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Original Research Article

CLINICAL PROFILE, RADIOLOGICAL SPECTRUM AND SURGICAL OUTCOME OF SPINAL CORD TUMORS: A PROSPECTIVE INSTITUTIONAL STUDY OF 100 CASES

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ABSTRACT

Background: Spinal cord tumors are uncommon neoplasms with a heterogeneous clinical presentation that frequently delays diagnosis. Prospective institutional data correlating clinical, radiological, and pathological features with short-term functional outcomes after surgery remain limited. This study aimed to analyze the presenting symptoms, neurological status, radiological and pathological findings, and functional outcome at one, three, and six months in patients undergoing surgery for spinal cord tumors.

Materials and Methods: This before-and-after interventional study was conducted in the Department of Neurosurgery at Government Stanley Medical College and Hospital, Chennai. A total of 100 patients, aged 18-60 years, who underwent surgical excision of a spinal cord tumor between Aug 2016 and Feb 2020 were selected using judgmental sampling. Clinical features, lesion compartment on magnetic resonance imaging, histopathological diagnosis, and Karnofsky Performance Scale (KPS) scores were recorded and analyzed. Patients were followed up at one, three, and six months post-surgery, and statistical analysis was performed using chi-square testing, one-way ANOVA, and repeated-measures ANOVA with Bonferroni correction.

Results: Most patients (55.0%) were aged 31-45 years, with a female preponderance (60.0%). Pain (83.0%) and sensory disturbance (76.0%) were the commonest presenting features; motor weakness was least common (35.0%). Intradural extramedullary tumors predominated (62.0%), and schwannoma was the commonest histological diagnosis (39.0%), followed by meningioma (29.0%). Neither lesion compartment nor pathology showed a significant association with age ($p>0.05$). Mean KPS improved significantly from 71.1±13.3 preoperatively to 79.4±11.4 at six months ($F=81.391$, $p<0.001$), with significant gains evident from three months onward.

Conclusion: Spinal cord tumors predominantly affect middle-aged adults and present with pain and sensory disturbance. Intradural extramedullary lesions, particularly schwannoma and meningioma, are most common. Surgical excision produces significant, progressive functional improvement across all age groups, supporting an operative approach irrespective of patient age.

Keywords: Spinal cord tumor; Schwannoma; Meningioma; Karnofsky Performance Scale; Laminectomy; Neurological outcome.

INTRODUCTION

Primary tumors of the spinal cord are an uncommon but clinically important subset of central nervous system neoplasms, accounting for approximately 4-18% of all primary tumors of the neuraxis.[1,2] Based on their anatomical relationship to the dura mater and the spinal cord parenchyma, these lesions are conventionally classified into three groups: extradural, intradural extramedullary, and intradural intramedullary.[3,4] Extramedullary tumors, principally nerve sheath tumors and meningiomas, constitute roughly two-thirds of all spinal cord tumors, while intramedullary lesions such as

astrocytoma and ependymoma make up the remaining third.[3,4] Unlike their intracranial counterparts, spinal cord tumors are predominantly benign and are frequently amenable to complete surgical excision, although their occurrence at any level of the cord produces a wide and often non-specific range of clinical presentations, from an incidental radiological finding to profound paraplegia with bowel and bladder incontinence. The surgical management of spinal cord tumors has evolved considerably over the past two centuries. The earliest reported successful laminectomy for a spinal lesion was performed by Alban G. Smith in 1828 and published the following year,[5] while Sir Victor Horsley's 1887 excision of a thoracic tumor in a paraplegic patient, guided only by neurological localization, is regarded as a landmark that established laminectomy as a viable intervention.[6] Subsequent contributions by von Eiselsberg, Cushing, and particularly Charles Elsberg, who pioneered staged extrusion of intramedullary tumors and is regarded as the father of spinal cord surgery, laid the foundation for modern spinal oncological surgery.[7-10] The introduction of intrathecal myelography permitted, for the first time, a radiological basis for the extradural/intradural classification, and the subsequent advent of the operating microscope and micro neurosurgical technique in the 1960s, followed by magnetic resonance imaging in the 1980s, transformed both the accuracy of preoperative localization and the safety of resection.

Epidemiological data suggest an incidence of primary spinal cord tumors of approximately 0.74 per 100,000 person-years, with a slight female preponderance,[11] and notable regional variation exists in the relative proportion of individual histological subtypes, with nerve sheath tumors forming a disproportionately larger share of extramedullary tumors in some Asian populations than in Western series.[12-15] Diagnosis is frequently delayed because the initial symptoms - vague pain, mild sensory change, or subtle weakness - are often mistaken for degenerative spinal disease, with reported intervals from symptom onset to diagnosis ranging from 8 to 17 months.[16,17] The character of pain, sensory distribution, and pattern of motor involvement can, however, provide useful clues to the level and intradural/extradural relationship of the lesion even before imaging is obtained.[18] Contrast-enhanced magnetic resonance imaging remains the investigation of choice, permitting differentiation of tumor from the surrounding dura, cord, and cerebrospinal fluid on the basis of signal characteristics and pattern of enhancement.[19] Given the variability in clinical presentation, the frequent delay in diagnosis, and the paucity of prospective institutional data correlating clinical, radiological, and pathological features with functional recovery from the Indian subcontinent, we undertook this study to analyze the presenting symptoms, neurological status, radiological findings, and short-term functional outcome, assessed using the Karnofsky Performance Scale at one, three, and six months, in patients who underwent surgery for spinal cord tumors at our institution.

MATERIALS AND METHODS

Study design and setting: This was a hospital-based, before-and-after interventional study conducted in the Department of Neurosurgery, Government Stanley Medical College and Hospital, Chennai. The study population was drawn from the departmental patient database of all individuals who presented with a spinal cord tumor between August 2016 and February 2020 and who subsequently underwent surgical excision with structured clinical follow-up at one, three, and six months. Data abstraction, follow-up analysis, and outcome scoring were carried out by the principal investigator between November 2020 and January 2021, after approval was obtained from the Institutional Ethics Committee of Government Stanley Medical College and Hospital (approval dated 3 November 2020). Written informed consent for the use of clinical records for research purposes was obtained from all patients at the time of their original presentation.

Patient selection: Patients who had consented to surgery and who satisfied the pre-specified selection criteria were included by judgmental sampling.

Inclusion criteria:

1. A confirmed diagnosis of spinal cord tumor in patients presenting to the department between August 2016 and February 2020.
2. Patients who underwent surgical excision and were followed up at one, three, and six months.
3. Age between 18 and 60 years.
4. Either sex.

Exclusion criteria:

1. Patients with compressive myelopathy are attributable to degenerative disc disease.
2. Patients with compressive myelopathy attributable to trauma.
3. Patients with compressive myelopathy attributable to infective/inflammatory aetiology.

These aetiologies do not represent true neoplastic disease and would confound the assessment of tumor-related functional recovery. Applying these criteria, 100 case records meeting the selection criteria were chosen for detailed analysis; every patient presenting with a histologically confirmed spinal cord tumor who consented to surgery was considered operable and taken up for excision.

Clinical assessment: For every patient, a detailed history and a complete spino-motor and sensory examination were documented preoperatively and at each follow-up visit using a structured proforma. Recorded variables included the duration of symptoms in months; the presence or absence of pain (further classified as local, radicular, or funicular/ill-localized) and sensory disturbance; the presence of gait ataxia; the presence of motor weakness, graded

using the Medical Research Council (MRC) scale; and the presence of sphincter (bowel/bladder) dysfunction. Overall functional status was quantified preoperatively (baseline) and at one, three, and six months postoperatively using the Karnofsky Performance Scale (KPS), a validated 0-100 ordinal instrument in which higher scores denote greater independence and lower symptom burden (30).

Radiological evaluation: All patients underwent gadolinium-enhanced magnetic resonance imaging (MRI) of the relevant spinal segment as the investigation of choice, since this modality best delineates the tumor from the adjacent cord, dura, and cerebrospinal fluid. Sagittal and axial T1- and T2-weighted sequences, together with post-contrast imaging, were used to localize the lesion and to assign it to one of three anatomical compartments: extradural (ED), intradural extramedullary (IDEM), and intradural intramedullary (IM). This classification, together with lesion-specific imaging characteristics (signal intensity, pattern and homogeneity of enhancement, presence of a dural tail, cystic change, flow voids, or a "cap sign"), guided operative planning and was subsequently correlated with the final histopathological diagnosis.

Surgical technique: All patients received a single dose of pre-operative antibiotic prophylaxis, and the lateral thigh was prepared for harvest of a fascia lata graft should this be required for dural closure. Patients were positioned prone with the abdomen and thorax adequately supported to minimize epidural venous engorgement, and pressure points, the eyes, and the genitalia were carefully padded. The vertebral level was confirmed by intraoperative fluoroscopy both before and after surgical exposure. A midline skin incision was carried down to the fascia, and the paraspinal musculature was subperiosteally elevated from the spinous processes and laminae with bipolar coagulation of bleeding vessels. A conventional laminectomy was performed using a flat-footed Kerrison punch to avoid pressure on the underlying cord, with the ligamentum flavum kept intact until adequate bony decompression had been achieved. The epidural fat was then divided in the midline and mobilized laterally with bipolar coagulation. For intradural lesions, a midline durotomy was performed under the operating microscope; the dural edges were retained under gentle tension with stay sutures, and arachnoid dissection was completed with micro scissors; moist cotton patties were kept along either side of the cord throughout to prevent blood tracking into the subdural space. For intramedullary tumors, a midline myelotomy was fashioned over the point of maximal swelling or discoloration, aided where possible by the identification of enlarged or arterialized feeding vessels; the tumor was then debulked using a combination of tumor forceps, sharp microdissection, and, where indicated, ultrasonic aspiration, with dissection carried along the tumor-cord interface up to the transition zone. An identical stepwise technique of debulking and circumferential dissection was applied for extramedullary lesions. After excision, watertight dural closure was performed primarily or, where the native dural margins were insufficient, using an artificial dural substitute or an autologous fascia lata graft; the remaining layers were closed in an imbricated fashion to minimize the risk of postoperative cerebrospinal fluid leak. Drains were removed on the second postoperative day, after which patients were mobilized, and skin sutures were removed on the tenth postoperative day.

Statistical analysis: Data were entered in Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY). Categorical variables were summarized as frequencies and percentages, and continuous variables as mean and standard deviation. Associations between categorical variables (lesion compartment and pathological diagnosis with age group) were tested using Pearson's chi-square test. Differences in continuous variables (duration of symptoms and Karnofsky score) across the three age groups were assessed by one-way ANOVA. Change in Karnofsky score across the four study time points (preoperative, one, three, and six months) was analyzed using repeated-measures ANOVA, with pairwise comparisons corrected for multiple testing using the Bonferroni method to control the type I error rate. A two-tailed p-value of less than 0.05 was considered statistically significant throughout.

RESULTS

One hundred patients meeting the selection criteria were analyzed. The majority (55.0%) were aged between 31 and 45 years, with 23.0% aged 18-30 years and 22.0% aged 46-60 years. There was a female preponderance, with 60 patients (60.0%) being female and 40 (40.0%) male [Table 1].

Table 1: Age and sex distribution of patients with spinal cord tumors (n=100)

Variable	Frequency (n)	Percentage (%)
Age group		
18 - 30 years	23	23.0
31 - 45 years	55	55.0
46 - 60 years	22	22.0
Sex		
Female	60	60.0
Male	40	40.0
Total	100	100.0

Values are expressed as frequency (n) and percentage (%). Data are derived from the departmental case-record proforma.

Pain was the most frequent presenting symptom, reported by 83 patients (83.0%), followed by sensory disturbance in 76 patients (76.0%). Gait ataxia was present in 48 patients (48.0%) and sphincter dysfunction in an equal proportion (48.0%). Motor weakness was the least common presenting complaint, documented in only 35 patients (35.0%) [Table 2, Figure 1].

Table 2: Distribution of presenting clinical features (n=100)

Clinical feature	Present (n)	Present (%)	Absent (n)	Absent (%)
Pain	83	83.0	17	17.0
Sensory disturbance	76	76.0	24	24.0
Gait ataxia	48	48.0	52	52.0
Motor weakness	35	35.0	65	65.0
Sphincter dysfunction	48	48.0	52	52.0

Percentages are calculated out of the total cohort of 100 patients for each clinical feature independently.

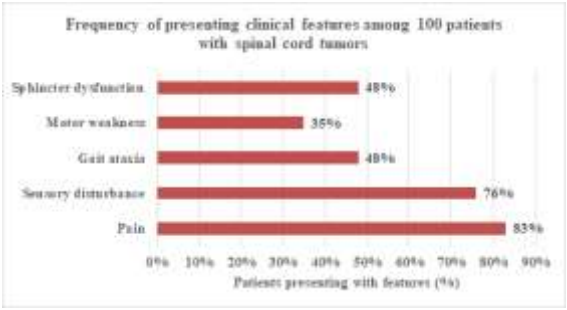

Figure 1: Frequency of presenting clinical features among 100 patients with spinal cord tumors

Values shown above each bar represent the percentage of the total cohort (n=100) presenting that clinical feature. Pain and sensory disturbance were the most frequent presenting complaints; motor weakness was the least frequent.

On anatomical classification by MRI, intradural extramedullary (IDEM) tumors were the most common lesion type, accounting for 62 cases (62.0%), followed by extradural (ED) tumors in 25 cases (25.0%) and intradural intramedullary (IM) tumors in 13 cases (13.0%). When lesion compartment was cross-tabulated against age group, extradural lesions were proportionally most frequent in the 46–60-year group (40.9%), while intramedullary lesions were proportionally most frequent in the youngest group (17.4%); however, this association did not reach statistical significance on Pearson's chi-square testing ($\chi^2 = 5.468$, $p = 0.243$) [Table 3].

Table 3: Distribution of tumor lesion compartment across age groups

Lesion compartment	18-30 yrs n (%)	31-45 yrs n (%)	46-60 yrs n (%)	Total n (%)
Extradural (ED)	6 (26.1)	10 (18.2)	9 (40.9)	25 (25.0)
Intradural extramedullary (IDEM)	13 (56.5)	37 (67.3)	12 (54.5)	62 (62.0)
Intradural intramedullary (IM)	4 (17.4)	8 (14.5)	1 (4.5)	13 (13.0)
Total	23 (100.0)	55 (100.0)	22 (100.0)	100 (100.0)

ED, extradural; IDEM, intradural extramedullary; IM, intradural intramedullary. Pearson's chi-square test: $\chi^2 = 5.468$, $p = 0.243$ (not significant).

Histopathological examination of the excised specimens showed schwannoma to be the single most common tumor, accounting for 39 cases (39.0%), followed by meningioma in 29 cases (29.0%) and ependymoma in 11 cases (11.0%). Neurofibroma accounted for 5 cases (5.0%), astrocytoma for 4 cases (4.0%), lipoma for 3 cases (3.0%), and angioblastoma, cavernous angioma, dermoid, epidermoid, lymphoma, and metastatic secondaries each accounted for 1-2 cases (1.0-2.0%) (Figure 2). As with lesion compartment, the distribution of pathological diagnoses across the three age groups showed no statistically significant association ($\chi^2 = 33.051$, $p = 0.061$), although schwannoma showed a numerically increasing proportional representation with advancing age group (30.4%, 40.0%, and 45.5% in the 18-30-, 31-45-, and 46–60-year groups respectively) [Table 4].

Table 4: Distribution of histopathological diagnosis (n=100)

Histopathological diagnosis	Frequency (n)	Percentage (%)
Schwannoma	39	39.0
Meningioma	29	29.0
Ependymoma	11	11.0
Neurofibroma	5	5.0
Astrocytoma	4	4.0
Lipoma	3	3.0
Angioblastoma	2	2.0
Cavernous angioma	2	2.0
Secondaries (metastasis)	2	2.0

Dermoid	1	1.0
Epidermoid	1	1.0
Lymphoma	1	1.0

Association between histopathological diagnosis and age group: Pearson's chi-square test, $\chi^2 = 33.051$, $p = 0.061$ (not significant).

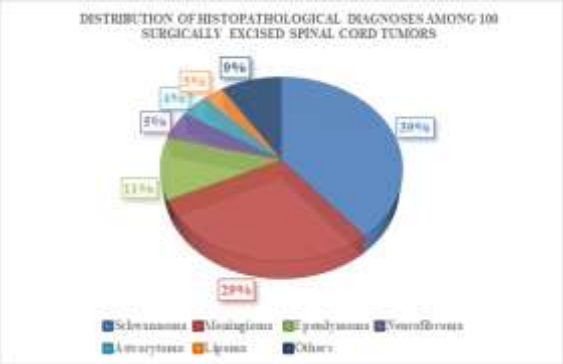

Figure 2: Distribution of histopathological diagnoses among 100 surgically excised spinal cord tumors

"Others" comprises angioblastoma, cavernous angioma, dermoid, epidermoid, lymphoma, and metastatic secondaries (2 cases each or fewer). Schwannoma and meningioma together accounted for 68% of all tumors.

The mean duration of symptoms before presentation was 10.1 ± 4.0 months in the 18–30-year group, 11.5 ± 4.2 months in the 31–45-year group, and 9.6 ± 3.8 months in the 46–60-year group; this difference was not statistically significant on one-way ANOVA ($F = 1.918$, $p = 0.152$).

Functional status, assessed by the Karnofsky Performance Scale, showed a consistent improvement across all age groups over the course of follow-up. When compared across the three age groups at each time point, mean Karnofsky scores did not differ significantly - preoperatively (72.6 ± 14.8, 72.7 ± 12.7, and 65.5 ± 12.2 respectively; $F = 2.614$, $p = 0.078$), at one month ($F = 2.563$, $p = 0.082$), at three months ($F = 2.755$, $p = 0.069$), or at six months ($F = 1.343$, $p = 0.266$) - although scores in the oldest age group (46-60 years) were consistently, if not significantly, lower than in the two younger groups at every time point (Table 5).

When the overall cohort was analyzed longitudinally, repeated-measures ANOVA demonstrated a highly significant improvement in mean Karnofsky score over the course of follow-up (preoperative 71.1 ± 13.3, one month 71.9 ± 13.2, three months 75.6 ± 11.9, and six months 79.4 ± 11.4; $F = 81.391$, $p < 0.001$) (Table 5). Bonferroni-corrected pairwise comparisons showed that the improvement between the preoperative assessment and the one-month follow-up alone did not reach statistical significance (mean difference -0.800, $p = 0.354$); every other pairwise comparison - preoperative versus 3 months, preoperative versus 6 months, 1 month versus 3 months, 1 month versus 6 months, and 3 months versus 6 months - showed a highly significant improvement in functional score ($p < 0.001$ for all) [Table 5]. This pattern indicates that while meaningful functional recovery is not yet detectable at one month, a significant and progressive gain in performance status becomes evident from the third postoperative month onward and continues through six months of follow-up.

Table 5: Karnofsky Performance Scale (KPS) score across the follow-up period (repeated-measures ANOVA)

Time point	N	Mean KPS	S.D.	Statistic
Preoperative (baseline)	100	71.1	13.3	Repeated measures ANOVA: $F = 81.391$ $p < 0.001$
1 month postoperative	100	71.9	13.2	
3 months postoperative	100	75.6	11.9	
6 months postoperative	100	79.4	11.4	

S.D., standard deviation. Overall comparison by repeated-measures ANOVA with Bonferroni correction for multiple comparisons: $F = 81.391$, $p < 0.001$.

Table 5 (continued). Pairwise comparison of Karnofsky Performance Scale scores between follow-up time points

Comparison	Mean difference	p-value	95% CI
Preoperative vs 1 month	-0.800	0.354 (NS)	-1.93 to 0.33
Preoperative vs 3 months	-4.500	<0.001*	-6.23 to -2.77
Preoperative vs 6 months	-8.300	<0.001*	-10.33 to -6.27
1 month vs 3 months	-3.700	<0.001*	-5.06 to -2.34
1 month vs 6 months	-7.500	<0.001*	-9.31 to -5.69
3 months vs 6 months	-3.800	<0.001*	-5.22 to -2.38

*Statistically significant at $p < 0.001$ (Bonferroni-corrected). NS, not significant ($p > 0.05$). CI, confidence interval.

DISCUSSION

This institutional series of 100 surgically treated spinal cord tumors demonstrates a demographic, clinical, and pathological profile broadly consistent with that reported in wider literature, while adding prospectively collected short-term functional outcome data using the Karnofsky Performance Scale. The peak occurrence of spinal cord tumors in the middle-aged group (31-45 years), together with

the female preponderance observed in this cohort, mirrors previously reported epidemiological data, which similarly describe a middle-aged predilection with a slight female excess, largely attributable to the higher frequency of meningioma in women.[11] Pain was, as in most published series, the dominant complaint, followed by sensory disturbance, while motor weakness was comparatively uncommon at presentation. This sequence is consistent with the described distinction between funicular pain, which is characteristically ill-localized and more typical of intramedullary lesions, and radicular pain, which is sharper, dermatomal, and provoked by maneuvers that raise intraspinal pressure, and which tends to present earlier and more specifically in extramedullary and extradural tumors.[18] The comparatively low prevalence of motor weakness and the near-equal prevalence of gait ataxia and sphincter dysfunction in our series likely reflect the slow, indolent growth pattern characteristic of most spinal cord tumors, in which sudden neurological deterioration is uncommon, and patients often present only once a symptom becomes functionally disabling rather than at first onset.

Intradural extramedullary tumors accounted for almost two-thirds of cases in this series, a proportion in keeping with the widely cited observation that extramedullary tumors - principally nerve sheath tumors and meningiomas - constitute the majority of spinal cord neoplasms, with intramedullary lesions accounting for a smaller minority.[3,4,16] Schwannoma was the single most common histological diagnosis in our cohort, followed closely by meningioma, together accounting for over two-thirds of all tumors. This distribution is broadly comparable with several Asian series and is consistent with the previously described tendency of schwannomas to constitute a disproportionately larger share of extramedullary tumors in Japanese and other Asian populations relative to Western cohorts, in which meningioma or an even split between the two entities is more typical.[12-15] At the tissue level, the histological features observed on review of our specimens - the Antoni A/Antoni B architecture and S100/SOX10 positivity of schwannoma [Figure 3], the whorled meningothelial architecture with EMA and progesterone receptor positivity of meningioma [Figure 4], and the perivascular pseudo rosette formation characteristic of ependymoma [Figure 5] - correspond closely with descriptions in standard neuropathological references, supporting the reliability of pathological diagnosis in this series.[20-24] Although schwannoma and meningioma are conventionally graded as WHO Grade I, and most spinal astrocytomas and ependymomas in adults are similarly low-grade, we noted the expected higher-grade features (increased cellularity, mitotic activity) among the small subset of anaplastic and diffuse astrocytomas identified [Figure 6], findings consistent with the histological spectrum described for spinal cord gliomas.[25,26] The absence of a statistically significant association between lesion compartment or histological diagnosis and age group in our cohort is in keeping with the generally accepted view that, unlike many intracranial tumors, most spinal cord tumor subtypes do not show strong age-restricted predilection, aside from the recognized paediatric preponderance of astrocytoma and the female preponderance of meningioma described elsewhere.[16]

Figure 3: Photomicrograph of a spinal schwannoma

Haematoxylin and eosin-stained section from an excised intradural extramedullary schwannoma, showing the characteristic hypercellular Antoni A and loosely cellular Antoni B architecture described in the surgical specimens of this series.

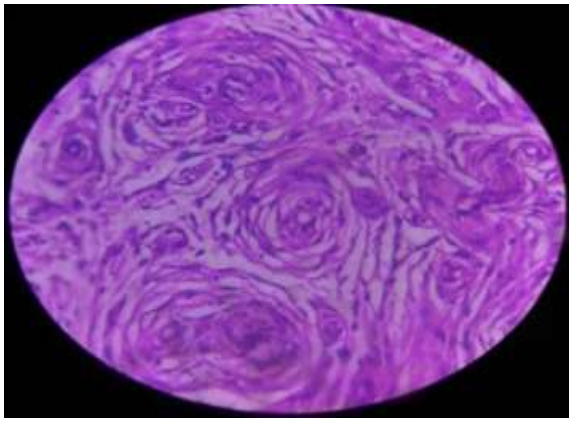

Figure 4: Photomicrograph of a spinal meningioma

Haematoxylin and eosin-stained section showing whorled meningothelial architecture with syncytial cells and indistinct cell membranes, typical of the meningiomas excised in this cohort.

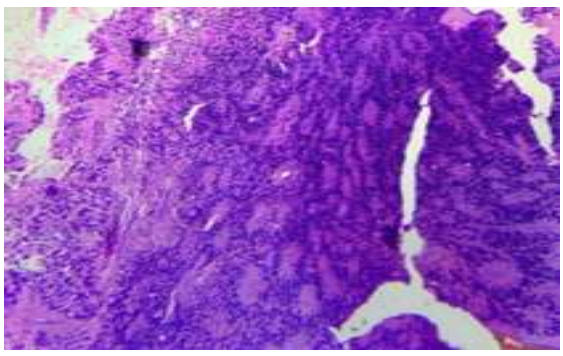

Figure 5: Photomicrograph of a spinal ependymoma

Section showing perivascular pseudorosette formation, a characteristic histological feature used to confirm the diagnosis of ependymoma among the intramedullary tumors in this series.

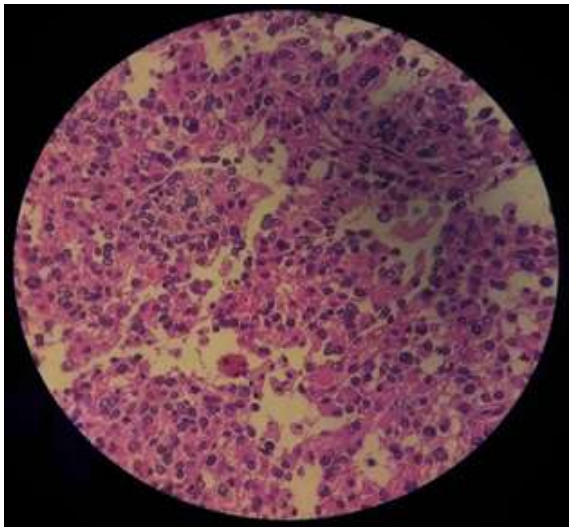

Figure 6: Photomicrograph of a spinal cord astrocytoma

Section from a low-grade spinal astrocytoma showing glial cell proliferation with moderately increased cellularity, representative of the astrocytomas identified in this cohort.

The functional outcome data in this series are, in our view, the most clinically relevant findings. The overall cohort showed a highly significant and sustained improvement in Karnofsky Performance Scale score from the preoperative baseline through six months of follow-up, with the greater part of this recovery becoming statistically demonstrable only after the first postoperative month. This pattern - an initial plateau followed by progressive gain - is consistent with the recognized trajectory of neurological recovery following decompressive and tumor-excisional spinal surgery, in which early postoperative oedema, positional pain, and wound-related morbidity can transiently mask or delay the emergence of the neurological benefit of decompression, which then becomes more apparent over subsequent months as perilesional oedema resolves and any residual, non-transected neural pathways recover function. Although patients in the oldest age band (46-60 years) had consistently lower mean Karnofsky scores at every time point than their younger counterparts, the absence of a statistically significant age-related difference in either the degree or the rate of recovery is an important and reassuring observation, suggesting that chronological age alone should not be used as a determinant of candidacy for surgery in an otherwise operable spinal cord tumor, and that meaningful functional gains can be anticipated even in patients presenting in the sixth decade of life.

This study has several limitations that merit consideration. It was conducted at a single tertiary referral centre using a judgmental (non-random) sampling method, both of which may limit generalizability. Follow-up was restricted to six months, and the study was therefore not designed to capture late recurrence, delayed neurological deterioration, or long-term survival, particularly relevant to higher-grade intramedullary lesions. Finally, functional outcome was assessed using a global performance scale rather than a spine-specific or health-related quality-of-life instrument, which may not capture the full spectrum of residual sensory or sphincteric morbidity. Prospective, multicentric studies with longer follow-up and validated spine-specific outcome instruments would help to further characterize the determinants of long-term recovery in this population.

CONCLUSION

This prospective institutional analysis of 100 surgically managed spinal cord tumors confirms that these lesions occur predominantly in middle-aged adults, with a modest female preponderance, and that pain and sensory disturbance, rather than overt motor weakness, are the dominant presenting features. Intradural extramedullary tumors, principally schwannoma and meningioma, constitute the great majority of lesions in this series, a distribution consistent with previously reported regional patterns. Neither the anatomical compartment nor the final histopathological diagnosis showed a statistically significant relationship with patient age, and the duration of symptoms prior to presentation did not differ meaningfully across age groups, reinforcing the observation that clinical suspicion, rather than age or symptom chronology alone, should guide the decision to pursue spinal imaging.

The most clinically important finding of this study is the pattern of functional recovery following surgery. Karnofsky Performance Scale scores improved significantly and progressively from the preoperative baseline through six months, with the majority of this improvement emerging after the first postoperative month rather than immediately, and this trajectory of recovery was preserved across all age groups, including patients in their fifth and sixth decades. These findings support an operative approach to spinal cord tumors whenever technically feasible, regardless of patient age, and underscore the importance of structured postoperative surveillance extending beyond the immediate perioperative period, since the true extent of neurological benefit may not become apparent for several months. We recommend that surgical intervention be complemented by prompt and sustained rehabilitation for patients presenting with neurological deficits, and that functional outcome be tracked using a standardized scale such as the Karnofsky Performance Scale to allow objective comparison across time points and, ultimately, across institutions. Larger, multicentric, and longer-term prospective studies are warranted to validate these

findings and to further define the predictors of functional recovery in this patient population.

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