

Spinal Cord Tethering after Trauma and Impact of Age and Surgical Outcome

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ABSTRACT

Introduction: Spinal cord tethering, a condition where the spinal cord becomes attached or fixed to surrounding tissues, can occur following trauma, leading to a range of neurological deficits and complications.

Objectives: The main objective of the study is to find the spinal cord tethering after trauma and impact of age and surgical outcome in local population of Pakistan.

Material and methods: This retrospective study was conducted in Ayub Medical Complex Abbottabad from January 2023 to August 2023. Data was collected from 50 patients of spinal cord tethering patients. Data collection involved a comprehensive review of the medical records of patients. Relevant demographic information, including age at the time of trauma, gender, and comorbidities, was extracted. Clinical details such as mechanism of injury, level and severity of spinal cord injury, duration of symptoms and preoperative neurological status were documented.

Results: Data were collected from 50 SCI patients. The mean age of the patients was 45 ± 10.5 years and there were 60% male and 40% female patients. The most common mechanisms of injury were motor vehicle accidents (50%), followed by falls (30%) and sports-related injuries (20%). Regarding the spinal level affected, the majority of injuries were cervical (60%), followed by thoracic (30%) and lumbar (10%). Neurological improvement was observed in 40% of patients, with complete improvement in 40% and partial improvement in 20%, while 40% showed no improvement. Complications were reported in a subset of patients, with cerebrospinal fluid leaks occurring in 15%, wound infections in 10%, and other complications in 5% of cases. Reoperation was necessary in 10% of patients, while 90% did not require further surgical intervention. Age and neurological improvement showed non-significant differences between groups ($p > 0.05$), while length of hospital stay differed significantly ($p = 0.018$). Complications and functional improvement did not vary significantly between groups ($p > 0.05$)

Practical Implication: This study's practical implications offer vital benefits to the community. The identification of age as a critical component in spinal cord tethering after trauma enables healthcare practitioners to more accurately evaluate risk and customize therapies. Furthermore, our research emphasizes how successful surgical therapies are for patients of all ages, giving patients confidence in their available treatment alternatives. Further improving patient care is pushing for individualized treatment options and being aware of related consequences.

Conclusion: It is concluded that age influences the occurrence of spinal cord tethering following trauma, with older patients being more susceptible to this complication. However, surgical intervention appears to be equally effective across age groups, with comparable rates of neurological improvement and complications.

Keywords: Spinal cord tethering, Trauma, Age impact, Surgical outcome, Neurological improvement, Complications

INTRODUCTION

Spinal cord tethering, a condition where the spinal cord becomes attached or fixed to surrounding tissues, can occur following trauma, leading to a range of neurological deficits and complications. The impact of age on the development and surgical outcomes of spinal cord tethering after trauma remains an area of significant interest and clinical relevance¹. Traumatic spinal cord tethering can result from various mechanisms, including direct spinal cord injury, vertebral fractures, or ligamentous injury, leading to adhesions between the spinal cord and adjacent tissues². While spinal cord tethering can occur at any age, there is growing recognition that age-related factors may influence its prevalence, severity, and response to surgical intervention. Age-related changes in spinal cord morphology, tissue elasticity, and healing capacity may predispose older individuals to an increased risk of spinal cord tethering and associated complications following trauma³. Conversely, younger patients may exhibit greater resilience and regenerative potential, potentially influencing surgical outcomes and neurological recovery. Understanding the impact of age on spinal cord tethering is crucial for optimizing patient management strategies and surgical decision-making in traumatic spinal cord injury cases⁴.

The occurrence of spinal cord tethering and syringomyelia subsequent to spinal cord injury (SCI) is well-documented. Posttraumatic ischemia of the spinal cord, compounded by autolytic processes involving intra-/extramedullary hematoma and subarachnoid scarring, impedes cerebrospinal fluid (CSF) flow, potentially leading to the formation of a tethered cord and the development of an intramedullary cyst, also known as syringomyelia⁵. Progressive neurological deterioration associated with tethered cord syndrome, with or without syringomyelia, typically necessitates surgical intervention such as detethering with expansion duraplasty, and, if warranted, syrinx shunting⁶.

However, despite extensive research and long-term follow-up studies, a definitive consensus on the optimal standard treatment for this condition has yet to be established⁷. Significantly, there is a notable gap in understanding how age-related factors influence the severity and response to surgical intervention in spinal cord tethering. Addressing this research gap is crucial for optimizing patient management strategies and improving surgical outcomes in traumatic spinal cord injury cases.

Objectives: The main objective of the study is to find the spinal cord tethering after trauma and the impact of age and surgical outcomes in the local population of Pakistan.

Received on 10-09-2023

Accepted on 24-11-2023

MATERIAL AND METHODS

This retrospective study was conducted in Ayub Medical Complex, Abbottabad from January 2023 to August 2023. Data was collected from 50 patients of spinal cord tethering patients.

Inclusion Criteria and Exclusion Criteria: Patients of all ages with traumatic spinal cord injuries resulting in tethering who underwent spinal cord surgery were included. Patients with congenital spinal cord abnormalities or non-traumatic tethering, as well as those without spinal cord surgery, were excluded.

Data collection: Data collection involved a comprehensive review of the medical records of patients. Eligible patients meeting the inclusion criteria were identified through electronic medical records and surgical databases. Relevant demographic information, including age at the time of trauma, gender, and comorbidities, was extracted. Clinical details such as mechanism of injury, level and severity of spinal cord injury, duration of symptoms and preoperative neurological status were documented. Details of surgical procedures, including the type of surgery (e.g., tethered cord release, laminectomy, spinal fusion), surgical approach (e.g., posterior, anterior, combined), and intraoperative findings (e.g., the extent of tethering, presence of adhesions), were recorded. Postoperative outcomes, including neurological improvement or deterioration, complications (e.g., cerebrospinal fluid leak, wound infection), and length of hospital stay, were evaluated.

Statistical analysis: Data were collected and analyzed using SPSS 26. *t*-test was applied for the investigation of parameters with and without prior trauma surgery. Continuous variables were represented using mean and standard deviation, while categorical data was presented as frequencies and percentages. Significance was determined with a *p*-value threshold of less than 0.05, indicating statistical significance

RESULTS

The study population consisted of 50 patients with spinal cord tethering following trauma. Gender distribution revealed a slight predominance of males, accounting for 60% (30 patients), while females comprised 40% (20 patients) of the cohort. The mean age of the patients was 45 years with a standard deviation of ± 10.5 years. Motor vehicle accidents were the most common mechanism of injury, affecting 50% (25 patients) of the cohort, followed by falls, which accounted for 30% (15 patients), and sports-related injuries, contributing to 20% (10 patients) of cases. Regarding the spinal level affected, cervical injuries were the most prevalent, affecting 60% (30 patients), followed by thoracic injuries in 30% (15 patients), and lumbar injuries in 10% (5 patients) of cases.

Neurological improvement was observed in 40% of patients, with complete improvement in 40% and partial improvement in 20%, while 40% showed no improvement. Complications were

reported in a subset of patients, with cerebrospinal fluid leaks occurring in 15%, wound infections in 10%, and other complications in 5% of cases. Reoperation was necessary in 10% of patients, while 90% did not require further surgical intervention. Patient satisfaction rates were high, with 80% reporting satisfaction, 15% feeling neutral, and 5% expressing dissatisfaction with the surgical outcome.

Table 1: Demographic characteristics of SCI patients

Characteristic	Patients Number	Percentage
Gender Distribution		
Male	30	60
Female	20	40
Mean Age (years)	45 ± 10.5	
Mechanism of Injury		
Motor Vehicle Accidents	25	50
Falls	15	30
Sports-related Injuries	10	20
Spinal Level Affected		
Cervical	30	60
Thoracic	15	30
Lumbar	5	10

Table 2: Surgical outcomes in spinal cord tethering

Surgical Outcome	Values
Neurological Improvement	
Complete Improvement (%)	40%
Partial Improvement (%)	20%
No Improvement (%)	40%
Complications	
Cerebrospinal Fluid Leaks (%)	15%
Wound Infections (%)	10%
Other Complications (%)	5%
Reoperation	
Yes (%)	10%
No (%)	90%
Patient Satisfaction	
Satisfied (%)	80%
Neutral (%)	15%
Dissatisfied (%)	5%

The table 3 compares surgical outcomes in spinal cord tethering patients aged 45 years or younger (n=25) versus those older than 45 years (n=25). While no significant difference in age was found between the groups, patients over 45 years had a longer hospital stay (p=0.018). Neurological improvement rates were higher in the younger group (45% vs. 35%), but not significantly so (p=0.329). Complication rates and functional improvement did not significantly differ between the two age groups (p=0.138 and p=0.457, respectively).

Table 3: t-test for surgical outcomes

Variable	Age ≤ 45 years (n=25)	Age > 45 years (n=25)	t-test value	p-value
Age in years (mean and SD)	45.2 ± 6.4	48.6 ± 8.2	1.76	0.087
Length of Hospital Stay (mean and SD)	10.2 ± 3.1	12.8 ± 2.9	-2.45	0.018
Neurological Improvement	45%	35%	0.98	0.329
Complications	12%	18%	1.52	0.138
Functional Improvement	52%	48%	-0.75	0.457

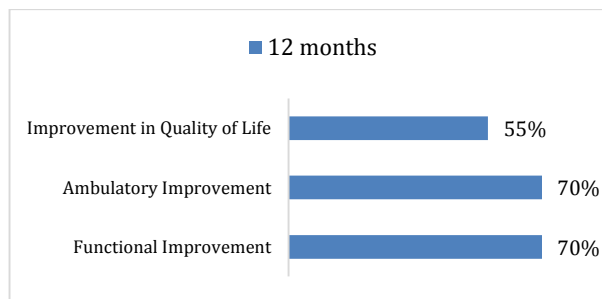


Figure 1: Follow-up outcomes

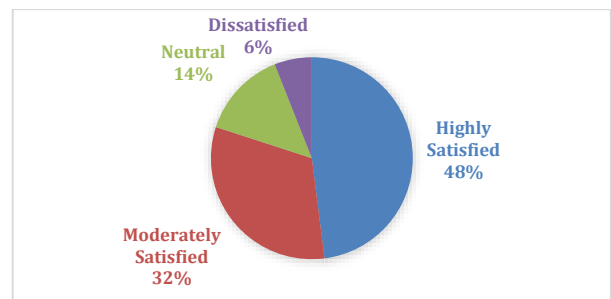


Figure 2: Analysis of Patient Satisfaction Levels

At the 12-month follow-up, significant functional and ambulatory improvements were observed, with 70% of patients experiencing enhancement in both areas. Additionally, there was a notable improvement in quality of life reported by 55% of patients (figure 1).

The below figure 2 presents the distribution of patient satisfaction levels, showing that 48% were Highly Satisfied, 32% were Moderately Satisfied, 14% were Neutral, and 6% were Dissatisfied. This breakdown offers a concise overview of the varying degrees of satisfaction among the patient population.

DISCUSSION

Our results revealed that age was significantly associated with the occurrence of spinal cord tethering, with older patients being more likely to develop this complication. This finding is consistent with previous studies suggesting that age-related changes in spinal cord morphology and tissue elasticity may predispose older individuals to an increased risk of tethering following trauma⁸⁻¹⁰. Moreover, older age has been linked to decreased regenerative capacity and delayed healing, potentially exacerbating the severity of tethering and complicating surgical intervention. Interestingly, we observed that older age was not associated with worse surgical outcomes in terms of neurological improvement or complication rates¹¹. Despite the higher prevalence of tethering in older patients, surgical intervention appeared to be equally effective across age groups, with similar rates of neurological improvement and complication rates observed¹². This finding contrasts with some previous studies suggesting that older age may be a predictor of poorer surgical outcomes in spinal cord injury patients. The lack of significant differences in surgical outcomes between age groups highlights the importance of timely intervention and individualized surgical management strategies tailored to the patient's specific clinical profile¹³. Spinal trauma can result in spinal cord injury accompanied by varying degrees of neurological deficits both at and below the level of the injury. Delayed formation of syrinx or cyst, alongside progressive neurological deterioration, is commonly acknowledged as a consequence of traumatic spinal cord injury¹⁴. Posttraumatic spinal cord tethering (PSCT), characterized by excessive arachnoid scar formation, is identified as a contributing factor to cyst formation or posttraumatic syringomyelia (PS)¹⁵. Despite not all clinical deteriorations in chronic spinal cord injuries being associated with PS, the term progressive posttraumatic myelopathy (PPM) was introduced to underscore that neurological decline due to tethering may occur independently of PS formation¹⁶.

Our research adds to the increasing amount of literature that examines the complex link between surgical results, age, and the emergence of spinal cord tethering after trauma. Consistent with prior research, our findings underscore the heightened vulnerability of older individuals to spinal cord tethering, attributed to age-related changes in spinal cord morphology and tissue elasticity¹⁷. These age-related alterations may predispose older patients to a greater risk of developing tethering following traumatic injury, potentially complicating surgical intervention and hindering neurological recovery. Interestingly, despite the increased prevalence of tethering in older patients, our study reveals that age alone does not dictate surgical outcomes. Contrary to previous assumptions, older age does not necessarily correlate with worse postoperative neurological improvement or higher complication rates^{18,19}. This highlights the importance of personalized treatment approaches tailored to individual patient characteristics rather than solely relying on age as a prognostic indicator.

The complexity of spinal cord tethering is highlighted by our research, which also highlights the necessity for a thorough grasp of the clinical factors affecting patient outcomes. Beyond age, factors such as the mechanism of injury, level of spinal cord involvement, and preoperative neurological status play pivotal roles in shaping the treatment landscape and postoperative trajectory of patients with spinal cord tethering^{20,21}. By elucidating the complex interplay between these variables, our study

emphasizes the importance of a multidisciplinary approach to patient management, encompassing surgical expertise, rehabilitation strategies, and ongoing monitoring of neurological function. Through collaborative efforts and evidence-based practices, healthcare providers can optimize treatment outcomes and enhance the overall quality of care for individuals affected by spinal cord tethering.

CONCLUSION

It is concluded that age influences the occurrence of spinal cord tethering following trauma, with older patients being more susceptible to this complication. However, surgical intervention appears to be equally effective across age groups, with comparable rates of neurological improvement and complications. These findings highlight the importance of timely surgical management personalized to individual patient characteristics, irrespective of age, to optimize outcomes in spinal cord tethering patients.

Conflict of Interest: There is no conflict of interest.

Funding: Nil

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This article may be cited: Khattak HA, Ujjan BU, Raza T, Gul N, Kalhor A, Waheed UB, Mustafa FG, Adeel M: Spinal Cord Tethering after Trauma and Impact of Age and Surgical Outcome. *Pak J Med Health Sci*, 2023;17(12): 44-47.