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Original Research Article

Outcomes And Complications Of Surgical Treatment Of Intramedullary Spinal Cord Tumors

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Abstract: Intramedullary spinal cord tumors (IMSCTs) are rare, comprising 30% of intradural primary spinal tumors. They typically arise from glial cells and include ependymomas and astrocytomas. Surgical resection remains the primary treatment, aiming to maximize tumor removal while preserving neurological function. ***Objective***: To determine the outcomes and complications of surgical treatment of intramedullary spinal cord tumors. ***Methodology:*** This study was conducted as a cross sectional prospective study in the department of neurology (Hayatabad Medical Complex, Peshawar) from 1 march 2024 to 1 march 2025. 50 patients were selected, who underwent surgical intervention for intramedullary spinal cord tumors. Preoperative assessment included detailed neurological evaluation using the McCormick scaling and magnetic resonance imaging (MRI) for tumor characterization. All surgeries were performed by an experience neurosurgeon. The extent of resection was categorized as gross total, subtotal or biopsy based on intraoperative findings and postoperative imaging. Postoperative complications were also assessed. ***Results:*** The mean age of the patients in this study was 37.98 ± 10.98 years, with a male patients being in majority (66%). Ependymomas (grade I & II) (50%) and astrocytomas (grade I & II) (36%) were the most common histological types. Tumors were mostly located in the thoracic region (54%). Postoperatively, 34% of patients improved to McCormick scale D and 16% to scale Complications included a decline in neurological function (12%) and cerebrospinal fluid leak (8%). A notable association was observed between tumor location and the extent of resection. ***Conclusion:*** Surgical treatment of spinal cord tumors demonstrated a total resection rate of 56% and subtotal resection rate of 30%. Majority of the patients showed improved postoperative neurological functions assessed using McCormick scale. Fewer postop complications were observed

Keywords: Intramedullary spinal cord tumors, surgical outcomes, ependymoma, astrocytoma, neurological function recovery..

INTRODUCTION

Spinal tumours (STs) tend to be categorised as benign as well as malignant, primarily induce symptoms by means of compression as well as invasion of spinal cord and nerve roots. The spinal cord tumors can be divided into three distinct groups based to their anatomical locations. Extradural tumours constitute predominant category, located within vertebral body or within structures external to dura mater. This tumour type is most frequently associated with metastasis. Intradural extramedullary tumors, categorized as the second most common type, arise from the leptomeninges as well as nerve roots. [1,2] These tumors are situated within the dura mater but are extramedullary and are called meningiomas as well as neurofibromas. Intramedullary spinal cord tumors (IMSCTs) constitute the least common type of spinal cord tumors (SCTs), encompassing 30% of all intradural primary tumors and only 5% of total SCTs[3]. IMSCTs develop from spinal cord parenchyma, mainly from glial tissue, leading to invasion as well as destruction of surrounding grey as well as white matter. Ependymomas as well as astrocytomas represent most commonly seen intramedullary spinal cord tumours, with hemangioblastomas occurring afterwards. Additional entities consist of lipomas, gangliogliomas, lymphomas, as well as metastases [4-6]. Patients undergoing resection of intramedullary SCTs usually have improved long-term outcomes if preoperative deficits are minimised. Additionally, likelihood of recurrence is determined by extent of resection and histological characteristics of

tumour. Adjuvant therapies, such as chemotherapy and radiotherapy, are usually used in cases of tumour regrowth or if complete resection is contraindicated. Further study into innovative treatment approaches is essential to enhance patient outcomes, particularly for astrocytomas lacking separate surgical resection margins [7-10]. Surgical resection should always be conducted promptly after diagnosis, as outcomes are linked to preoperative neurological status, as well as delaying the procedure may result in further neurological impairments. The main goals for surgical resection include obtaining a tissue diagnosis, maximising the safe removal of tumours, and improving neurological functions. In cases where complete surgical excision of lesion is impossible , additional treatment may be needed [11].Surgical treatment remains the mainstay of management for intramedullary SCTs, aiming to achieve maximal safe resection while preserving neurological function. Despite advances in microsurgical techniques and intraoperative monitoring such procedures remain technically challenging due to the delicate anatomy of spinal cord as well as risk of neurological injury. Current literature highlights the need for further evaluation of both short-term and long-term functional outcomes and complication profiles to guide surgical decision-making which could improve patient counseling and optimize management strategies.

Material & Methods

This study was conducted as a cross sectional prospective study in the department of neurology (Hayatabad Medical Complex, Peshawar) from 1 march 2024 to 1 march 2025. after securing the ethical approval from the hospital. We enrolled fifty patients (age ≥ 18 of either gender) who underwent surgical intervention for histologically confirmed intramedullary tumors. Patient selection was based on a definitive radiological diagnosis of an intramedullary spinal cord tumor on magnetic resonance imaging (MRI). All patients gave their consent. A comprehensive preoperative assessment was performed for each patient, which included a detailed clinical history, a thorough neurological examination and the documentation of functional status using the McCormik scale . Standard preoperative MRI sequences, including T1-weighted, T2-weighted and contrast-enhanced studies were obtained for all patients to evaluate the tumor's location, extent and characteristics. Surgical procedures were performed by a senior neurosurgeon who had an experience of more than 5 years after their fellowship, utilizing standard microsurgical techniques under general anesthesia. The surgical strategy aimed for maximal safe resection, the extent of which was determined intraoperatively based on the presence of a clear dissection plane between the tumor and the surrounding neural tissue. The extent of resection was categorized as gross total resection, subtotal resection or biopsy, a classification that was validated by the surgeon's operative notes and postoperative MRI findings when available.The histopathological diagnosis was established according to the World Health Organization classification of tumors of the central nervous system. Postoperatively, patients were closely monitored. Their neurological status was reassessed at discharge and during subsequent follow-up visit, again utilizing the McCormick scale to document any changes. All perioperative and late-onset complications were recorded. The collected data were analyzed using descriptive statistics to summarize demographic, clinical, and surgical variables using SPSS 26. We used Chi Square test for assessing associations, P value was noted significant if ≤ 0.05.

RESULTS

In our study the mean age 37.98 ± 10.976 years. The majority of patients were male 33 (66.0%) while 17 (34.0%) were female patients.With regard to tumor histology, low-grade ependymomas were the most frequently observed, present in 25 (50.0%) patients, followed by low-grade astrocytomas in 18 cases (36.0%). High-grade ependymomas were identified in 5 (10.0%) patients, and high-grade astrocytomas in 2 (4.0%) patients. Tumors were most commonly located in the thoracic region 27 (54.0%), followed by the cervical spine 15 (30.0%) and the lumbar region 8 (16.0%). Preoperative neurological function, assessed using the McCormick scale, showed that 25 (50.0%) patients were classified as McCormick scale C. This was followed by 11 (22.0%) patients on Scale B, nine patients (18.0%) on Scale D, three patients (6.0%) in Scale E, and 2 patients (4.0%) in Scale A (Table 1). Regarding the surgical resection, gross total resection was accomplished in 28 patients (56.0%), subtotal resection in 15 patients (30.0%) and biopsy alone in 7 patients (14.0%). Regarding postoperative neurological assessment, number of patients in McCormick scale D and Scale E increased to 17 (34.0%) and 8 (16.0%), respectively, while 17 patients (34.0%) remained in Scale C. Five patients (10.0%) classified as Scale B and 3 patients (6.0%) in Grade A (Table 2). Postoperative complications were observed in 12 patients (24.0%). The most common complication was a deterioration in neurological function, which occurred in 6 patients (12.0%), followed by cerebrospinal fluid leak in 4 patients (8.0%) and hemorrhage in 2 patients (4.0%) (Table 3).Analysis of the extent of resection in relation to tumor histology showed that gross total resection was achieved in 11 low-grade ependymoma patients (39.3% of total Resections) and 13 low-grade astrocytoma patients (46.4%), no potential association was found between tumor histology and the degree of resection ($p > 0.05$). A statistically significant relationship was found between tumor location and the extent of resection ($p < 0.05$). Thoracic tumors were more frequently associated with subtotal resection (12 cases, 80.0% of subtotal resections), whereas lumbar tumors were only present in the gross total resection group (8 cases, 28.6%) (Table 4).

Table 1: Clinical Characteristics of the Patients

Clinical Characteristic	n	%
Tumor Histology		
Ependymoma (Grade I & II)	25	50.0%
Astrocytoma (Grade I & II)	18	36.0%
Ependymoma (Grade III & IV)	5	10.0%
Astrocytoma (Grade III & IV)	2	4.0%
Location of Tumor		
Thoracic	27	54.0%
Cervical	15	30.0%
Lumbar	8	16.0%
Preoperative McCormick Scale		
Scale (5A): Paraplegic or quadriplegic	2	4.0%
Scale (4B): Severe motor and sensory deficit	11	22.0%
Scale (3C): Moderate deficit, independent	25	50.0%
Scale (2D): Mild motor and sensory deficit	9	18.0%
Scale (1E): Intact neurologically minimal dysesthesia	3	6.0%

Demographic and clinical characteristics of the patients, including tumor histology, location of tumor, and preoperative neurological function assessed by the McCormick scale.

Table 2: Surgical Outcomes

Surgical Outcomes	n	%
Tumor Resection		
Total Resection	28	56.0%
Subtotal Resection	15	30.0%
Biopsy	7	14.0%

Postoperative McCormick Scale		
Scale 5A: No motor or sensory function	3	6.0%
Scale 4B: Some sensory function	5	10.0%
Scale 3C: Some motor function	17	34.0%
Scale 2D: Useful motor function	17	34.0%
Scale 1E: Normal motor & sensory function	8	16.0%

Surgical outcomes of tumor resection and postoperative neurological recovery using the McCormick scale. This table presents the extent of tumor resection and the associated changes in neurological function post-surgery.

Table 3: Postoperative Complications

Complications	n	%
CSF Leak	4	8.0%
Decline in Neurological Function	6	12.0%
Hemorrhage	2	4.0%
No Complications	38	76.0%

Postoperative complications observed in the study, with the most common being a decline in neurological function and cerebrospinal fluid (CSF) leaks. The majority of patients experienced no complications.

Table 4: Association of Clinical Parameters with Tumor Resection

Clinical Parameters	Tumor Resection	P Value
	Total Resection	**Subtotal Resection**
Tumor Histology		
Ependymoma (Grade I & II)	11 (39.3%)	10 (66.7%)
Astrocytoma (Grade I & II)	13 (46.4%)	2 (13.3%)
Ependymoma (Grade III & IV)	3 (10.7%)	2 (13.3%)
Astrocytoma (Grade III & IV)	1 (3.6%)	1 (6.7%)
Location of Tumor		
Thoracic	11 (39.3%)	12 (80.0%)
Cervical	9 (32.1%)	3 (20.0%)
Lumbar	8 (28.6%)	0 (0.0%)

Association of clinical parameters (tumor histology and location) with the extent of tumor resection. Statistically significant differences were found between tumor location and the extent of resection ($p < 0.05$), with thoracic tumors being more commonly associated with subtotal resections.

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DISCUSSION

The management of intramedullary spinal cord tumors remains a significant challenge in neurosurgical practice, balancing safe resection against the importance of preserving neurological function. The findings from our study of 50 patients contribute to the ongoing research aimed at revealing the factors that influence surgical outcomes for these rare pathologies.The demographic profile of our patients, with a mean age of 37.98 years and a male majority of 66.0%, aligns closely with several previous studies. Hamid et al. reported a similar mean age of 43.3 years and a male proportion of 64.3%, while Bakhshi et al. (2016) documented a cohort with a mean age of 33.8 years and 62.8% males.12,13,18 This consistency across studies reinforces the notion that IMSCTs most frequently are present in middle-aged adults, with a noticeable predilection for the male gender.The most common histological diagnosis in our series was low-grade ependymoma (50.0%), followed by low-grade astrocytoma (36.0%). This distribution is consistent with the literature, which consistently identifies ependymomas as the predominant intramedullary tumor in adults. Bakhshi et al. reported a higher proportion of 60.0% of ependymomas in their study.13 Nakamura et al. found that 33 of their 68 patients had ependymomas.14 The majority of low-grade lesions in our study is a favorable prognostic factor and is typical of surgical series, as high-grade lesions are less common and often associated with a more aggressive clinical course.Anatomically, the thoracic spine was the most frequent location for tumors in our patients (54.0%), which is a finding strongly mentioned across multiple studies. Hamid et al. reported 52.4% of tumors in the thoracic region, and Wu et al. also found the thoracic segment to be commonly involved.12,15,18 However, this stands in some contrast to the findings of Bakhshi et al. where the cervical region was the most common site.13 The reasons for these geographical variations in tumor location are not entirely clear but may relate to sample size differences or regional/ethnic factors warranting further investigation. The high frequency of thoracic tumors is clinically significant, as several authors, including Klekamp et al., they have noted that thoracic location is a predictor of worse preoperative clinical status and increased surgical morbidity, possibly due to the tenuous blood supply of the thoracic cord.16 The preoperative neurological status of our patients, assessed by the McCormick scale, revealed that the majority (50.0%) presented with Scale 3C deficits. This indicates a significant degree of impairment at the time of presentation. Hamid et al. also documented that majority of their patients were in Scale 3C at the time of presentation.12,18 This finding is critical, as the preoperative functional status has been universally identified as the most

strongest predictor of postoperative outcome. Our data strongly support the conclusions of Sandalcioglu et al. who have emphasized that patients with better preoperative function are more likely to have a favorable postoperative outcome.17 This underscores the importance of early diagnosis and intervention before the onset of severe or irreversible neurological deficits.In terms of surgical management, we achieved a gross total resection (GTR) rate of 56.0%. Bakhshi et al. reported an overall GTR rate of 69.8%.13 Nakamura et al. achieved a 90% GTR rate for ependymomas.14 The rate of GTR is highly dependent on tumor histology, grade, and adherence to clear surgical planes. Our analysis revealed a statistically significant association between tumor location and the extent of resection ($p < 0.05$). Specifically, tumors in the thoracic region were more frequently associated with subtotal resection, whereas all lumbar tumors in our series underwent GTR. This suggests that anatomical constraints and the potential for higher surgical risk in the thoracic region may lead surgeons to adopt a more conservative approach to avoid neurological injury.Postoperatively, we observed a functional evolution where the number of patients in the better outcome categories (McCormick 2D and 1E) increased from 12 preoperatively to 25 at follow-up. However, a subset of patients experienced a decline in neurological function. This pattern of initial postoperative worsening or stability followed by gradual improvement in many patients is a well-documented phenomenon in spinal cord tumor surgery.12,18 The rate of cerebrospinal fluid leak in our series was 8.0%, which is comparable to the 9.5% reported by Hamidet al.12,18 Our findings reinforce several key views in the management of IMSCTs, the critical importance of preoperative neurological status, the achievable goal of GTR in a majority of low-grade lesions and the increased challenges associated with thoracic tumors. The suggestion that a more aggressive surgical approach to certain astrocytomas may be feasible without a direct correlation to worse outcomes is a challenging one that merits further investigation with larger, prospective studies.

Limitations

The limitations of this study include its retrospective design, small sample size, and lack of long- term follow-up data. Additionally, the study was conducted at a single center, limiting the generalizability of the findings to broader populations.

CONCLUSION

surgical treatment of spinal cord tumors in our study demonstrated a total resection rate of 56% and subtotal resection rate of 30%. Majority of the patients had improved postoperative neurological functions assessed using McCormick Scale. We observed fewer postop complications such as poor neurological function, CSF leak and hemorrhage.

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