PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

The Surgical Outcome of Intramedullary Spinal Cord Tumors

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ABSTRACT

Objective: This study focused on assessing the surgical outcome of the intramedullary spinal cord tumor.

Materials & Methods: A prospective study was conducted in the Department of Neurosurgery, Jinnah Postgraduate Medical Center, Karachi. The clinical records and imaging studies of 42 patients with intramedullary spinal cord tumors who underwent surgery, were analyzed and followed up. The data was collected for tumor location, histology, extent of resection, and pre and postoperative neurological status.

Results: Around 64.3% of patients were predominantly males while 35.7% were females. The mean age was found to be 43.3 years. The highest frequency (52.4%) of tumors was located in the thoracic region. Most patients presented with Frankel's grade C (52.4%). In 54.8% (n:23) patients, subtotal excision or incomplete excision was done, in 12 patients (28.6%), complete resection was done. In histology, most patients had low-grade Ependymoma (40.5% n:17) and 7 patients (16.7%) had high-grade Ependymoma. Postoperatively, 33.3% (n:14) patients had grade D and were able to walk, followed by 28.6% (n:12) with grade B.

Conclusion: Progression-free survival is increased by adjuvant radiation combined with subtotal resection; complete resection is still the key to improved results. Thoracic-located tumors possess an increased risk of surgical morbidity. The preoperative neurological function is an important predictor of increased functional survival, including histology and the extent of resection. Long-term survival outcomes are achieved with an early and aggressive surgical treatment targeted at total tumor excision.

Keywords: Spinal tumors, intramedullary tumors, ependymoma, astrocytoma, resection, outcome.

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Date of Submission: 09-06-2024
Date of Revision: 23-08-2024
Date of Acceptance: 23-08-2024
Date of Online Publishing: 30-9-2024
Date of Print: 30-9-2024

DOI: 10.36552/pjns.v28i3.989

INTRODUCTION

Spinal tumors affect only a minority of the population and are a rare group of tumors. These lesions can cause significant morbidity in terms of neurological dysfunction and can be associated with mortality as well. Spinal malignancies can be identified as extradural, intradural–extramedullary, or intramedullary using magnetic resonance imaging (MRI), which is the primary method used to image spinal malignancies.

Extradural lesions account for 60% of all spinal tumors and are the most common type, in general.[1] Primary bone tumors are far less common than metastasis, which are the most common type of extradural malignancy. Thirty percent 30% of all spinal tumors are extramedullary intradural tumors, the most common of which are Meningiomas and Nerve sheath tumors (Schwannoma and Neurofibroma) and Ten percent 10% of all spinal tumors are intramedullary, which are rare and usually affect the cervical and thoracic spine region.[1] The majority of intramedullary tumors are Ependymomas and Astrocytomas, with Ependymomas occurring approximately twice as frequently as Astrocytomas.

The main objective of surgery for IMSCTs (intramedullary spinal cord tumors) is complete resection. Adjuvant chemotherapy and radiotherapy are utilized in malignant diseases where complete resection is hardly feasible. Important variables influencing functional outcome include age and the location of the spinal cord tumor.[2]

Most Intramedullary Ependymomas (WHO Grade II) are benign tumors that are most commonly located in the cervical and thoracic spine. They occur usually during the third and sixth decades and are somewhat more common in males. Ependymomas can be categorized as myxopapillary, papillary, cellular, epithelial, or mixed based on their histopathological characteristics. Extremely uncommon are WHO Grade III intramedullary Ependymomas.[3] Surgical excision is the main recommended course of treatment.[4]

Depending on the extent of the tumor, some writers advocate for en-bloc resection while others recommend internal decompression and resection, in a piecemeal manner. Maintaining spinal cord function requires careful management of the tumor's anterior vascular supply. When it is safe to do so, some writers advise en bloc resection to reduce the danger of dissemination. The usefulness of radiation after complete resection is questionable, whereas adjuvant radiotherapy in Ependymomas is frequently followed after Subtotal resection.[5]

Approximately 60% of intramedullary tumors are Astrocytomas.[1] They develop either in childhood or later in maturity, with a little male predominance (1.5:1). The thoracic spine is where they are most commonly found. While adult spinal Astrocytomas can more frequently be WHO Grade III and IV lesions, those in children are typically benign. It is rare to be able to do a full surgical resection at this point and the recurrence rate can reach up to 50% after five years. Although surgery can cause neurological impairments and slightly improve survival even after resection, some authors prefer biopsy and radiation therapy [6,7]

When removed early, low-grade tumors have good long-term outcomes and a low rate of surgery-related complications. Malignant spinal Astrocytomas continue to have a dismal prognosis. Solid along the cystic component appears to displace rather than penetrate the cord in Pilocytic Astrocytomas, which may allow for complete resection. On the other hand, complete resection may be avoided due to widespread cyst formation or recurrent bleeding chances associated with the inflammation.

Patients having infiltrative Astrocytomas may benefit from spinal cord decompression by tumor debulking, in the absence of an identifiable resection plane. Radiation therapy might not improve tumor control in this particular entity.

Merely 5% of IMSCTs are composed of Gangliogliomas, Subependymomas, Hemangioblastomas, Neurocytomas, Lymphomas, and Metastasis. Few cases are reported because they occur infrequently. Surgery aims to achieve complete total resection while preserving or regaining neurological function.

Numerous minimally invasive techniques have been introduced in recent times. Small surgical corridor or endoscopic removal carries the risk of incomplete resection and tumor cell dissemination, despite the benefits of minimally invasive techniques. As a result, the strategy must be modified to guarantee complete or maximum safe resection. The majority of malignancies can be safely removed using conventional posterior microsurgical techniques. Ventral methods should be taken into consideration for ventral malignancies. Expanded laminoplasty and extended midline myelotomy have all been linked to successful complete resection with improved neurological function and positive mid-term control in low-grade lesions.

The study aims to see the surgical outcome of the intramedullary spinal cord tumors and variable factors influencing the surgical outcome which might lead to a better understanding and knowledge of the disease along with improving the prognosis of intramedullary spinal cord tumors by addressing those variables.

MATERIALS & METHODS

Study Design & Setting

A prospective cross-sectional descriptive study was conducted at the Department of Neurosurgery, Jinnah Postgraduate Medical Centre Karachi from August 2023 to March 2024. Forty-two (42) patients with symptomatic intramedullary spinal cord tumors were admitted and underwent surgical procedures during this period. Demographic details, location of the tumor identified by imaging, clinical presentation, clinical outcome, and predisposing factors were analyzed in medical data. Patients were examined in follow-up meetings after 6 weeks. Informed written consent was taken from every patient.

Inclusion Criteria

All age group patients who were diagnosed with intramedullary spinal cord tumors were included. Other considerations for inclusion criteria were related to the availability of clinical notes, examination findings, imaging, and histological confirmation of the diagnosis.

Exclusion Criteria

Previously operated patients, recurrent disease, extradural and intradural-extramedullary spinal tumors, patients lost to follow up and patients with life-threatening comorbidities are excluded from this study.

Pre and Post Op evaluation

All demographic details, clinical history, examination, radiological findings, and observations during surgery were evaluated. The location of the tumor was classified into three groups: (1) cervical (2) thoracic (3) lumbar (including the conus medullaris).

The preoperative and postoperative neurological functions of the patients were graded using Frankel’s scale to analyze the limitations of daily life activities and gait disturbances. A preoperative MRI was done in all cases. If the MRI revealed a vascular lesion, spinal angiography was also performed. Surgical removal of the IMSCT was performed under standard microsurgical techniques. Cystic tumors were generally resected including the cyst wall. However, the cyst was not removed in cases with suspicion of tumor infiltration.

Surgical resection of the tumor was classified as Complete Resection, Sub-Total Resection, or Biopsy, using intraoperative observations and postoperative MRI. Complete resection was defined as the resection of the whole tumor mass under a microscope and; the removal of more than 95% of tumor mass while leaving the tumor pieces attached to functional neural tissue behind. If the resected tissue was <95% but more than 75% of tumor mass, the surgical resection was identified as subtotal resection. These resections were done under a microscope and confirmed with postoperative MRI.

Tumors were histologically classified as low-grade tumors (WHO grade I and II), high-grade tumors (WHO grade III and IV), hemangioblastoma, and others.

Using Frankel's scale, the outcome was categorized as poor (A-B), fair (C), and good (D-E). The histological findings, tumor location, extent of resection, and improvement or worsening of the neurological status postoperatively were used to calculate the outcome. Clinical and imaging follow-up was done in all the patients within 6 weeks.

Table 1: Demography and descriptive analysis.

Characteristics	Subgroups	Number (n)	Percentage (%)
Gender	Male	27	64.3%
	Female	15	35.7%
Location	Cervical	13	31.0%
	Thoracic	22	52.4%
	Lumbar	7	16.7%
Resection	Complete	12	28.6%
	Subtotal	23	54.8%
	Biopsy	7	16.7%
Pre-operative Neurological assessment	No motor or sensory response (Grade A)	1	2.4%
	Some sensory response (grade B)	9	21.4%
	some motor response, unable to walk (Grade C)	22	52.4%
	Able to walk (Grade D)	8	19.0%
	Normal (Grade E)	2	4.8%
Histology	Low-grade Ependymoma	17	40.5%
	Low-grade Astrocytoma	7	16.7%
	High-grade Ependymoma	7	16.7%
	High-Grade Astrocytoma	6	14.3%
	Hemangioblastoma	3	7.1%
	Other	2	4.8%
Post-operative Neurological assessment	No motor response (Grade A)	4	9.5%
	Some sensory response (Grade B)	12	28.6%
	Some motor response, unable to walk (Grade C)	8	19.0%
	Able to walk (Grade D)	14	33.3%
	Normal (Grade E)	4	9.5%

Statistical Analysis

SPSS version 25 was used to analyze the data statistically, using descriptive statistics. Mean and standard deviation were calculated for quantitative data i.e., demography. Frequencies and percentages were calculated for qualitative variables i.e., location, resection, histology, and preop and postop neurological status. The chi-square test was applied to see the relationship between variables such as location, histology, extent of resection, and postoperative neurological function by calculating the p-value between them.

RESULTS

Demographics

Out of 42 patients, the majority of the patients belonged to the adolescent age group. The mean age was found to be 43.3 years (+/- 9.18 years) as given in Table 1. The minimum age was reported to be 23 years and the maximum age was 54 years. Around 64.3% (n=27) were predominantly males while 35.7% (n=15) were females.

Distribution by Location

The distribution of IMSCTs according to the location is detailed in Table 1, showing the highest frequency (52.4% n:22) of tumors located at the thoracic region, followed by cervical (31.0% n:13). Only 16.7% (n:7) presented at the lumbar and conus medullaris region.

Distribution by Pre-Op Assessment

Frankel's scale was used for the preoperative assessment of the neurological function of the patient. The majority of the patients presented to us with Frankel's grade C with a percentage of

52.4%(n:22) followed by 21.4%(n:9) of the patients having grade B. Around 8 (19.0%) patients were able to walk and only 2 (4.8%) patients presented to us with normal neurological function.

Distribution by Extent of Surgical Resection

Surgery was done in all 42 patients. In 54.8% (n:23) patients, subtotal excision or incomplete excision was done under standard surgical techniques. Biopsy was taken in 7(16.7%) patients. In only 12 patients (28.6%), complete or maximum safe resection was done.

Distribution by Histology

After a histological diagnosis was made, it was observed that the highest number of patients had low-grade Ependymoma (40.5%, n:17). 7 patients (16.7%) had high-grade Ependymoma and 6 patients had high-grade Astrocytoma(14.3%) respectively. Only 3 patients (7.1%) had Hemangioblastoma on histology.

Distribution by Post-op Assessment

Postoperatively, patients were assessed for neurological function using Frankel's scale. Around 33.3% (n:14) patients were grade D and were able to walk, followed by 28.6% (n:12) who had a score of grade B. However, 4 patients (9.5%) became normal (Grade E).

As shown in Table 2, in 22 out of 42 patients (52.3%) with IMSCTS, a tumor was found at the thoracic region followed by the cervical region (30.9%, n:13). Those patients having tumors at the thoracic region were found to have low-grade ependymoma on histology (36.4%, n:8) and 3 to 4 patients had high-grade ependymoma (13.6%) and high-grade astrocytoma (18.2%) respectively. However, cervical-located tumors also had low-grade ependymoma on histology (61.5%, n:8). Hemangioblastomas were also located at the thoracic spine (13.6%, n:3). The P-value for the relationship was found to be 0.224.

According to Table 3, Subtotal excision was performed in 23 patients (54.8%) with histology coming out to be low-grade ependymoma in 9 patients (39.1%), and high-grade astrocytoma in 5

Table 2: Cross tabulation showing a comparison of location vs. histology.

Location	Histology Low-Grade Ependymoma	Low-Grade Astrocytoma	High-Grade Ependymoma	High-Grade Astrocytoma	Hemangioblastoma	Others	Total	p-value
Cervical	8 (61.5%)	1(7.7%)	2 (15.4%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	13 (100%)	0.224
Thoracic	8 (36.4%)	3 (13.6%)	3 (13.6%)	4 (18.2%)	3 (13.6%)	1 (4.5%)	22 (100%)	
Lumbar	1 (14.3%)	3 (42.9%)	2 (28.6%)	0 (0.0%)	0 (0.0%)	1 (14.3%)	7 (100%)	
Count	17(40.5%)	7 (16.7%)	7 (16.7%)	6 (14.3%)	3 (7.1%)	2(4.8%)	42 (100%)	

Table 3: Crosstabulation showing the comparison of histology vs resection.

Resection	Histology Low-Grade Ependymoma	Low-Grade Astrocytoma	High-Grade Ependymoma	High-Grade Astrocytoma	Hemangioblastoma	Others	Total	P-value
Complete	7 (58.3%)	1 (8.3%)	0 (0.0%)	1 (8.3%)	2 (16.7%)	1 (8.3%)	12 (100%)	0.264
Subtotal	9 (39.1%)	5 (21.7%)	5 (21.7%)	3 (13.0%)	1 (4.3%)	0 (0.0%)	23 (100%)	
Biopsy	1 (14.3%)	1 (14.3%)	2 (28.6%)	2(28.6%)	0 (0.0%)	1 (14.3%)	7 (100%)	
Count	17 (40.5%)	7 (16.7%)	7 (16.7%)	6 (14.3%)	3 (7.1%)	2 (4.8%)	42 (100%)	

patients (21.7%). Complete surgical excision was done in 12 patients (28.6%) which came out to be low-grade ependymoma in 58.3% (n:7) of the patients. Biopsy was done in 7 patients (16.7%) who also had high-grade pathology. P-value was calculated to be 0.264, for the relationship in between.

When patients were neurologically assessed postoperatively and were compared to the location of the tumor as shown in Table 4, it was found that patients having tumors at the thoracic region had postoperative Frankel's grade B (42.9% n:3) mostly. However, the cervical (38.5% n:5) and lumbar (36.4% n:8) regions were mostly where Frankel's Grade D. Insignificant relationship was found (p-value: 0.715).

According to Table 5, it was observed that patients found to have low-grade Ependymoma on histology were able to walk, with a Frankel's grade D (64.7% n:11). Patients having high-grade Ependymoma and Astrocytoma had only some sensory response on neurological assessment (42.9%, n:3 and 50.0%, n:3 respectively). Patients who were diagnosed with Hemangioblastoma had normal postoperative neurological function-Grade E (66.7%, n:2) or were able to walk-Grade D (33.3% n:1). Significant relationship was found between histology of the tumor and postoperative neurological status and the calculated p-value was 0.003.

When the extent of surgical excision was compared to the postoperative neurological assessment as shown in Table 6, it was found that patients having tumors that were completely resected were able to walk (41.7%, n:5) or had normal neurological functions (33.3%, n:4). Patients having subtotal resection of the tumors had a dispersed pattern. However, patients having

Table 4: Cross Tabulation showing a comparison of postoperative neurological assessment vs location.

Location	No Sensory or Motor Response (Grade A)	Some Sensory Response (Grade B)	Some Motor Response Unable to Walk (Grade C)	Able to Walk (Grade D)	Normal (Grade E)	Total	P-value
Cervical	0 (0.0%)	4 (30.8%)	3 (23.1%)	5 (38.5%)	1 (7.7%	13 (100%)	0.715
Thoracic	1 (14.3%)	3 (42.9%)	2 (28.6%)	1 (14.3%)	0 (0.0%)	7 (100%)	
lumbar	3 (13.6%)	5 (22.7%)	3 (13.6%)	8 (36.4%)	3 (13.6%)	22 (100%)	
Total	4 (9.5%)	12 (28.6%)	8 (19.0%)	14 (33.3%)	4 (9.5%)	42 (100%)	

Table 5: crosstabulation showing a comparison of postoperative neurological status vs histology.

Histology	No Sensory or Motor Response (Grade A)	Some Sensory Response (Grade B)	Some Motor Response Unable to Walk (Grade C)	Able to Walk (Grade D)	Normal (Grade E)	Total	P-value
Low-grade Ependymoma	0 (0.0%)	2 (11.8%)	2 (11.8%)	11 (64.7%)	2 (11.8%)	17 (100%)	0.003 (significant Value)
Low-grade Astrocytoma	2 (28.6%)	2 (28.6%)	2 (28.6%)	1 (14.3%)	0 (0.0%)	7 (100%)	
High-grade Ependymoma	0 (0.0%)	3 (42.9%)	3 (42.9%)	1 (14.3%)	0 (0.0%)	7 (100%)	
High-grade Astrocytoma	2 (33.3%)	3 (50.0%)	1 (16.7%)	0 (0.0%)	0 (0.0%)	6 (100%)	
Hemangioblastoma	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	2 (66.7%)	3 (100%)	
Others	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (100%)	
Total	4 (9.5%)	12 (28.6%)	8 (19.0%)	14 (33.3%)	4 (9.5%)	42 (100%)	

Table 6: Crosstabulation showing a comparison of post-op neurological status vs resection.

Resection	No Sensory or Motor Response (Grade A)	Some Sensory Response (Grade B)	Some Motor Response, Unable to Walk (Grade C)	Able to Walk (Grade D)	Normal (Grade E)	Total	P-value
Complete resection	1 (8.3%)	2 (16.7%)	0 (0.0%)	5 (41.7%)	4 (33.3%)	12 (100%)	0.004 (significant value)
Subtotal resection	2 (8.7%)	5 (21.7%)	7 (30.4%)	9 (39.1%)	0 (0.0%)	23 (100%)	
Biopsy	1 (14.3%)	5 (71.4%)	1 (14.3%)	0 (0.0%)	0 (0.0%)	7 (100%)	
Total	4 (9.5%)	12 (28.6%)	8 (19.0%)	14 (33.3%)	4 (9.5%)	42 (100%)	

Table 7: Cross-tabulation showing a comparison of Pre Op vs Post op neurological status.

	Poor		Fair	Good			
Outcome	No Sensory or Motor Response (Grade A)	Some Sensory Response (Grade B)	Some Motor Response, Unable to Walk (Grade C)	Able to Walk (Grade D)	Normal (Grade E)	Total	P-value
Preop	1 (2.4%)	9 (21.4%)	22 (52.4%)	8 (19.0%)	2 (4.8%)	42	0.000 Significant P value
Postop	4 (9.5%)	12 (28.6%)	8 (19.0%)	14 (33.3%)	4 (9.5%)	42	
Difference	3	3	14	6	2		

a biopsy performed had neurological scores of grade B (71.4%, n:5). The p-value calculated was found to be 0.004, being statistically significant.

When the neurological assessment of preoperative and postoperative patients was compared as shown in Table 7, it was observed that mostly preoperative patients presented with Frankel's grade C (52.4% n:22). However, when patients were evaluated postoperatively, eight (8) patients improved to the grade D and E but six (6) patient's neurological status deteriorated including three (3) patients who completely lost their sensory and motor function.

Complications are shown in Table 8. Around 14.3% (n:6) patients developed worsening of neurological functions, 4 patients (9.5%) had post-op CSF leak and 2 patients developed meningitis, however, 28 patients (66.7%) developed no complications.

Table 8: Showing postoperative complications.

Complication	Frequency (n)
Worsening of neurological function	6 (14.3%)
CSF leak	4 (9.5%)
Meningitis	2 (4.8%)
Hemorrhage	2 (4.8%)
None	28 (66.7%)
Total	**42 (100%)**

DISCUSSION

The evolution of microsurgical procedures along with the introduction of contemporary neuroimaging approaches and the use of CUSA have improved procedure safety in intramedullary spinal cord tumors. Male predominance seen in our study is also well known. In a study done by Bostrom et al, 33 out of 57 of the patients were male, hence supporting male predominance also seen in our study.[8] According to Lin et al's, retrospective analysis, the female sex was revealed to be an independent predictor of low morbidity and mortality in IMSCTs.[9]

In our study, the most common location for intramedullary spinal cord tumors was the thoracic region, followed by the cervical. Tumors at the thoracic region included low-grade Ependymomas as well as high-grade lesions, in contrast to the cervical region which mostly included low-grade Ependymomas. Although an insignificant relationship was found between location and histological features, cervical-located tumors usually had a better outcome as compared to the thoracic region. In another study, Sandalcioglu et al reported that thoracic-located tumors possessed an increased risk of surgical morbidity.[10] According to Klekamp et al's, experience, postoperative clinical outcomes for thoracic Ependymomas were comparatively worse than those for cervical tumors. They noted that thoracic Ependymoma, advanced age, a longer clinical history, tumor bleeding, and surgery for a recurring lesion, all elevated the likelihood of lasting morbidity.[11]

In our study, a significant relationship was found between post-operative neurological status and the histology of the tumor, reflecting that low-grade Ependymomas including hemangioblastomas, are associated with a good surgical outcome, improving the neurological function of the patients postoperatively.

In our study, subtotal resection was done in 54.8% of the patients, and complete resection was done in 24.6% of the patients. Patients with subtotal resection included mostly low-grade pathology as well as high-grade pathology. Studies showing complete tumor removal and good postoperative functional results have been described by multiple authors.[6,12] Similar results have been found in our study, showing a significant association between the extent of resection and the postoperative neurological status of the patient.

Astrocytomas are known for their infiltrative development, which frequently results in partial tumor removal.[6] Studies have brought attention to the surgical restriction resulting from the lack of a distinct plane of cleavage, which has led to the use of biopsy or decompression solely for diagnosis or partial resection.[13] In our study, biopsy (16.7%; n:7) was done due to the lack of a distinct plane of dissection and to prevent further medullary injury and irreversible neurological degeneration. An infiltrative malignant tumor growth limits the resection, possibly due to multiple factors i.e., the aggressive nature of the disease, delay in seeking medical attention, or lack of availability of medical resources leading to high-grade pathology.

Because of their well-defined plane of dissection, Ependymomas are typically acknowledged as resectable tumors.[14] This further explains the significant relationship found in our study between the extent of resection and postoperative neurological function, reflecting that low-grade Ependymomas and Hemangioblastomas were generally completely excised and had a good postoperative outcome. On the other hand, low-grade Astrocytoma and high-grade lesions (Ependymoma and Astrocytoma) were subtotal excised or biopsied and had poor surgical outcomes.

Regarding survival outcomes, Safaee et al, proposed that the most significant prognostic component was the degree of resection. Patients receiving complete resection were reported to have considerably superior progression-free survival. The authors also noted that establishing complete resection in the upper spinal cord was difficult, which adds another important prognostic aspect to the debate.[15] When compared to other intramedullary entities, Ependymomas often exhibit a benign nature and a well-defined dissection plane; yet, their propensity for recurrence, malignant transformation, and neural-axis metastasis commonly leads to severe morbidity and mortality.[16]

In our study, a majority of the patients had some motor power and were unable to walk (Frankel's Grade C). However, when patients were examined after surgery, they tended to have a bimodal pattern of distribution, showing 8 patients improved to grade D & E (Good outcome) and 6 Patients worsened to grade A & B (poor outcome). It is assumed that those patients who improved, had low-grade Ependymomas and complete excision was being done leading to debulking of the spine providing enough room for the normal spine, causing improvement of the neurological function. However, few patients deteriorated after surgery, assuming that those patients already had high-grade, aggressive disease along with poor preop neurological status leading to the development of ischemic changes in the normal spine after surgery. The Postoperative neurological function and surgical outcome are directly linked to the preoperative neurological function of the patient, as shown by a significant relationship observed in our study.

Ohata et al, conducted a study of 18 patients with intramedullary spinal cord Ependymoma who underwent surgery, achieving complete resection in 17 patients, while 1 patient, with a grade II Ependymoma, received subtotal resection, while there was no surgical morbidity and mortality, the final neurological outcome remained unchanged in 15 cases.[17] In our study, 6 patients developed worsening of neurological status and four patients developed CSF leak attributed to poor dural closure technique or dural invasion by the tumor. Even in cases of persistent deficits, Wostrack et al, found that the extent of resection was the most significant predictor of survival. Age and Ependymomas situated in the cervical region were substantially associated with transient impairments. Only a considerable proportion of the older patients had permanent impairments, which was seen in 2% of the patients.[18]

According to a publication by Hoshimaru et al, intraoperative observation of spinal cord atrophy and arachnoid scarring was the most significant predictor of surgical morbidity.[19] Klekamp et.al, made a similar observation, noticing that patients who had arachnoid scarring at surgery had a worse surgical result and astrocytomas were more likely to present with arachnoid scarring.[11] It could be hypothesized that arachnoid scarring is linked to neurological deficits preoperatively, which further needs to be evaluated.

CONCLUSION

Intramedullary spinal cord tumors are an uncommon and difficult condition to treat. Although progression-free survival is increased by adjuvant radiation combined with subtotal resection, gross total or complete resection is still the key to improved results. Overall survival, however, is primarily dependent on tumor recurrence and pre-operative condition. Thoracic-located tumors possess an increased risk of surgical morbidity. The preoperative neurological function is an important predictor of increased functional survival, including histology and the degree of resection is also significant. Therefore, the best long-term survival outcomes for these individuals are achieved with an early and aggressive surgical treatment targeted at total tumor excision.

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Additional Information

Disclosures: Authors report no conflict of interest.
Ethical Review Board Approval: The study conformed to the ethical review board requirements.
Human Subjects: Consent was obtained by all patients/participants in this study.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.
Financial Relationships: None.
Data Availability Statement: For data sharing, interested researchers can contact the corresponding author.

AUTHORS' CONTRIBUTION

S. No.	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Haris Hamid	Study design and methodology.
2.	Iram Bokhari	Literature review and referencing.
3.	Asra Aslam	Final review and approval.
4.	Bushra Maqsood	Data collection and calculations.
5.	Mohammad Daniyal Mumtaz	Interpretation of results.
6.	Farrukh Javeed	Analysis of data.