

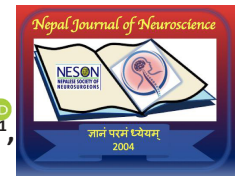
## Factors influencing surgical outcome of intradural spinal tumors: A prospective study

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### Abstract

**Introduction:** Intradural tumors are a diverse group of neoplasms that occur within the dural sac, which can be either intramedullary or extramedullary, representing 40% of all spinal tumors.

**Methods:** This was a prospective study conducted at Bir Hospital. 45 patients with intradural spinal tumors who underwent surgical intervention were included. Preoperative neurological status and postoperative neurological outcome were assessed using the Modified McCormick Scale (MMS). Spearman's correlation test was done for continuous variables and Fisher's exact/ Kruskal-Wallis test for categorical variables. The change in MMS from pre-operative assessment to the end of follow-up was assessed using Wilcoxon's signed rank test. P-value <0.05 is considered statistically significant.

**Results:** A total of 45 patients who met the inclusion criteria, with a mean age of 35.9 years, of whom 40 (88.9%) had extramedullary tumors, and 5 (11.1%) had intramedullary tumors. 2 patients presented with cauda equina syndrome. The demographics of patients, like age (p=0.366), sex (p=0.662), level of tumor (p=0.187), and the surgical approach (Laminectomy vs Laminoplasty) (p=0.126) were not found to be significantly associated with change in MMS, with the strongest predictor being the baseline MMS (p<0.001). However, the location of extramedullary tumors has a better outcome than intramedullary tumors (p<0.003).

**Conclusion:** A good preoperative neurological baseline and location are significant positive predictors of an improved functional outcome. The demographic profile, level of tumor, or surgical approach did not significantly alter the post-operative outcome of patients in our study.

**Keywords:** extramedullary, intramedullary tumor, Modified McCormick scale

## INTRODUCTION

Intradural tumors are a diverse group of neoplasms that occur within the dural sac but can be either intramedullary or extramedullary. These tumors represent approximately 4-10% of all central nervous system tumors and 40% of all spinal tumors.<sup>1</sup> Surgery remains the mainstay of treatment, aiming to achieve maximal tumor resection while preserving neurologic

function.<sup>2</sup> Intramedullary tumors such as ependymomas and astrocytomas are less common but often more challenging to treat. Intradural extramedullary tumors such as meningioma, schwannoma and neurofibroma are more frequent and usually have a better prognosis due to their accessibility for surgical resection.<sup>3</sup> Complete surgical resection is associated with better long-term outcomes for most intradural spinal tumors.<sup>4</sup> Patients with good preoperative neurological function, MMS Grade I-II, have better surgical outcomes compared to those with advanced deficits.<sup>5</sup> CSF leakage, wound infection, and spinal instability can adversely affect recovery.<sup>6</sup>

This study aims to identify key predictors of favorable and unfavorable outcome which can help in tailored surgical planning.

*Table: Modified McCormick Scale*

Grade	Modified McCormick Scale
1	Intact neurologically, normal ambulation, minimal dysthesia
2	Mild motor and sensory deficit, functional independence
3	Moderate deficit, limitation of function, independent with external aid
4	Severe motor or sensory deficit, dependent, limited function
5	Paraplegia or quadriplegia, even with flickering movement

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## METHODS

This was a prospective observational study conducted at Bir Hospital, National Academy of Medical Sciences, Kathmandu, Nepal. A total of 45 patients who underwent surgery for intradural spinal tumors from July 2025 to March 2026 were included in our study. The study was conducted after approval by the Institutional Review Board, National Academy of Medical Sciences (Reference number: 140/2082/83). Patients with extradural or metastatic tumors, with spinal infection or trauma, and recurrent tumors were excluded from the study. The demographics and clinical data, including location, level, preoperative MMS, surgical approach, and post-operative MMS, were recorded on a Proforma. Patients were followed up with histopathology reports to observe the incidence and functional outcome of various intradural spinal tumors. Statistical analysis was done by using IBM SPSS version 23. Patient demographics, tumor location, tumor level, surgical approach, and change in MMS are compared using non-parametric tests- Spearman's correlation for continuous variables and Fisher's exact/ Kruskal-Wallis test for categorical values. The change in MMS from pre-operative assessment to the end of follow-up was assessed using Wilcoxon's signed rank test. P-value <0.05 is considered statistically significant.

## RESULTS

### RESULTS

In a total of 45 patients, the mean age was 35.9 years, with 27 (60%) male. 40 (88.9%) had extradurellary, and 5 (11.1%) had intradurellary tumors. Out of 7 myxopapillary ependymoma, 2 of them were from conus (intradurellary) and 5 of them were from filum terminale (extradurellary). 2 patients presented with cauda equina syndrome. The lumbar/lumbosacral was 9 (20%), thoracic/thoracolumbar was 26 (57.7%), and cervical/cervicothoracic was 10 (22.22%). Laminoplasty was done in 5 (11%) and Laminectomy in 40 (89%). Gross total resection (GTR) in 41 (91.1%) and Subtotal resection (STR) in 5 (8.9%) patients. The mean length of hospital stay was 10 days. Cerebrospinal fluid leak was seen in 2 (4.4%) patients, and infection was seen in 3 (6.6%). In our study, the most common extradurellary tumor was meningioma 15 (33.3%), followed by schwannoma 12 (26.6%). The most common intradurellary tumor was astrocytoma 2 (4.4%). The change in MMS, better MMS was seen in 29 (64.4%), the same status was seen in 14 (31.1%), and worse was seen in 2 (4.4%) patients. All preoperative grade I MMS were static. Out of 16 grade II preoperative MMS, 2 had static, and 14 had improved post-operative MMS. Out of 15 grade III preoperative MMS, 3 had static, and 12 had improved post-operative MMS, 6 by grade I and 6 by grade II. Out of 6 grade IV preoperative MMS, 2 had static, 2 had improved by grade I, and 2 had worse post-operative MMS. Out of 2 preoperative grade V MMS, 1 improved by grade I, and 1 was static. 38 out of 40 (95%) extradurellary tumors had Gross total resection, while 2 (5%) had subtotal resection. 3 out of 5 (60%) of intradurellary tumors had GTR, and

2 out of 5 (40%) had STR. The baseline good preoperative MMS and postoperative outcome was statistically significant ( $p < 0.001$ ). Extradurellary tumors have a good postoperative outcome ( $p = 0.003$ ) and have a good extent of resection ( $p < 0.001$ ), which was statistically significant.

*Table 2. Demographic factors and treatment factors*

Factors	Statistics
Age years (mean $\pm$ SD)	35.9 $\pm$ 16.5 years
Sex (%male)	27 (60%)
Pathology	
Extradurellary	40 (89%)
Intradurellary	5 (11%)
Level	
Lumbar/Lumbosacral	9 (20%)
Thoracic/Lumbothoracic	26 (57.7%)
Cervical/Thoracocervical	10 (22.2%)
Type of surgery	
Laminectomy	40 (89%)
Laminoplasty	5 (11%)

*Table 3. Postoperative outcomes*

Factor	Statistics
Wound infection	3 (6.6%)
CSF leak	2 (4.4%)
Preoperative MMS	
1	6 (13.3%)
2	16 (35.5%)
3	15 (33.3%)
4	6 (13.3%)
5	2 (4.4%)
Postoperative MMS	
1	25 (55.5%)
2	10 (22.2%)
3	6 (13.3%)
4	2 (4.4%)
5	2 (4.4%)
Change in MMS	
Better	29 (64.4%)
Same	14 (31.1%)
Worse	2 (4.4%)

**Table 4.** Associations with various parameters and changes in MMS at the last follow-up (3 months).

Change in Modified McCormick Scale	Better			p-value
	28(19-60)	28.5 (19-69)	57.5 (50-65)	
Age				p=0.366
Sex				p=0.662
Female	13 (72.2%)	4 (22.2%)	1 (5.55%)	
Male	16 (59.2%)	10 (37.03%)	1 (3.7%)	
Pathology				p=0.003
Extramedullary	28 (70%)	12 (30%)	0 (0%)	
Intramedullary	1 (20%)	2(40%)	2 (40%)	
Level				p=0.187
Lumbar/ Lumbosacral	6 (66.6%)	3(33.3%)	0 (0%)	
Thoracic/ Thoracolumbar	19 (73.07%)	6(23.07%)	1 (3.8%)	
Cervical/ Cervicotho- racic	4 (40%)	5 (50%)	1 (10%)	
Type of Surgery				p=0.126
Laminectomy	28 (70%)	11 (27.5%)	1 (2.5%)	
Laminoplasty	1 (20%)	3 (60%)	1 (20%)	
Preoperative MMS				p<0.001
1	0 (0%)	6 (100%)	0 (0%)	
2	12 (75%)	4 (25%)	0 (0%)	
3	13 (86.6%)	2 (12.5%)	0 (0%)	
4	4 (66.6%)	1 (16.6%)	1 (16.6%)	
5	0 (0%)	1 (50%)	1 (50%)	

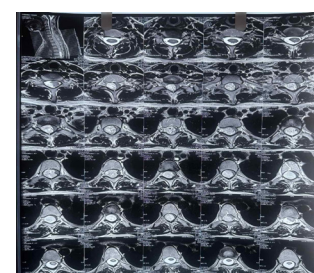
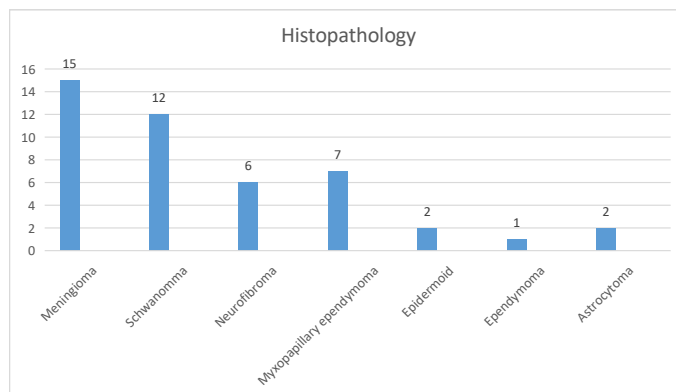
Spearman's p-value, Fisher's exact test, Kruskal-Wallis H test, and Wilcoxon's signed rank test

**Table 5.** Location of tumor and extent of resection

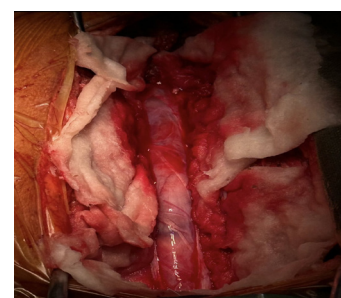
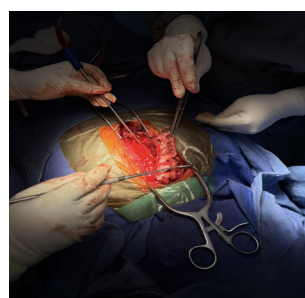
Location	GTR	STR
Extramedullary	38 (95%)	2 (5%)
Intramedullary	3(60%)	2 (40%)

**Table 6.** Histopathology and change in the Modified McCormick scale

Histopathology	Better	Same	Worse
Meningioma	12	3	0
Schwanomma	10	2	0
Neurofibroma	2	4	0
Myxopapillary ependymoma	2	4	1
Epidermoid	1	1	0
Astrocytoma	1	0	1
Ependymoma	1	0	0



**Picture 1.** Sagittal MRI C7-D5 IDEM **Picture 2.** Axial MRI C7-D5 IDEM



**Picture 3.** Laminoplasty **Picture 4:** Intraoperative image showing C7-D5 IDEM-Schwanomma

## DISCUSSION

The surgical management of intradural spinal tumors aims for maximal safe resection while preserving neurological status. Our study demonstrated that functional outcomes were influenced by a combination of pre-operative status and tumor location, mirroring trends observed in recent global literature.

### 1.Functional outcomes and preoperative status

In our cohort, 64.4% of patients showed improvement in their Modified McCormick Scale (MMS) score, while 31.1% remained stable. This high rate of improvement of stability (95.5%) is consistent with the findings of Guerrero-Saurez et al.<sup>1</sup>, who reported that surgical intervention is highly effective for intradural tumors when the patient presents with a better baseline neurological status. In a study by Ottenhausen et al.<sup>2</sup>, they concluded

that preoperative neurological state is a primary predictor of long-term functional outcomes. Our data supports this, as only 4.4% of our patients experienced a worsening of their MMS score.

## 2. Extramedullary vs Intramedullary comparison

The majority of our cases were intradural extramedullary (IDEM) tumors (89%), with meningioma (33.3%) followed by schwannoma (26.6%).

- IDEM tumors: In our cohort of 89% of extramedullary tumors, 95% had GTR and 5% had STR, showing IDEM had a good extent of resection ( $p < 0.001$ ) and better postoperative MMS score ( $p = 0.003$ ). This aligns with Soon et al.<sup>6</sup>, who identified that benign IDEM generally allows for more radical resection with lower morbidity compared to intramedullary tumors, but location of the tumor and postoperative outcome were not statistically significant ( $p = 0.098$ ) in their study.
- Intramedullary tumors: Our study included 5 patients (11.1%) with intramedullary tumors, primarily astrocytoma, followed by myxopapillary ependymoma at conus, and ependymoma with 3 patients (60%) had GTR, and 2 (40%) of them had subtotal resection. In a study by Khalil et al.<sup>7</sup>, the surgical management of intramedullary tumors is more complex due to a lack of clear surgical planes, often requiring a balance between resection and functional preservation.

## 3. Anatomical distribution and surgical approach

The thoracic/lumbothoracic regions were the most frequent sites in our study (57.7%), followed by the cervical/cervicothoracic region (22.2%), and meningioma (33.3%) was most common, followed by schwannoma (26.6%). In a study by Liu et al.<sup>3</sup>, the most common histological findings were schwannoma (36.6%), followed by meningioma (13.93%), and the most common level was lumbar/lumbosacral, followed by cervical/cervicothoracic. In our study, we have 89% laminectomy and 11% laminoplasty, all of which were done for long-segment intramedullary tumors. While Dieringer et al.<sup>8</sup> discussed the benefits of long segment approaches for certain resections, we focused on targeted laminectomies to minimize instability while achieving higher GTR.

## 4. Postoperative complications

In our study, we had 4.4% CSF leaks and 6.6% infection, which aligns with studies done by Hegazy et al.<sup>9</sup> and Ali et al.<sup>5</sup>. The authors highlight that while complications can occur, they do not always preclude a good functional outcome if properly managed. In a study by Jenkinson et al.<sup>10</sup>, the most common complications were CSF leak

(10%) and infection (7%), which aligns with our study. Similarly, in our study, 70% of extramedullary tumors improved, 30% had the same status, and 0% worse, while 20% of intramedullary tumors had improved, and 40% had the same status, and 40% had worse postoperative MMS, which aligns with a study done by Jenkinson et al.<sup>10</sup>

## 5. Histopathology and functional outcome:

In our study, meningioma, schwannoma and, and neurofibroma had better and static modified McCormick scale while astrocytoma and myxopapillary ependymoma at conus had worse MMS postoperatively, which was consistent with a study done by Ali AMS et al.<sup>5</sup> There was no significant association between tumor histopathology and change in MMS in our study.

## LIMITATION

This was a single-center analysis with a relatively small sample size, which limits statistical power and generalizability. It has significant cohort imbalance, extramedullary (n=40), intramedullary (n=5), and short-term follow-up.

## CONCLUSION

By comparing our results with Sharma et al.<sup>11</sup> and Randhawa et al.<sup>12</sup>, it is evident that the transition from preoperative deficit to postoperative recovery is a standard expectation in intradural lesions. A good preoperative neurological baseline and location is a significant positive predictors of an improved functional outcome. Our finding focuses that early diagnosis and surgical management are vital for optimizing the Modified McCormick scale score in spinal tumor patients.

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## CONFLICT OF INTEREST

The author(s) declare that they do not have any conflict of interest regarding the publication of this article.

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