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Original Article

Surgical Outcomes of Patients with Benign Spinal Tumors: Insights from A Prospective Quasi Experimental Study

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Abstract:

Background: *Spinal tumor is one of the causes of back pain, sensory motor deficit and bowel bladder dysfunction. Evaluation of postoperative mortality, morbidity and outcomes after resection of spinal cord tumors is critical to the practice of evidence-based medicine. Hence, it is important to carefully examine surgical outcomes at an institutional level.*

Objectives: *The aim of the study was to describe the results of benign spinal tumor after surgical treatment according to location.*

Materials & Method: This quasi-experimental study was conducted in the Department of Neurosurgery, Chittagong Medical College and Hospital for a period of 12 months. Twenty eight cases of benign spinal tumor underwent surgical treatment were enrolled in the study. Average hospital stay from surgery to discharge was 12-15 days. Postoperative neurological outcome in Frankel's grade and bowel bladder involvement were assessed from 1st POD to 3rd month after surgery and data were recorded at 7th POD, 1st month and 3rd month after surgery. Collected data were analyzed by using SPSS-23.

Results: *Among the 28 cases, 15 were men and 13 were women. The mean age was 36.19 (±14.29) years and age range was 15 to 62 years. Twenty three (82.14%) patients improved by at least one Frankel grade and remaining five (17.86%) patients maintained their preoperative Frankel grade. Out of eight (28.6%) cases with absent bowel bladder dysfunction before surgery six (75%) recovered within three months. Postoperative deterioration was not observed in any of the included case. Ten (35.7%) patients had excellent outcome (having Frankel grade E with normal bowel bladder control) and 18 patients (64.3%) had good/ fair outcome (partial recovery or clinically insignificant recovery) after 3 months. Age, gender and location (axial and sagittal) of benign spinal tumor were not found to have significant variation of neurological outcome.*

Conclusion: *Majority of patients irrespective of the location (axial/ sagittal) of the tumor had a favorable clinical outcome three months after the operation.*

Key words: *Spinal Tumor, Benign, Surgical Outcome, SOL, Frankel Grade*

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Introduction:

Spinal tumor can arise from intraspinal structure such as spinal cord, nerve roots, meninges, blood vessel, and other tissues[1]. The location of a spinal tumor and its cell of origin have an important anatomic correlation that serves to guide diagnosis and treatment [2]. Spinal cord tumors account for about 15% of central nervous system tumors. Primary spinal cord tumor may be benign or malignant. 5-10% primary spinal cord tumors originate from cells within the spinal cord parenchyma. The other 90-95% of primary spinal cord tumor arise from cells adjacent to the spinal cord, such as those of the spinal nerve roots or meningeal coverings. Meningioma and neurofibromas are the most common benign intradural extramedullary spinal cord tumors[3]. Spinal tumors or lesions are classified according to their relation with dura and spinal cord. These are - 1. Extradural (ED) - Arises from vertebra, epidural tissues or secondary. Examples: Chondroma, osteoid sosteoma, osteogenic sarcoma, multiple myeloma, plasmacytoma, abscess, neurinoma, meningioma, lipoma etc. 2. Intradural Extramedullary (IDEM) - Meningioma, schwannoma, neurofibroma etc. 3. Intramedullary spinal cord tumor (IMSCT) - Astrocytoma, ependymoma, epidermoid, dermoid,cavernoma, hamangioblastoma . Nerve sheath tumors are the most common type of accounting for 25-30% of all primary spinal cord tumor. Meningioma account for 25% of spinal cord tumor [3].Most common histological types of intramedullary tumors are astrocytomas and ependymomas .Other intramedullary tumors are haemangioblastomas, lipoma, metastases and miscellaneous lesions [4]. Majority spinal tumors are benign in nature. The axial skeleton is common site for primary tumors and metastatic disease.

Pain is the early symptom of spinal tumor followed by numbness, motor weakness, muscle wasting, myoclonus are common. Bowel bladder involvement occurs in spinal tumor both above the sacral centers and roots corresponding to cauda equina or at sacral centers and roots corresponding to cauda equina. Investigations are X-ray of spine, MRI of spine with contrast and CT scan of spine in most cases. Surgical removal of spinal tumor is the treatment option followed by treatment depends upon histopathology. In appropriate patient, surgery can improve the quality of life by improving pain relief and mobility. The aim of surgery should not only be debulking the tumor, but also preservation of neural structures and realign the spinal elements with restoration of spinal stability [3,4]. Treatment of spine and spinal cord tumors is complex and multidisciplinary approach. Outcome is depended upon a number of factors. These factors are the site of tumor compression within the spinal canal, early diagnosis, the histological characteristics of the tumors, the neurological progression, initial response to corticosteroid therapy, patient age, comorbidity, tumor extension, involvement of neighbor structures and organ [5]. Benign spinal tumor has a favorable immediate outcome and long time prognosis. The degree and rate of recovery after removal of tumor depends on some factors like the duration, severity, location of tumor and the change in the spinal cord [6]. Due to the rarity of spinal tumors, there have been large time gaps among the reports and studies that involve cases collected for more than a 10 year period or the reports have been focused on an analysis of the existing literature. In other words, it is difficult to find studies that are focused on a certain radiological examination technique or a surgical procedure. In this study, we assessed the benign spinal tumors that were surgically managed in the Neurosurgery Department of Chittagong Medical College and Hospital (CMCH) with regard to the tumor location, the preoperative medical history and the clinical symptoms and the postsurgical outcome.

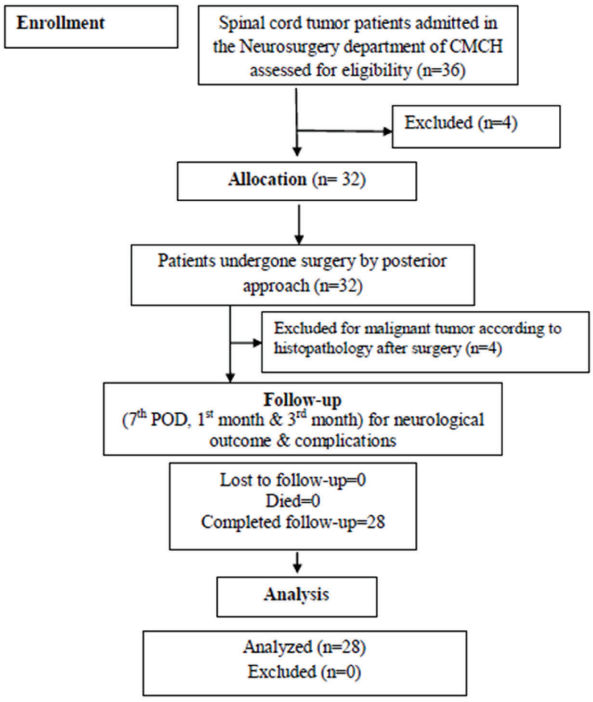
Methods:

Single institutional study ethics approval was granted by the local institutional ethics board. Written informed consent was obtained from all patients or guardians. This was a quasi-experimental study conducted in the Department of Neurosurgery, Chattogram Medical College and Hospital, Chattogram, Bangladesh for a period of 1 year from June 2019 to June 2020. All patients with a diagnosis of benign spinal tumor admitted in the Neurosurgery department, CMCH during study period was included in the study based on certain inclusion criteria: 1. Benign intradural extramedullary spinal tumor. 2. Benign intramedullary spinal tumor. 3. Benign extradural spinal tumor. Exclusion criteria were: 1. Malignant tumor. 2. Associated with infection. 3.Benign spinal tumor extending to neighbor organ. 4.Patients or guardians not willing to participate in the study by signing informed consent form. A predesigned Structured Case Record Form was used to collect data. Preoperative neurological evaluations were recorded by Frankel grading. Assessment of bowel bladder involvement was recorded. Surgery was done after proper counseling and taking informed written consent. Nature of the tumor (benign or malignant) was confirmed by histopathology and immunohistochemistry (where applicable). Then assessment was done after 7th POD, 1st month & 3 months follow up.

Data obtained were compiled in Microsoft Xcel sheet to generate a master sheet. Then they were fed into computer software package (SPSS, version 23) for

processing and analysis. Continuous data were reported as the means ± SD. Qualitative or categorical data were described as frequencies and proportions. Proportions were compared using chi-square test. Independent sample t test was used for between-group comparisons of mean and ANOVA test was used to compare more than two means. Statistical significance was defined as $p < 0.05$.

Study Flow Chart:



Results:

Table I depicts that spinal lesions occur over a wide age range (15 to 62 years), with mean age at surgery being 36.19 (±14.29) years among 28 patients. There was a male preponderance in the present study.

Almost all patient presented with Pain and paresthesia 28(100) followed by motor involvement in the form of paraparesis 57.1%, paraplegia and quadriplegia 17.9%. Only 28.6% patient presented with bladder / bowel problem.

Overall the most common spinal level affected in this 28 patients were dorsal spine (10/28=35.71%) followed by cervical and lumbar region (9/28=32.14% in each level).

Both Table III and Table IV depicts that, In present study schwannomas constitute 60.7% followed by Neurofibromas which is 21.4% in axial location as per histopathology.

Preoperative neurological status as assessed by Frankel Grade classification is shown in Figure 3. It depicts that, majority of the patients (13/28=46.4%) were in Grade C, followed by 35.7% (10/28) in Grade D. Only 2 (7.1%) and 3 (10.7%) of patients were in Grade A and Grade B respectively.

Another case is Intradural extramedllary spinal SOL at D12-L1 level which was managed by posterior laminectomy and excison of SOL. Watertight dural closure was done without any stabilization as single level laminectomy was performed in posterior segment.

Rosai-Dorfman disease is a rare, benign, self-limiting lymphoproliferative disorder can present at any age, but most commonly in the third and fourth decade, with a slight male predominance. Surgery is the treatment of choice and has good recovery if diagnosed early.

Table-I

Distribution of age, sex and anatomical site of benign spinal tumors in 28 patients

Variables	Total n=28	Extradural n=2	IDEM n=24	IMSCT n=2	P value
Age (years)					
Mean ±SD	36.19±14.29	31.50±2.12	37.25±14.39	36.50±26.16	0.870*
Sex					
Male	15 (53.6)	2 (100)	12 (50.0)	1 (50.0)	0.393†
Female	13 (46.4)	0 (0)	12(50.0)	1(50.0)	

Data are expressed as frequency (percentage). ED: Extradural; IDEM: Intradural extramedullary; IMSCT: Intramedullary spinal cord tumor.

*Obtained from ANOVA test I; †Obtained from Chi-square test.

Table-II

Clinical characteristics of 28 patients with benign spinal tumors

Characteristics	Frequency (percentage)
Types of motor involvement	
Paraparesis	16 (57.1)
Paraplegia	5 (17.9)
Quadriplegia	5 (17.9)
Hemiparasis	2 (7.1)
Pain and paresthesia	28 (100)
Absence of bladder/bowel bladder control	8 (28.6)

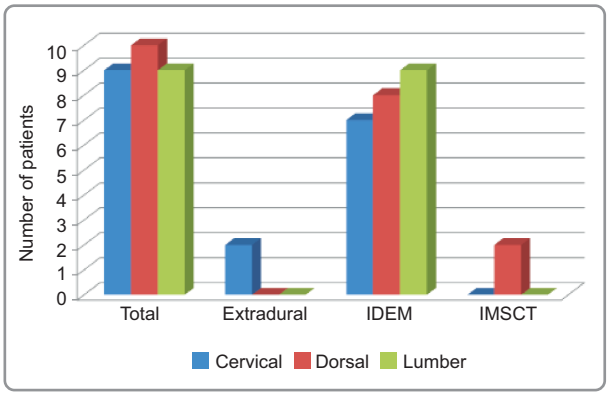


Figure 2: *Spinal level of the 28 benign spinal tumors according to their anatomical site (IDEM: Intradural extramedullary; IMSCT: Intramedullary spinal cord tumor).*

Table-III

Histopathology according to anatomical site (axial location) of 28 patients of benign spinal tumors

Histological type	Total (n=28)	Extradural (n=2)	IDEM (n=24)	IMSCT (n=2)	P value†
Schwannomas	17 (60.7)	0 (0)	16 (94.1)	1 (5.9)	0.046
Neurofibromas	6 (21.4)	1 (16.7)	5 (83.3)	0 (0)	0.467
Meningiomas	3(10.7)	0 (0)	3 (100)	0 (0)	0.756
Hemangioma	1 (3.6)	0 (0)	0 (0)	1 (100)	0.001
Rosai-Dorfman disease	1 (3.6)	1 (100)	0 (0)	0 (0)	0.001

Data are expressed as frequency (percentage); IDEM: Intradural extramedullary; IMSCT: Intramedullary spinal cord tumor.
†Obtained from Chi-square test.

Table-IV

Histopathology according to spinal region (sagittal location) of 28 patients of benign spinal tumors

Histological type	Total (n=28)	Cervical (n=9)	Dorsal (n=10)	Lumbar (n=9)	P value†
Schwannomas	17 (60.7)	7 (41.2)	4 (23.5)	6 (35.3)	0.219
Neurofibromas	6 (21.4)	1 (16.7)	2 (33.3)	3 (50.0)	0.512
Meningiomas	3 (10.7)	0 (0)	3(100)	0 (0)	0.048
Hemangioma	1 (3.6)	0 (0)	1 (100)	0 (0)	0.393
Rosai-Dorfman disease	1 (3.6)	1 (100)	0 (0)	0 (0)	0.334

Data are expressed as frequency (percentage).
†Obtained from Chi-square test.

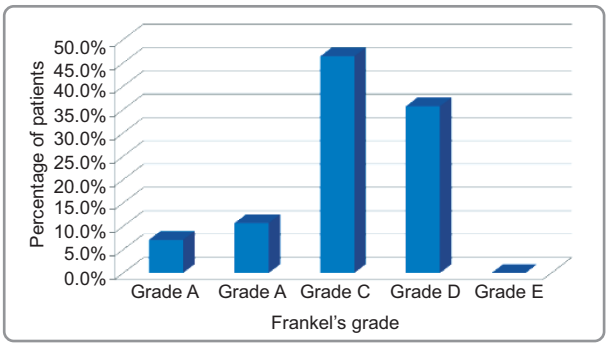


Figure 3: *Preoperative neurological status in 28 patients with benign spinal tumor.*

Table-V

Neurological outcome according to the Frankel classification grading system preoperative and at 3 months after surgery in 28 patients of benign spinal cord tumors

Preoperative Frankel grading	n	Outcome in Frankel grading at 3 months after surgery					P value†
		A	B	C	D	E	
A	2	1 (50.0)	0 (0)	0 (0)	1 (50.0)	0 (0)	
B	3	0 (0)	0 (0)	2 (66.7)	1 (33.3)	0 (0)	
C	13	0 (0)	0 (0)	1 (7.7)	9 (69.2)	3 (23.1)	<0.001
D	10	0 (0)	0 (0)	0 (0)	3 (30.0)	7 (70.0)	
E	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	

Data are expressed as frequency (percentage). Figure in bold faces had at least one Frankel grade improvement.;†Obtained from Chi-square test.

Table-VI

Frankel grading at preoperative and at 3 months after surgery in 28 patients of benign spinal tumors by their dural based (axial) location

Group	Pre-operative Frankel grading	n	Outcome in Frankel grading at 3 months after surgery					p value
			A	B	C	D	E	
Cervical	A	2	1(50.0)	1(50.0)	0	0	0	<0.001
	C	5	0	0	0	2(40.0)	3(60.0)	
	D	2	0	0	0	0	2(100.0)	
Dorsal	B	2	2	0	0	2(100.0)	0	<0.001
	C	6	0	0	1(16.7)	5(83.3)	0	
	D	2	0	0	0	1(50.0)	1(50.0)	
Lumber	B	1	0	0	0	1(100.0)	0	<0.001
	C	2	0	0	0	2(100.0)	0	
	D	6	0	0	0	2(33.3)	4(66.7)	

Data are expressed as frequency (percentage). Figure in bold faces had at least one Frankel grade improvement.
†Obtained from Chi-square test.

Table-VIII

Variation of neurological outcome by Frankel grading after 3 months of surgery in 28 patients of benign spinal tumors according to histopathology of tumors

Histological type	Number of cases	Not improved	Improved	P value†
Schwannomas	17	4 (23.5)	13 (76.5)	0.329
Neurofibromas	6	0 (0)	6 (100.0)	0.197
Meningiomas	3	1 (33.3)	2 (67.7)	0.458
Hemangioma	1	0 (0)	1 (100.0)	0.634
Rosai-Dorfman disease	1	0 (0)	1 (100.0)	0.634

Data are expressed as frequency (percentage).
†Obtained from Chi-square test.

Table-IX

Outcome in bowel and bladder involvement from 3 months after surgery in 28 patients of benign spinal tumors by their axial location

Group	Preoperative Bowel bladder control	n	Bowel bladder control 3 months after surgery		P value†
			Absent	Present	
ED	Absent	1	0 (0)	1 (100.0)	NA
	Present	1	0 (0)	1 (100.0)	
IDEM	Absent	5	1 (20.0)	4 (80.0)	0.046
	Present	19	0 (0)	19(100.0)	
IMSCT	Absent	2	1 (50.0)	1 (50.0)	0.248
	Present	0	0 (0)	2 (100)	
Overall	Absent	8	2 (25.0)	6 (75.0)	0.020
	Present	20	0 (0)	20 (100.0)	

Data are expressed as frequency (percentage); ED: Extradural; IDEM: Intradural extramedullary; IMSCT: Intramedullary spinal cord tumor. NA: Not applicable.
†Obtained from Chi-square test.

Table-X

Outcome of bowel bladder function 3 months after surgery in 8 patients with absent bowel bladder control at preoperative state by their sagittal level of tumor

Sagittal location	Number of cases	Bowel bladder control 3 months after surgery		p value†
		No	Yes	
Cervical	3	1 (33.3)	2 (66.7)	0.108
Dorsal	4	0 (0)	4 (100.0)	
lumbar	1	1 (100.0)	0 (0)	

Data are expressed as frequency (percentage). p values were obtained from Chi-square test
†Obtained from Chi-square test.

Table-XI

Overall outcome of surgery after 3months in 28 patients with benign spinal tumors

3months' outcome	Frequency	Percentages
Excellent	10	35.7
Good/Fair	18	64.3

Excellent outcome (Frankel grade E with normal bowel bladder control)
Good/Fair outcome (Partial recovery or clinical insignificant recovery)

Table-XII

Comparison of different variables between patients with excellent outcome and good/fair outcome in 28 patients with benign spinal tumors

Characteristics		Excellent outcome (n=10)	Good / Fair Outcome (n=18)	p value
Age (Years)	37.23 (±12.44)	36.14 (±17.01)	0.688*	
Sex	Male	6 (60.0)	9 (50.0)	0.611†
	Female	4 (40.0)	9 (50.0)	
Sagital Location	Cervical	5 (50.0)	4 (22.2)	0.094†
	Dorsal	1 (10.0)	9 (50.0)	
Axial Location	Lumber	4 (40.0)	5 (27.3)	0.495†
	ED	1 (10.0)	1 (5.6)	
	IDEM	9 (90.0)	15 (83.3)	
	IMSCT	0 (0.0)	12 (11.1)	

Data are expressed as frequency (percentage) or Median (IQR); P values were obtained from either *Independent sample t test or †Chi-square test

Illustrative Cases:

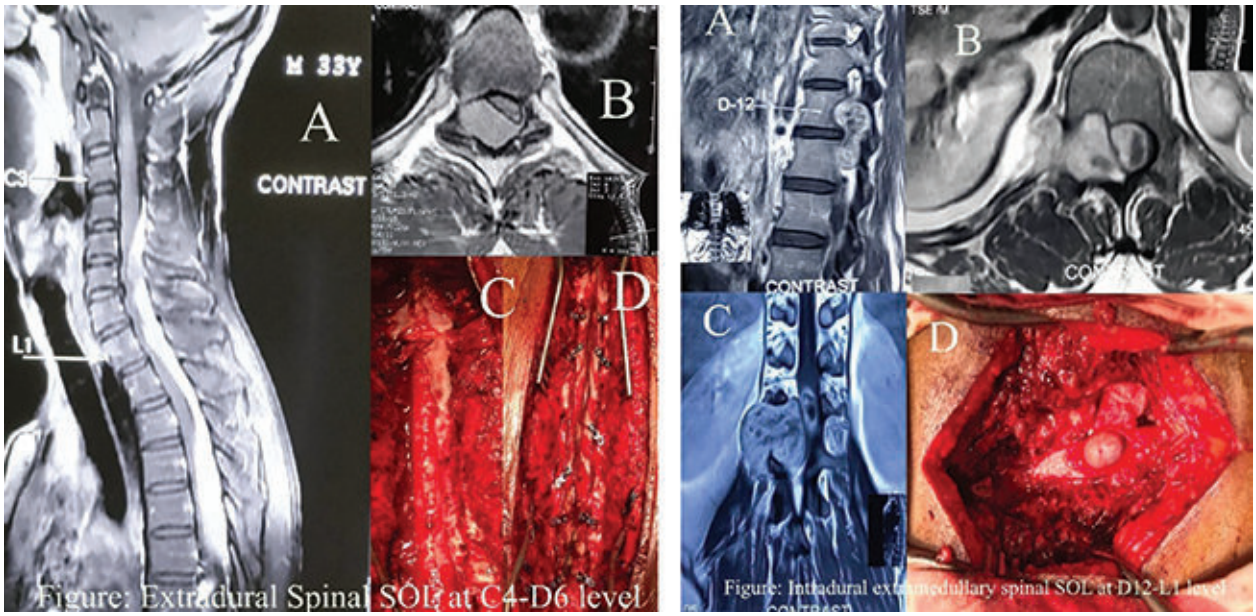


Figure 4: *Extradural Spinal SOL at C4-D6 level. Patient was managed operatively by posterior approach. Decompression was done by laminectomy followed by excision of tumor, and stabilization was done by laminoplasty in corresponding level.*

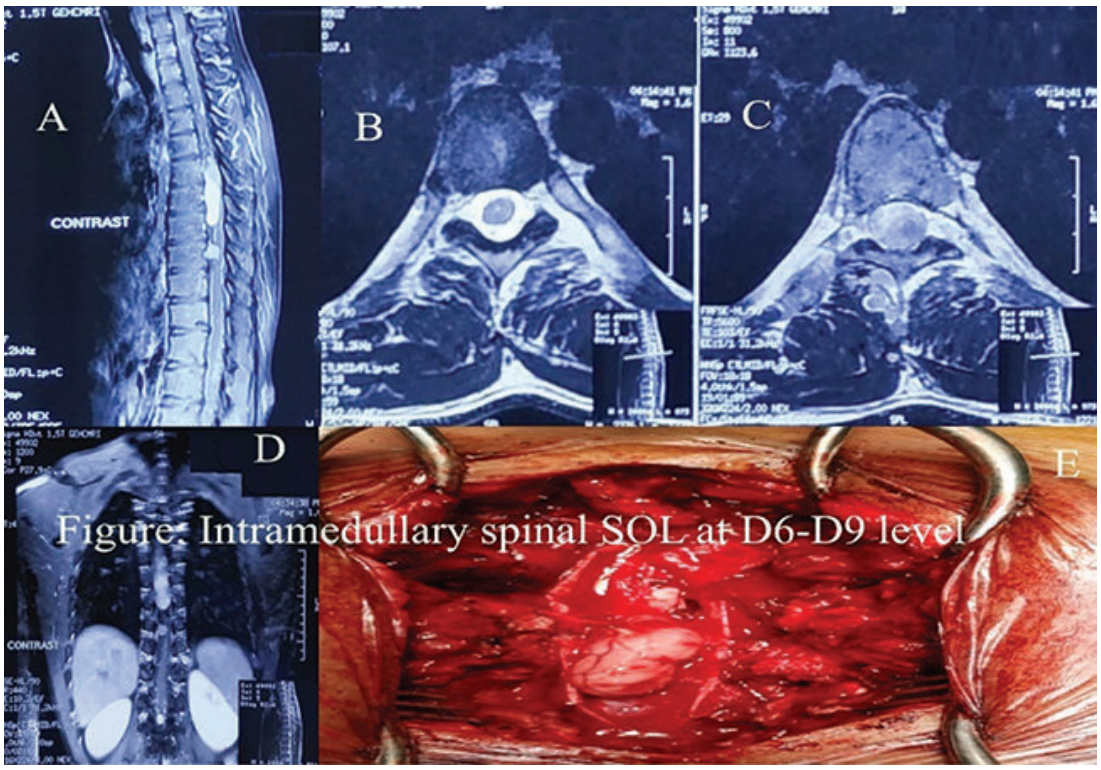


Figure 5: *Intramedullary spinal SOL at D6-9 level. Patient was managed by operative management in posterior approach by laminectomy and excision of SOL.*

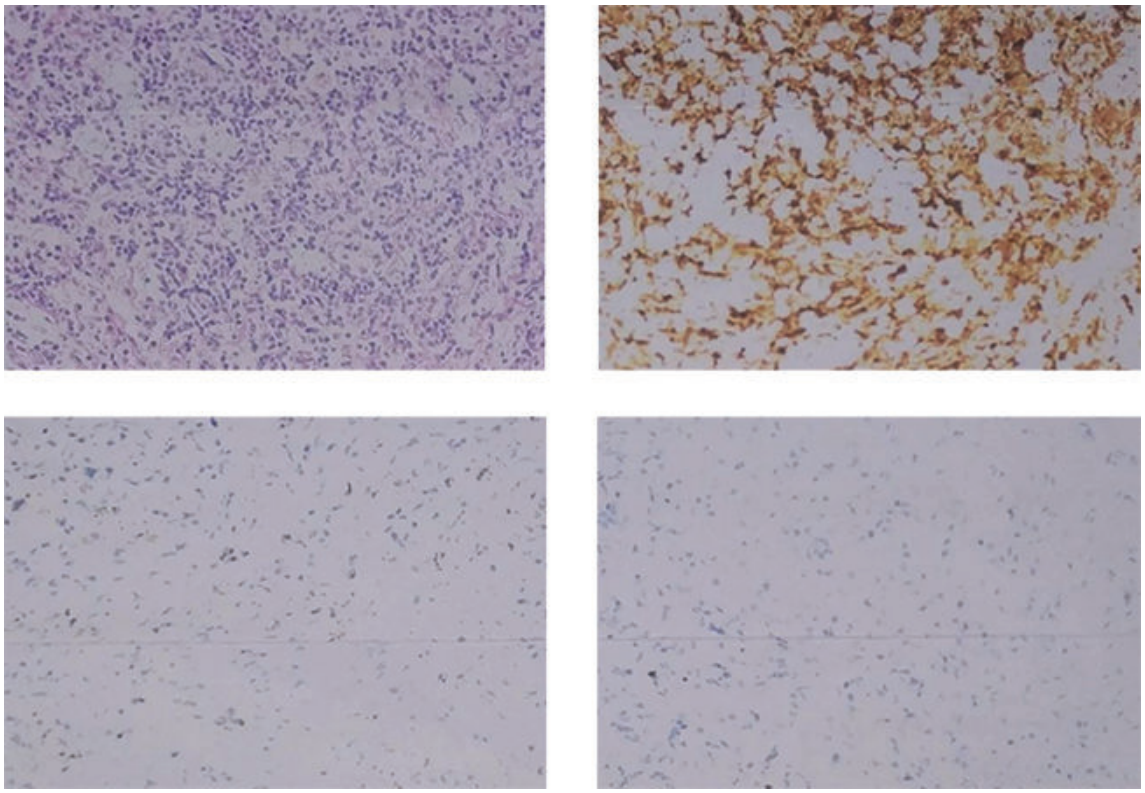


Figure 6: *Histopathology and immunocyto-histochemistry of Rosai-Dorfman disease. Rosai-Dorfman disease was present as 35 years male patient.*

Discussion:

This study presents characteristics of benign spinal cord tumors with surgical outcomes in 28 patients. Due to the rarity of spinal tumors, it was not easy to enroll a large enough study population to assess the outcome of surgical procedure. The patients were operated and assessed in the time interval of one year. These patients were followed up from 1st POD till the end of 3rd months to see the sensory, motor and bowel bladder recovery in those patients who presented with bowel bladder involvement initially. Outcome was recorded at 7th POD, 1 month and 3 months after surgery in Frankel grade which is universal classification for spinal cord injury assessment. The results found to be good/fair in most of the cases with motor and sensory recovery. The bowel bladder recovery was also there in patients with initial bowel bladder involvement.

Present study showed that the spinal lesions occur over a wide age range (15 to 62 years), with mean age at surgery being 36.19 (±14.29) years which was similar to other literature. There was a male preponderance in the present study. In western population, primary spinal tumors are seen more commonly in females, whereas in Asia, male preponderance is seen [7-8]. In the present study, most of the lesions were IDEM (85.8%) followed by IMSCT (7.1%) and extradural (7.1%). Our results correlate well with previous studies done in Asia [7-8].

In the present study, as observed on the sagittal plane images, the most frequently involved localization was the thoracic region followed by cervical and lumbar region. Thoracic level was the most frequently involved spinal level reported by other studies [9,10]. The largest category of tumors in the study were benign nerve sheath tumor - schwannomas/ neurofibromas form 82.1% and the most common IDEM tumor. Other studies also found that these lesions are mostly IDEM and rarely intramedullary[8]. Lumbar region was the common site of origin of schwannomas in the present study, as also seen in most literature [11,12]. Out of 17 schwannomas majorities (16) were IDEM and other one was intramedullary. In the present study schwannomas constitute the major type of the benign spinal cord tumor (17/28). Male to female ratio was almost similar (8 male and 9 female).

In the present study, as in almost all the series reported [12-14], a posterior approach with laminectomy was used for our patients. Out of 17 Schwannomas cases only 4 (23.5%) failed to show any improvement in their Frankel grade and majority (58.8%) of cases shows one grade improvement in Frankel grade. Only 4 cases had bowel bladder dysfunction initially and 2 of them regain their bowel bladder control at 3 months. In the present study, 3 cases of schwannomas which failed to show any improvement were IDEM.

In thoracic region spinal neurofibromas constitute 23% of all of the spinal tumors (De Oliveira et al., 2013). In the present study following schwannomas next most frequent tumor type was spinal neurofibromas (21.4%). Majority of them were IDEM and only one is extradural. None was present in Intramedullary. The most important factor affecting the prognosis in the spinal neurofibroma cases is tumors surgical resection pattern. The prognosis was exceptionally good in the cases, in which the total resection was made [13]. In the present study, all of the 6 cases showed at least one grade improvement in Frankel grade. In this study, three IDEM meningiomas out of 28 cases of benign spinal tumor were also found in the thoracic vertebra of female patients. Spinal meningiomas are mostly located in the thoracic vertebra and they are more common in females, which is presumably due to the influence of female hormones [14].

The primary goal of surgery is to achieve complete tumor removal and to avoid additional neurological damage. The postoperative results varied according to preoperative neurological status, the nature and location of the tumor and the type of surgical resection. IDEM meningioma cases had excellent outcome in one case and good/fair outcome in two cases at the last follow-up. Surgical outcome of functional status of the meningioma cases was similar to other literature. In this study, no neurological deficit occurred as a postoperative complication. There was no deterioration of the neurological symptoms after surgery.

Regarding variation of postoperative neurological outcome of benign spinal tumor of different location in present study failed to establish any. Ten (35.7%) patients had excellent outcome (having Frankel grade E with normal bowel bladder control) and 18 patients (64.3%) had good/fair outcome (partial recovery / clinically insignificant recovery) after 3 months. Patients having excellent outcome were comparatively younger, more male in the present study. However, none of these differences were statistically significant. Small sample size of the present study was the

probable explanation. In general, better postoperative neurological outcome occurs with lesser preoperative neurological deficits.

Comparison of functional outcome between series is difficult as different scoring systems are used. The Frankel system has several advantages. It provides an objective and reproducible score of useful function, the score can be determined from case records, and it is universally recognized. Among 24 cases of IDEM majority (79.2%) improved by at least one Frankel grade and 5 cases (20.8%) patients maintained their preoperative Frankel grade 3 months after their surgery. None of them lost useful function after surgery. It was particularly pleasing that both the patients with IMSCT had at least one Frankel grade improvement after surgery. Timely surgical resection can dramatically improve functional status even in patients who have complete loss of spinal cord function; however, in the one of the two patients with complete loss of spinal cord function in this study (50%) the functional status remained unchanged. In our small cohort one case of Rosai-Dorfman disease was present as 35 years male patient. After 3 months of surgery this case had good/fair outcome.

Conclusion:

Majority of patients irrespective of the location of the tumor had a favorable clinical outcome three months after the operation.

Limitations:

These results should be interpreted in the light of several limitations of our study.

1. Small sample size.
2. This was a single-center study with subjects belonging to a single ethnicity. Thus, the results need validation in a large multicenter study involving different ethnicities.
3. Our study also had a relatively short follow-up period.
4. Postoperative recurrence rate was not assessed.

Conflict of Interest: None to disclose.

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