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ORIGINAL ARTICLE

Prevalence, Management, and Outcomes of Spinal Cord Injury from Spinal Tumors A Cross-Sectional Clinical Study

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ABSTRACT

Background: Spinal cord injuries (SCIs) secondary to spinal tumors are a significant cause of morbidity, often leading to irreversible neurological deficits and reduced quality of life. Despite advancements in diagnostic imaging and surgical interventions, there is limited local data on the prevalence, treatment approaches, and clinical outcomes associated with spinal tumor-related SCIs.

Objective: To evaluate the prevalence, management strategies, and clinical outcomes of spinal cord injuries caused by spinal tumors among patients presenting to a tertiary care center.

Methodology: This cross-sectional clinical study included 83 patients diagnosed with spinal cord injury due to spinal tumors between June 2022 and June 2023 at Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan. Data were collected on patient demographics, tumor location and type (benign vs. malignant), neurological deficits, diagnostic modalities, treatment interventions (surgical decompression, radiotherapy, chemotherapy), and post-treatment outcomes. Functional status was assessed using the ASIA Impairment Scale and Modified Barthel Index before and three months after treatment.

Results: The prevalence of spinal cord injury from spinal tumors was highest in patients aged 45–65 years (56.6%), with a male predominance (61.4%). Thoracic spine involvement was most common (48.2%), and 62.7% of tumors were malignant. Surgical decompression was performed in 53% of patients, followed by adjuvant radiotherapy and/or chemotherapy. Neurological improvement was observed in 39.7% of cases, while 25.3% had no change and 10.8% deteriorated. Functional independence significantly improved in surgically treated patients ($p < 0.05$).

Conclusion: Spinal cord injuries from spinal tumors remain a challenging clinical entity, with a high burden of neurological deficits and variable recovery outcomes. Early diagnosis and timely surgical intervention are key to optimizing functional recovery and reducing long-term disability.

Keywords: Spinal cord injury, spinal tumors, neurological outcome, surgical decompression, functional recovery, cross-sectional study.

INTRODUCTION

Spinal cord injury (SCI) resulting from spinal tumors represents a significant clinical concern with profound implications on neurological function, functional independence, and quality of life. Unlike traumatic SCIs, which often present suddenly, tumor-related SCIs usually have a progressive onset, often delaying diagnosis and reducing the window for optimal intervention[1]. Tumors affecting the spine may be primary or, more commonly, metastatic in origin, and they exert their pathological impact by compressing or infiltrating the spinal cord and adjacent neural structures. This compression can lead to a cascade of pathophysiological events including ischemia, demyelination, axonal degeneration, and neuronal apoptosis culminating in motor, sensory, and autonomic dysfunction[2].

The global incidence of spinal tumors is rising, largely due to the increasing prevalence of malignancies and improved longevity of cancer patients. Spinal metastases occur in nearly 5–10% of all cancer patients, with up to 20% of them developing clinically significant spinal cord compression[3]. Primary spinal tumors, while less common, also contribute significantly to the burden of spinal cord dysfunction. Common primary tumors include meningiomas, schwannomas, and ependymomas, while the majority of metastatic lesions arise from breast, lung, prostate, and renal malignancies[4].

Prompt recognition and management of tumor-related SCI are critical, as timely intervention can significantly improve outcomes. Diagnostic modalities such as magnetic resonance imaging (MRI) play a central role in the early detection and anatomical delineation of spinal tumors[5]. Treatment options include surgical decompression, radiotherapy, and chemotherapy, often employed in a multidisciplinary manner. Surgical intervention is typically indicated in cases of acute neurological decline, spinal instability, or intractable pain, with the primary goal of relieving pressure on the spinal cord, stabilizing the spine, and obtaining tissue for histopathological diagnosis[6].

Despite the availability of these interventions, outcomes remain variable and largely depend on the severity of neurological deficits at presentation, the nature and location of the tumor, and the timeliness of treatment initiation. While many international studies have documented the epidemiology and outcomes of spinal tumors, local data from resource-constrained healthcare systems remain scarce. A better understanding of the clinical spectrum and treatment outcomes in the local context is essential for optimizing patient care and guiding policy decisions[7].

This study was therefore designed to evaluate the prevalence, clinical characteristics, treatment strategies, and neurological and functional outcomes of patients with spinal cord injury secondary to spinal tumors. By providing evidence from a defined patient population, this study aims to inform clinical practice, enhance early diagnostic protocols, and highlight the importance of prompt, tailored interventions in improving the prognosis of affected individuals[8].

MATERIALS AND METHODS

This cross-sectional clinical study was conducted at the Department of Neurosurgery, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan, over a one-year period from June 2022 to June 2023. The primary objective of this investigation was to evaluate the prevalence, management approaches, and clinical outcomes of spinal cord injuries resulting from spinal tumors in adult patients attending a tertiary care center.

A total of 83 patients were enrolled in the study using a consecutive non-probability sampling technique. All patients included were aged 18 years and above and presented with clinical features consistent with spinal cord compression, which were confirmed through magnetic resonance imaging (MRI) to be due to spinal tumors. Only those with a complete clinical and diagnostic record, and those who underwent at least three months of follow-up, were included. Patients who had spinal cord injuries resulting from trauma, infections such as tuberculosis, or

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degenerative spinal conditions were excluded from the study to ensure diagnostic specificity.

After obtaining written informed consent, comprehensive data were collected from each participant. This included demographic information such as age and gender, as well as clinical details including presenting symptoms, neurological deficits, tumor location (cervical, thoracic, or lumbar), histological type (benign or malignant), and the time elapsed between symptom onset and presentation. MRI served as the primary imaging modality for assessing tumor localization, extent of cord compression, and spinal alignment. Where surgery was performed, histopathological confirmation of tumor type was also obtained and recorded.

Neurological function was evaluated using the American Spinal Injury Association (ASIA) Impairment Scale at the time of admission and at the three-month follow-up mark. This scale grades neurological impairment from grade A (complete motor and sensory loss) to grade E (normal function). In addition to neurological status, the level of functional independence was assessed using the Modified Barthel Index (MBI), a standardized tool used to quantify a patient's ability to perform activities of daily living. Scores range from 0 to 100, with higher scores indicating greater independence.

Treatment decisions were made based on the severity of spinal cord compression, tumor type, and the patient's overall clinical condition. Surgical decompression and spinal stabilization were offered to patients with significant neurological deficits, spinal instability, or rapidly progressing symptoms. In cases where patients were found to have radiosensitive tumors, or were deemed unfit for surgery due to comorbidities or advanced disease, radiotherapy was administered. Selected patients with malignant tumors were referred for oncological consultation and subsequently received chemotherapy where indicated. Patients with widespread metastatic disease, poor functional status, or limited prognosis were managed with supportive and palliative care.

All surgical interventions were performed by experienced neurosurgeons under general anesthesia in an aseptic operating environment. Postoperative management included analgesia, physiotherapy, infection control, and where appropriate, referral to oncology for adjuvant therapy. All patients were followed for three months, during which time reassessment of their ASIA score and Barthel Index was carried out to evaluate neurological and functional recovery.

The study was conducted in full compliance with ethical standards. Ethical approval was obtained from the Institutional Review Board of Liaquat University of Medical and Health Sciences, Jamshoro. Written informed consent was obtained from all participants, and confidentiality of patient information was strictly maintained throughout the study.

Statistical analysis was performed using IBM SPSS version 26.0. Descriptive statistics such as means, standard deviations, frequencies, and percentages were calculated to summarize patient characteristics and clinical findings. Comparisons between pre-treatment and post-treatment outcomes, particularly changes in ASIA scores and Barthel Index values, were made using the Chi-square test and paired t-test as appropriate. A p-value of less than 0.05 was considered statistically significant in all analyses.

RESULTS

A total of 83 patients with spinal cord injury (SCI) due to spinal tumors were included in the study. The mean age of the patients was 54.2 ± 11.3 years, with the majority falling in the age group of 45–65 years (n=47; 56.6%). There was a male predominance, with 51 male patients (61.4%) and 32 female patients (38.6%). Most patients presented with gradually progressive lower limb weakness (79.5%), sensory disturbances (60.2%), and varying degrees of bladder and bowel dysfunction (35%).

Regarding tumor location, the thoracic spine was the most frequently affected region, accounting for 40 cases (48.2%), followed by the cervical spine in 25 patients (30.1%) and the lumbar spine in 18 patients (21.7%). Histologically, 52 tumors (62.7%) were classified as malignant, whereas 31 (37.3%) were benign. Metastatic spinal tumors were predominantly secondary to breast, prostate, and lung cancers, while benign lesions mainly included meningiomas and schwannomas.

Out of the total study population, 44 patients (53%) underwent surgical decompression, of whom 29 also received postoperative radiotherapy or chemotherapy. The remaining 39 patients (47%) were managed non-surgically: 24 received radiotherapy alone, 8 received both chemotherapy and radiotherapy, and 7 were managed conservatively with palliative intent due to extensive systemic disease and poor performance status.

Functional outcomes were assessed using the American Spinal Injury Association (ASIA) Impairment Scale and the Modified Barthel Index (MBI). Neurological improvement was observed in 33 patients (39.7%) at the three-month follow-up, with a shift from ASIA grades A or B to higher functioning grades C, D, or E. Twenty-one patients (25.3%) had no change in neurological status, while 9 patients (10.8%) experienced deterioration in ASIA grade. The remaining 20 patients (24.2%) maintained their pre-treatment neurological status.

Patients who underwent surgical decompression demonstrated significantly better neurological recovery (p=0.013) and greater improvement in functional independence as measured by the MBI (mean increase of 18.5 points, p=0.008), compared to those managed non-surgically.

Table 1: Demographic and Clinical Characteristics of Patients (n = 83)

Variable	Frequency (%)
Age group	
18–44 years	20 (24.1%)
45–65 years	47 (56.6%)
>65 years	16 (19.3%)
Gender	
Male	51 (61.4%)
Female	32 (38.6%)
Tumor Location	
Cervical spine	25 (30.1%)
Thoracic spine	40 (48.2%)
Lumbar spine	18 (21.7%)
Tumor Type	
Malignant	52 (62.7%)
Benign	31 (37.3%)

As shown in Table 1, the most common tumor location was the thoracic spine, and the majority of tumors were malignant, with males being more frequently affected.

Table 2: Treatment Modalities and Functional Outcomes

Treatment Modality	No. of Patients (%)	Neurological Improvement (%)	MBI Mean Score Increase
Surgical decompression ± RT/CT	44 (53%)	27 (61.4%)	+18.5 ± 6.7
Radiotherapy only	24 (28.9%)	4 (16.7%)	+6.2 ± 4.1
Chemoradiotherapy	8 (9.6%)	2 (25%)	+9.4 ± 3.9
Palliative/Conservative care	7 (8.4%)	0 (0%)	+1.5 ± 2.3

Table 2 highlights that patients who received surgical decompression had the highest rates of neurological improvement and gains in functional independence. Those who were managed conservatively or received only radiotherapy had comparatively poor outcomes.

Furthermore, subgroup analysis revealed that early surgical intervention (within 4 weeks of symptom onset) was associated with significantly better neurological outcomes (p=0.005) and fewer complications, compared to delayed surgery.

Complications were observed in 11 patients (13.2%). These included postoperative wound infections in 4 cases (4.8%), transient neurological worsening in 3 cases (3.6%), deep vein thrombosis in 2 patients (2.4%), and one case each of cerebrospinal fluid leak and nosocomial pneumonia. One patient died during the follow-up period due to complications related to widespread metastatic disease.

The findings suggest that early diagnosis and timely intervention, particularly surgical decompression, are critical in improving outcomes in patients with spinal cord compression secondary to tumors. These results align with previous clinical observations indicating the value of decompressive surgery combined with adjuvant therapy in optimizing recovery and preserving neurological function.

DISCUSSION

Spinal cord injury (SCI) resulting from spinal tumors is a critical condition that significantly affects neurological function, functional independence, and overall quality of life. The findings of this study underscore the high burden of tumor-related SCI in middle-aged and older adults, particularly among males, with thoracic spine involvement being most prevalent[9]. This anatomical predilection is consistent with existing literature and is thought to result from the narrower diameter of the thoracic spinal canal and its limited vascular supply, which predisposes it to compression-related dysfunction even with small lesions[10].

The predominance of malignant tumors (62.7%) observed in this cohort is in accordance with global trends, where spinal metastases from primary malignancies such as lung, breast, and prostate cancer are increasingly recognized as major contributors to spinal cord compression. Benign tumors, including meningiomas and schwannomas, though less aggressive, can still cause significant neurological impairment if not promptly addressed[11]. The gradual onset of symptoms, including progressive weakness, sensory changes, and autonomic dysfunction, often leads to delayed presentation. In this study, the average time from symptom onset to diagnosis was over four weeks in a substantial proportion of patients, highlighting a need for greater clinical vigilance and patient awareness[12].

Surgical decompression, either alone or in combination with radiotherapy or chemotherapy, emerged as the most effective therapeutic approach in terms of neurological recovery and improvement in functional independence. Patients undergoing surgery demonstrated a significantly higher rate of improvement in ASIA grades and Modified Barthel Index (MBI) scores compared to those managed conservatively or with radiotherapy alone. These results reinforce the importance of timely surgical intervention in preventing irreversible spinal cord damage and preserving quality of life[13].

Non-surgical patients, especially those managed with palliative intent or delayed radiotherapy, showed minimal to no improvement and, in some cases, further deterioration. This emphasizes that while radiotherapy remains crucial in the management of radiosensitive tumors, particularly lymphomas or small cell carcinomas, it should not be considered a substitute for surgical decompression in patients with significant neurological deficits. Chemoradiotherapy, although effective in a few cases, was primarily reserved for selected malignancies with known responsiveness to systemic therapy[14].

The complication rate associated with surgery in this study was relatively low and acceptable within clinical standards, suggesting that with proper perioperative care and surgical expertise, decompression can be safely performed even in resource-constrained settings. However, delayed presentation and advanced systemic disease remain major barriers to favorable outcomes, particularly in metastatic cases where neurological damage may already be extensive[15].

One important limitation of the study was its cross-sectional design, which restricts the ability to assess long-term survival and late complications. The follow-up period was limited to three months post-treatment, which, although adequate for assessing immediate recovery, does not capture recurrence rates, long-term functional decline, or disease progression. Additionally, this study was conducted in a single tertiary care institution, which may limit the generalizability of the findings to the broader population. Nonetheless, this research provides vital local data in a region where such epidemiological evidence is limited and offers practical insight into treatment strategies that can be adapted based on available resources[16].

Finally, the study affirms that early identification and prompt surgical decompression of spinal cord compression from spinal tumors can result in significant neurological and functional recovery. Multidisciplinary care involving neurosurgery, oncology, radiology, and rehabilitation is essential for optimal patient outcomes. Future studies should aim to evaluate long-term prognostic indicators and develop standardized treatment protocols tailored to tumor type, location, and individual patient status[17, 18].

CONCLUSION

Spinal cord injuries resulting from spinal tumors constitute a serious neurological emergency with significant morbidity. The findings of this study emphasize the predominance of malignant lesions, particularly in the thoracic region, and highlight the critical importance of early diagnosis and timely surgical decompression in optimizing neurological recovery and functional independence. While adjuvant therapies such as radiotherapy and chemotherapy are valuable in tumor control, their success in improving neurological outcomes is limited when used in isolation. Multimodal, patient-specific treatment approaches remain the cornerstone of effective management. Increasing awareness, improving referral pathways, and enhancing diagnostic capacity are essential steps toward minimizing long-term disability in affected patients.

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Authors' Contributions:

R.M. was responsible for study conception, design, and manuscript drafting.

A.K. contributed to data collection and background research.

S.P. carried out data analysis and assisted in interpretation.

M.A. critically reviewed the manuscript and approved the final version.

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