

Analysis of Surgical Outcome in Intradural Extramedullary Spinal Tumors – A Single Center Study

Raul Mayank¹, Narayan¹, Anand Prakash², Manjar Ali¹, Md Habibullah Ansari¹

¹Senior Resident, Department of Neurosurgery, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India. ²Additional Professor & Head of Department, Department of Neurosurgery, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India

Abstract

Background: Intradural extramedullary (IDEM) tumors account for nearly two-thirds of spinal tumors and are usually benign, most commonly schwannomas, meningiomas, and neurofibromas. Surgical excision is the primary treatment, with outcomes influenced by tumor type, location, and preoperative neurological status. This study aimed to analyze the clinical, radiological, and histopathological profiles of IDEM tumors and assess surgical outcomes with a focus on neurological recovery. **Material and Methods:** A prospective observational study was conducted on 35 patients with radiologically confirmed IDEM spinal tumors who underwent surgery between March 2023 and February 2025. Clinical evaluation, MRI findings, and histopathology were analyzed. Neurological function was assessed using the Modified McCormick Scale preoperatively, at discharge, and at six months postoperatively. **Results:** The mean patient age was 43.5 ± 9.5 years, with a slight female predominance (53.1%). The thoracic spine was the most common site, and schwannomas and meningiomas together comprised 84.4% of cases. Gross total excision was achieved in 87.5% of patients. Postoperatively, there was significant neurological improvement, with 75% of patients achieving McCormick Grade I or II at six months ($p < 0.001$) with minimal postoperative complications. **Conclusion:** Microsurgical excision of IDEM spinal tumors provides excellent functional outcomes with low morbidity. Early diagnosis and meticulous surgical technique are key determinants of recovery. Larger multicentric studies with long-term follow-up and use of intraoperative neuromonitoring are warranted to optimize surgical strategies and neurological preservation.

Keywords: Intradural extramedullary tumors; Spinal tumors; Schwannoma; Meningioma; Microsurgical excision; Neurological recovery; Modified McCormick Scale; Surgical outcome; Gross total resection.

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INTRODUCTION

Spinal tumors are relatively rare, comprising 5–12% of all central nervous system tumors, with an incidence of about 0.74 per 100,000 person-years.^[1] They are classified as extradural, intradural extramedullary (IDEM), and intramedullary, with IDEM lesions accounting for nearly two-thirds of spinal tumors.^[2] Schwannomas, meningiomas, and neurofibromas are the most common IDEM types, while ependymomas, lipomas, and paragangliomas occur less frequently.^[3]

Clinically, patients typically present with back pain and/or radicular pain, followed by progressive motor, sensory, or sphincter deficits.^[4] Magnetic resonance imaging (MRI) is the diagnostic modality of choice, whereas histopathology confirms the diagnosis.^[5] Gross total resection remains the standard of care, with advances in microsurgical techniques and intraoperative monitoring enhancing safety and outcomes.^[6] However, prognosis depends on multiple factors—most notably tumor type, location, and preoperative neurological status.^[7]

Given the scarcity of regional data, especially from Eastern India, this study analyzes the clinical, radiological, and histopathological profile of IDEM spinal tumors and evaluates surgical outcomes with emphasis on the correlation between preoperative neurological status and postoperative

recovery.

MATERIALS AND METHODS

This was a prospective observational study conducted at tertiary care hospital in Eastern India. The study period was from March 2023 to August 2025, with patient recruitment taking place between March 2023 and February 2025, while follow-up assessments continued until August 2025. Institutional ethical clearance was obtained prior to commencement, and written informed consent was taken from all patients or their caregivers. A total of 35 consecutive patients with intradural extramedullary (IDEM) spinal tumors who underwent surgical excision during the study period were included. The sample size was calculated using the formula for estimating a single population proportion, considering an expected favorable outcome proportion of 80%

Address for correspondence: Dr. Raul Mayank,
Senior Resident, Department of Neurosurgery
Rajendra Institute of Medical Sciences, Ranchi, Jharkhand,
India
E-mail: dr.raulmayank@gmail.com

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from previous literature,^[8,9] a 95% confidence interval, and a 10% margin of error. The minimum calculated sample size was 31; hence, 35 patients were included to account for attrition and incomplete follow-up.

The study included patients aged between 18 and 70 years who had a radiologically confirmed diagnosis of intradural extramedullary (IDEM) spinal tumors and underwent primary surgical excision with a minimum postoperative follow-up of six months. Patients with recurrent IDEM tumors, secondary or metastatic spinal lesions, and vascular malformations or other lesions deemed unsuitable for safe surgical excision were excluded from the study. Additionally, individuals who were lost to follow-up within six months after surgery were not included in the final analysis.

All patients underwent preoperative MRI of the whole spine with contrast to confirm diagnosis, assess tumor extent, and plan surgical approach. Clinical evaluation included detailed neurological examination and documentation of preoperative functional status using the modified McCormick scale.

Surgery was performed via a posterior approach under operating microscope with laminectomy/laminoplasty depending on tumor location. Gross total excision was attempted in all cases; for meningiomas, the involved dura was coagulated or excised, while in schwannomas, the affected root was sacrificed if necessary. The dura was closed primarily, and a wound drain was placed in all cases.

Postoperative neurological status was assessed using the modified McCormick scale at discharge and at six months of follow-up. Pain relief was assessed subjectively, and patient-centered questionnaires were used for functional evaluation.

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic, clinical, and tumor-related variables. Categorical data were expressed as frequencies and percentages, while continuous data were presented as mean ± standard deviation. Preoperative and postoperative McCormick grade were compared using the Wilcoxon signed-rank test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 35 patients with intradural extramedullary spinal tumors were included in the study. The clinical follow-up visits were completed by 32 participants at 6 months, and three patients were lost to follow-up. The age distribution showed that the majority of cases occurred in middle-aged individuals. The majority of patients were aged 41–50 years (34.38%), followed by those in the 51–60 years age group (28.13%) [Table 1]. Mean age of the patients are 43.5 ± 9.51 years. The gender distribution was nearly balanced, with 15 males (46.9%) and 17 females (53.1%). Although females were slightly more represented, no significant gender predilection was observed, indicating that IDEMs affect both sexes with comparable frequency.

Table 1: Age distribution of patients

Age	Number of patients	Percent
18-30	4	12.50
31-40	7	21.88
41-50	11	34.38
51-60	10	28.13
61-70	1	3.13

At the time of admission, the majority of patients presented with dull aching or radicular pain, observed in 25 patients (78.1%), making it the most common presenting symptom. Motor weakness was noted in 23 patients (71.8%), while sensory impairment was present in 17 patients (53.1%). Spasticity was documented in 13 patients (40.6%). Additionally, sphincter dysfunction was observed in 9 patients (28.1%).

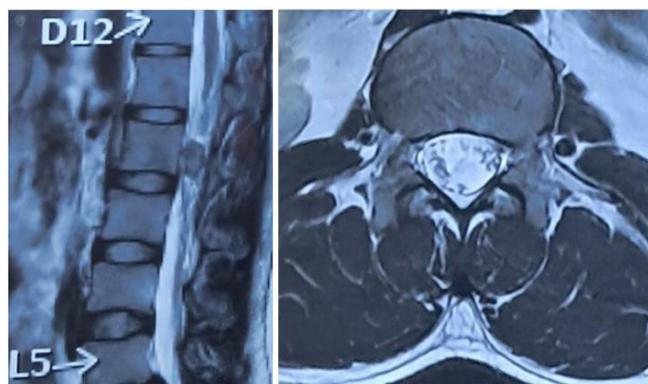


Figure 1: Preoperative magnetic resonance imaging-T2-weighted image showing Schwannoma at L2 level.

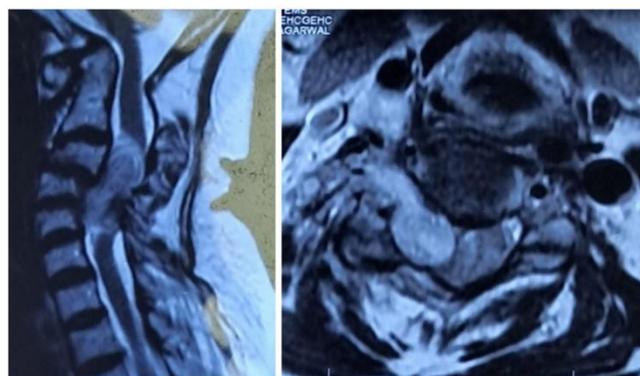


Figure 2: Preoperative magnetic resonance imaging-T2-weighted image showing Dumbbell-shaped Neurofibroma at C3-C5 level.

Magnetic resonance imaging (MRI) was performed in all patients to determine the anatomical location and size of the intradural extramedullary tumors [Figure 1-2]. The thoracic spine was the most common site, accounting for 53.1% of cases, followed by the lumbar region in 28.1%. Tumors located at the thoracolumbar junction were observed in 9.4%, while cervical spine involvement was seen in 6.3% of

patients. The cervicothoracic junction was affected in 3.1% of cases.

All surgically excised specimens were submitted for histopathological examination. The most common tumor types were schwannomas and neurofibromas, together accounting for 16 cases (50%). Meningiomas were the second most common histological type, identified in 11

patients (34.4%). Rare tumor types were observed in a small subset of patients, including one case each of myxopapillary ependymoma, spinal lipoma, and arachnoid cyst. Additionally, one case (3.1%) yielded an inconclusive histopathological report due to significant tissue artifact, limiting definitive diagnosis.

Table 2: Histological distribution of IDEM tumors

Type of Tumor	Number of patients	Percent
Schwannoma and Neurofibroma	16	50
Meningioma	11	34.4
Myxopapillary ependymoma	1	3.1
Lipoma	1	3.1
Arachnoid cyst	1	3.1
Inconclusive	1	3.1

Gross total excision of the tumor was achieved in 29 patients (90.6%), reflecting a high rate of complete resection in intradural extramedullary spinal tumors. Subtotal resection was performed in one patient (3.1%) with neurofibroma due to tumor encasement of nerve roots, and in one patient (3.1%) each with spinal lipoma and dermoid cyst, where infiltration into surrounding neural tissue limited safe dissection.

Preoperatively, most patients presented with moderate to severe neurological impairment, with the majority falling into Modified McCormick Grades III and IV (n=22, 68.7%), indicating significant functional limitation. Following surgical excision, there was an evident improvement in neurological status at the time of discharge. Many patients improved by at least one functional grade, and early postoperative assessment showed a statistically significant improvement in mean McCormick score compared to preoperative status (p < 0.05). Only a small number of

patients, particularly those with long-standing symptoms or subtotal resections, demonstrated minimal change at discharge.

At the 6-month follow-up, neurological recovery continued, with a larger proportion of patients achieving Grade I or II (n=24, 75%), reflecting near-normal or independent functional status. When compared with discharge scores, this improvement was also statistically significant (p < 0.01), indicating progressive neurological recovery over time. Overall, the difference between preoperative and 6-month postoperative scores was highly significant (p < 0.001), confirming that surgical intervention led to sustained functional improvement. These findings demonstrate that surgery for intradural extramedullary spinal tumors not only provides early symptomatic relief but also results in long-term neurological recovery and improved quality of life.

Table 3: Degree of neurological deficit in patients with IETs at admission, discharge and follow-up

Modified McCormick Grade	At Admission		At discharge		At 6 month follow up	
	Number of patients	Percent	Number of patients	Percent	Number of patients	Percent
Grade I	1	3.1	3	9.4	14	43.8
Grade II	7	21.9	10	31.3	10	31.3
Grade III	11	34.4	11	34.4	6	18.8
Grade IV	11	34.4	7	21.9	2	6.3
Grade V	2	6.3	1	3.1	0	0

Postoperative complications were observed in six cases. One patient developed a cerebrospinal fluid (CSF) leak from the wound site following resection of a thoracic neurofibroma, which was managed conservatively. Surgical site infections occurred in three patients, pseudomenigocele in one patient of dermoid cyst; all cases responded well to conservative treatment without the need for reoperation.

DISCUSSION

Intradural extramedullary tumors, comprising about two-thirds of primary spinal tumors,[8] are typically benign and their location influences clinical presentation, surgical approach, and outcomes. While plain radiographs may show indirect signs such as pedicle erosion or scoliosis, MRI is the investigation of choice. Gross total excision under operating

microscope remains the optimal treatment, offering favorable outcomes in most cases.

The age distribution in our study demonstrated a peak incidence in the 41–60-year age group, consistent with findings reported by Seppälä et al,^[10] and Fernandes et al,^[11] who also identified the highest incidence of intradural extramedullary tumors within the fourth to sixth decades of life. Previous studies have reported considerable variability in the female-to-male ratio of intradural extramedullary tumors, ranging from 1.2:1 to 1:2.4 across different series.^[12,13] In the present study, the female-to-male ratio was 1.13:1, indicating a slight female predominance.

In our study, the majority of patients (25 cases, 78.1%) initially presented with back pain or radicular symptoms. Progressive tumor enlargement led to compression of nearby neural elements, including the spinal cord and cauda equina, resulting in varying degrees of neurological impairment such as myelopathy, focal

muscle weakness, or manifestations of cauda equina syndrome. Motor weakness was observed in 23 patients (71.9%), and sphincter dysfunction occurred in 9 patients (28.1%).

Nitter,^[14] reported that more than half of intradural extramedullary tumors were located in the thoracic region, with approximately 22% each occurring in the cervical and lumbosacral regions. In the present study, a similar distribution pattern was observed, with the thoracic spine being the most frequently involved site (53.1%), followed by the lumbar (28.1%), thoracolumbar (9.4%), cervical (6.3%), and cervicothoracic (3.1%) regions. The predominance of thoracic involvement may be attributed to the relatively longer length of the thoracic spinal segment and the narrow spinal canal in this region.

In the present study, schwannomas and neurofibromas together accounted for 50% of intradural extramedullary tumors, followed by meningiomas, which constituted 34.4% of cases. These two histological types represented the majority of IDEM lesions in our series, consistent with the findings reported by Arora R et al,^[15] and Song et al,^[16] who also identified nerve sheath tumors and meningiomas as the predominant entities.

Spinal meningiomas were observed predominantly in the thoracic region and occurred more frequently in female patients, a trend that aligns with prior literature suggesting hormonal influences, particularly estrogen and progesterone receptor expression, as contributing factors in their pathogenesis.^[17] In our cohort, 9 out of 11 meningiomas were located in the thoracic region, showing a clear female predominance and further reinforcing the established gender and regional predilection of these tumors.

Several previous studies have documented favorable postoperative outcomes following gross total excision of intradural extramedullary tumors, with neurological improvement reported in 75–94% of cases and a low rate of morbidity and mortality, irrespective of histopathological subtype.^[18] Similarly, in our cohort, a significant neurological recovery was evident at 6-month follow-up, as evaluated using the Modified McCormick Scale.

In the present study, gross total resection was achieved in 90.6% of patients, while the remaining cases underwent subtotal excision. Although spinal lipomas are histologically benign, complete resection is often challenging due to dense adhesions with adjacent neural structures and the associated risk of postoperative neurological deterioration. Schwannomas, on the other hand, typically exhibit an eccentric growth pattern, displacing rather than infiltrating nerve fibers.^[19]

In cases where nerve fibers were seen coursing through the tumor, an intralesional excision was performed to preserve neurological function. When the involved nerve roots lacked identifiable distal continuity, marginal excision was carried out along with tumor removal. Notably, even in patients who underwent subtotal resection, neurological recovery was satisfactory, and no tumor progression was noted during follow-up. This was exemplified by one case of spinal lipoma and two cases of schwannoma, all of which remained clinically stable postoperatively.

In our series, postoperative cerebrospinal fluid (CSF) leakage occurred in one patient with a thoracic neurofibroma, which was successfully managed with conservative medical treatment. Surgical site infections were observed in three patients and responded well to oral antibiotic therapy. Additionally, one patient with a lumbar dermoid cyst developed a pseudomeningocele three weeks after surgery; this complication was effectively treated using non-surgical measures, including compression dressings and serial aspirations.

These postoperative complications were infrequent and manageable, reflecting the generally favorable safety profile of microsurgical excision for intradural extramedullary tumors. Our findings are in agreement with those reported by Randhawa et al,^[20] who also documented a low incidence of similar postoperative complications, most of which were successfully managed with conservative approaches.

This study is limited by its small sample size and single-center design, which may affect the generalizability of findings. The relatively short follow-up period precluded evaluation of long-term outcomes and recurrence rates. Intraoperative neuromonitoring was not used, as it was unavailable at our institution, which may have influenced the precision of nerve preservation during surgery. Despite these limitations, the study provides valuable insights into the surgical outcomes of intradural extramedullary spinal tumors in the regional setting.

CONCLUSION

Surgical excision remains the cornerstone of management for intradural extramedullary spinal tumors, offering excellent functional and neurological outcomes with minimal morbidity. In our series, gross total resection was achieved in the majority of cases, leading to significant improvement in postoperative neurological function and quality of life, as assessed by the Modified McCormick Scale. The thoracic region was the most common tumor location, with meningiomas, schwannomas and neurofibroma being the predominant histological types. Complications were infrequent and manageable with conservative measures. Overall, early diagnosis, meticulous microsurgical technique, and careful postoperative follow-up are key to achieving favorable outcomes. Larger, multicentric studies with long-term follow-up and incorporation of intraoperative neuromonitoring are recommended to further refine surgical strategies and enhance functional recovery.

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Conflicts of interest

There are no conflicts of interest.

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