the spinal cord independence measure (SCIM). This scale is SCI specific and is widely used and validated for the purpose of assessment of functional improvement.

Inclusion Criteria

Age more than 15 years and less than 60 years.

Diagnosed case of post-traumatic SCI with paraplegia and quadriplegia or paresis.

Both male and female patients were included.

Exclusion Criteria

- Age less than 15 years and more than 60 years.
- Associated traumatic brain injury along with SCI. Any patient not willing to be part of study.
- Patients with associated cardiopulmonary compromise with decreased work capacity.

The study was commenced after obtaining due ethical clearance from the Institutional Ethics Committee. All patients presenting to the outpatient department were assessed and if they fit the criterion they were included in the study. During study period, around 20 patients reported meeting inclusion criteria were included in the study by consecutive sampling method.

The patients were assessed for spinal cord independence measure version III score (SCIM III) including level and type of injury at the time of initial contact with the patient. Spinal cord independence measure scale was developed specifically for the population with SCIs and measures functional change post-rehabilitation. Spinal cord independence measure can be administered by observation or interview method and studies have noted that both methods are comparable.[11] Spinal cord independence measure is a valid instrument for SCI patient with a good inter-rater reliability. Spinal cord independence measure version III score was found to be more responsive to changes than Functional Independence Measure (FIM) in the subscales of respiration and sphincter management and mobility indoors and outdoors.[12]

After initial assessment, rehabilitation program is customized for each patient beginning with initial goal setting. At the start of the rehabilitation program, medical issues are taken care of, viz., urinary tract infection (UTI), pressure ulcer management, and orthostatic hypotension. Simultaneously, the patient was put on bedside mobility, exercises and stretching exercises to prepare patient for the next level out of bed activities, such as ADLs, transfer training, and ambulation training. This progression plan was common to all patients. Patient functional score was calculated again at the time of discharge. To reduce the observer error, recording of functional score was performed by the same evaluator both at the time of admission and at discharge in all patients.

The pretreatment and posttreatment scores were tabulated and compared by paired t-test to check for statistical significance. Statistical software used for analysis was SPSS version 21 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, New York: IBM Corp.).

RESULTS

Twenty subjects were included in the study out of which 18 had paraplegia while 2 subjects were suffering from quadriplegia. The two patients who were suffering from quadriplegia both had C8 neurological level. Among the 18 patients who had paraplegia, 7 patients had a neurological level between D1 and D6 and the rest of the 11 patients had neurological level between D7 and D12. Out of 20 patients, 11 patients had a complete lesion while the rest of the 9 patients had an incomplete type of neurological injury (Table 1).

The mean age of patients included in the study was 37.5 years with the median age of 37 (range 18–60) years. The mean duration of SCI at the time of admission was 8.5 months. None of the patients had undergone primary rehabilitation in the acute

Table 1: Demographic data for the patients included in the study

S.no.		No. of patients (n = 20)
1	Type of injury	
	Complete	11
	Incomplete	9
2	Gender distribution (n = 20)	
	Male	16
	Female	4

phase of treatment for SCI. The average length of in-hospital stay for rehabilitation of 43 days ranging from 30 to 60 days (Table 2).

The SCIM scale is a composite scale measuring total 17 items under different subscale categories of self-care, bed mobility with toilet transfer, indoor and outdoor mobility, respiration, and sphincter management. Items under self-care include feeding, bathing, dressing, and grooming. The mean score of self-care items was 7.8 at the time of admission which improved to 15 at the time of discharge. This improvement was found to be statistically very significant on performing the paired t-test with value of $t = 9.533$ with p value < 0.00001. Items under sphincter management include bladder management, bowel management, use of toilet, and respiration. The mean score for sphincter management at the time of admission was 15.9 which had improved to 28.6 at the time of discharge. This improvement was also statistically significant on performing the paired t-test with $t = 12.97$ and $p < 0.00001$ (Table 3).

The items included under bed and toilet mobility are bed mobility, transfer from bed to wheelchair, and transfer from wheelchair to toilet. Mean score for this was 1.65 which had significantly improved to 7.2 with t value of 11.956 ($p < 0.00001$).

Mobility (indoor and outdoor) items include indoor mobility with or without the need of orthosis, cane, or wheelchair. Mobility for moderate distance, i.e., 10–100 m or mobility for longer distance, i.e., more than 100 m. This mobility may be with use of orthosis with support of cane or crutches or may be wheelchair ambulation. Mobility items also include stairs management, wheelchair to car transfer, and transfer from ground to wheelchair. The mean score of indoor and outdoor mobility items at the time of admission was 1.5 which had showed significant improvement with the mean of 8.9 at the time of discharge with t value being $t = 7.259$.

Final total score of SCIM scale comprises 100 points. The mean total score of SCIMs at the time of admission was 26.7 with the median of 23 points. The mean total score at the time of discharge was 59.3 with the median of 58. This change in mean and median total score had showed significant improvement with t value $= 15.6$ and p value being <0.00001.

Level of ambulation at the point of admission: None of the participants of the study were ambulatory with the help of orthosis at the time of admission. Only four patients were wheelchair ambulatory and the rest of the patients were bedbound since their discharge from acute phase of their injury. The patients were dependent for the most of self-care, bowel, and bladder management-related activities, but the transfer and ambulation were affected the most. At the time of discharge, 3 of the 20 patients achieved community ambulatory capabilities; all 3 of them had lower dorsal injuries with incomplete lesions. Four patients achieved household ambulation capabilities and ambulation to moderate distance, while another three patients achieved exercise ambulation category (ambulation in restricted environment and under supervision). The remaining nine patients were able to maneuver wheelchair for ambulation of which one patient required a powered wheelchair for ambulation.

DISCUSSION

In this study, the mean age of the patients enrolled was 37.5 years at the time of the initial injury. Males vastly outnumbered females with a ratio of 9:1. Overall, 90% of the patients enrolled suffered from paraplegia and 55% had complete injuries.

According to NSCISC, the average age of patients with traumatic SCIs is around 43 years[2] while according to the study performed by Chhabra and Arora in India it is 34.4 years,[1] which is comparable to our study. Lately, there is an increasing trend in the average age of patients presenting with traumatic SCIs.[2] This trend can be attributed to an increase in the active life span with a larger number of working population working longer years in high-risk jobs. The trend also correlates with an increase in the number of motor vehicle and related accident leading to a higher number of accidents involving people in middle and old age.

The mean duration of in-hospital stay for rehabilitation was around 43 days which is similar to the data published from NSCISC Alabama.[2] Venkatachalam et al.[7] reviewed the length of stay for rehabilitation in SCI and found significant decline in the length of stay from 98 days in 1973 to 37 days in 2005 to 2008.[2,7] The biggest drop in the length of stay has undoubtedly come in the acute care setup due to the availability of better acute care setup, modern implants, surgical techniques, and postoperative care. It has also led to a decrease in the associated morbidity and mortality.[2] The time required for rehabilitation is more than taken for acute care in SCI. It is because rehabilitation is a facilitation process of patient into premorbid lifestyle, and it happens gradually in a stepping up manner and depends not only on the patients' participation in rehabilitation program but also on the duration following the injury and the type of rehabilitation program. Length of stay for rehabilitation has remained to around 34 days according to the data reported by NSCISC.[2] In our study, average length of stay was on the higher side. This can plausibly be linked to the fact that our

Table 2: Data showing patient mean age, average duration of disease, and length of stay in hospital

Parameter (n = 20)	Age at onset of SCI (in years)	Average duration of SCI (in months)	Length of stay in hospital (in days)
Mean	37.5	8.55	43.4
Standard deviation	14.11	2.96	7.5
Range (min–max)	18–60	3–12	30–60
Median (50th percentile)	37	8	43

Table 3: Comparison of mean spinal cord independence measure scale pre-treatment and post-treatment (n = 20)

Component of SCIM (subscale)	Max. score	Admission		Discharge		Paired t-test
		Mean	Median	Mean	Median	t value (p value)
Self-care items	20	7.8	7	15.05	16.5	$t = 9.533$ ($p < 0.00001$)
Respiration and sphincter management	40	15.9	15	28.6	30	$t = 12.972$ ($p < 0.00001$)
Mobility (bed and toilet)	10	1.65	2	7.2	7	$t = 11.956$ ($p < 0.00001$)
Mobility (indoor, outdoor)	30	1.5	2	8.9	6.5	$t = 7.259$ ($p < 0.00001$)
Total score	100	26.7	23	59.2	58	$t = 15.629$ ($p < 0.00001$)

patients presented to us relatively late from the time of injury having had no or minimal rehabilitation in the interim. Also, 6 out of 20 patients included in the study were having pressure ulcer varying from grade II to grade IV degree, while 4 patients were having UTI at the time of inclusion into the program. The longer duration of stay also reflects the fact that we had to manage these medical issues as well as plan the rehabilitation program accordingly. The fact that most of them had not had any formal rehabilitation before enrolling with us also led to some compliance issues in the beginning which also led to an increase in the length of stay.

The functional parameters we have studied were self-care, indoor mobility, outdoor mobility, and sphincter management.

Anderson et al.[11] have reviewed and compared different outcome measures to document functional outcome had found that the SCIM is a scale developed specifically for people with SCI to evaluate their performance of ADL and to make functional assessments of this population sensitive to change; hence, we have used SCIM and its subscale to document functional improvement among the pre- and post-group.

There was a significant gain observed among the preadmission and post-discharge score of self-care items, which includes feeding, bathing, grooming, and toilet care. There was also significant difference in pre- and post-score sphincter management, bed and toilet mobility, and indoor–outdoor mobility items. Scivoletto et al.[12] studied the functional outcome in early (<30 days), mid (30–60 days), and delayed rehabilitation group (>60 days) and found that similar neurological recovery was present in all three groups but better ADL improvement and high Barthel index score in early rehabilitation group. Similar study performed by Sumida et al.[13] in a retrospective analysis studied early, mid, and delayed group where delayed rehabilitation group was comprised of patients undergoing rehabilitation after more than 6 months of SCI. They also found better functional improvement in early rehabilitation group, in the form of better FIM score. We have not compared between early and delayed group as all our patients were having spinal injury for more than 3 months, with average being 8.5 months, thus they have all undergone delayed rehabilitation. We have noted significant improvement in all subscale of SCIM including change in total score. This signifies the importance of rehabilitation program, even if instituted late can improve the functional outcome of patients with SCI.[14] This late gain can be attributed to the comprehensive and structured nature of the program and the fact that it was patient centered and customized to the need of the patients lead to a better participation from our patients in rehabilitation program. Most of the patients admitted for rehabilitation were bedbound at home for longer periods of time, since the time of injury our rehabilitation program has provided them with an increased function and an improved chance at leading to a better functional quality of life.

Maximum improvement was observed among the self-care, i.e., feeding, bathing, dressing, and grooming as most of the patients were fully independent in self-care items at the end of the treatment. Also, in items of bed and indoor mobility, i.e., bed mobility, bed to wheelchair transfer, and wheelchair to toilet transfer as most of the patients achieved independence in these items and achieved mean score 7.2 out of 8 at the end of treatment.

All our patients except one were able to use manual wheelchair independently who required power wheelchair for maneuvering. This patient was case of quadriplegia with complete SCI at cervical level. This gain was significant as only four patients were able to use wheelchair at the time of admission and the rest of

the patients were bedbound since the time of their injury. This represents a considerable shift in their functional status and lead to an improved social life, interactions, and self-esteem. Out of 19 patients who were able to maneuver wheelchair, 3 patients were able to achieve community ambulation capabilities, 4 patients were able to achieve ambulation in home environment, 3 patients were able to achieve exercise ambulation category, and the rest of the 9 patients were wheelchair ambulatory at full time. Again, this gain in their ambulation category was very significant considering their functional status at the time of admission.

Authors' Conclusion

A structured and comprehensive rehabilitation program improves the functional outcome in patients presenting late with traumatic SCIs. Even though early institution of rehabilitation provides best outcomes, yet delayed rehabilitation has also shown marked improvement in patients' functional outcome. The program needs to be tailored with specific ambulatory and functional goals determined in the initial assessment of the patients, to ensure compliance and better results.

Acknowledgments

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