Original Article

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Spinal Space Occupying Lesions: A Comprehensive Study of Clinico-pathological Spectrum and Measure of Degree of Agreement Between The Diagnostic Modalities

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ABSTRACT

Background: Spinal SOLs are quite fascinating group of lesions, comprising a minority of central nervous system lesions often resulting in significant morbidity. There is paucity of comprehensive population-based data of these SOLs in Indian subcontinent.

Material and Methods: The present study was a retrospective descriptive study conducted at the department of pathology, Kamineni Institute of Medical Sciences for 3 years starting from January 2017 to December 2019.

Results: We analyzed eighty-nine spinal SOLs during the study period. Spinal neoplasms encompassed the largest number accounting for 70.7% of total spinal SOLs. Majority were reported in the 20-40 years' age group with predominant male preponderance except for universal phenomenon of female predominance in meningioma. Back pain was the most common clinical presentation. Among spinal neoplasms, NSTs comprising of schwannoma and neurofibroma, was the most common finding and spinal tuberculosis was the most common non-neoplastic SOL. Majority of benign spinal tumors were distributed in the intradural extra medullary location and involved thoracic vertebrae. Malignant tumors predominantly involved extradural location and were clustered along thoracic and lumbar vertebrae. Measure of agreement between radiological and histopathological diagnosis using kappa statistics revealed almost perfect agreement for extradural spinal SOLs and moderate agreement for intradural intramedullary and intradural extra medullary SOLs.

Conclusion: Comprehensive evaluation of spinal SOLs warrants multidisciplinary approach. Rapid advancements in radiology optimised diagnostic evaluation of non-neoplastic SOLs, however we conclude that histopathological evaluation is still the gold standard for diagnosis of primary spinal cord tumours and for planning the treatment and predicting prognosis.

Keywords: *Spinal Space Occupying Lesions (SOLs), Nerve Sheath Tumors, Meningioma, Intradural, Extradural.*

Introduction

Spinal SOLs are a distinct, quite intriguing heterogeneous group with wide spectrum of clinical, radiological and morphological presentations. It encompasses neoplastic as well as non-neoplastic entities. Primary tumours of the spinal cord are ten to fifteen times less common than primary intracranial tumours and overall represent 2% to 16% of all primary tumours of the CNS according to various reports [1-6]. Morphology of spinal cord tumours is similar to their intracranial counterparts; however spinal cord tumours show no association between age at diagnosis and increasing grade of malignancy and prognosis [7].

Primary spinal cord tumours are divided into three categories based upon anatomic location. Extradural tumours predominantly are comprised of metastatic tumours [7]. Intradural extra-medullary tumours include NSTs and meningioma and are usually amenable to surgical resection. Intradural intramedullary spinal tumours constitute 8% to 10% of all primary spinal tumours and majority are comprised of gliomas of which 60% to 70% are ependymomas and 30% to 40% are astrocytoma [8]. Among these non-neoplastic lesions, Spinal tuberculosis is most common and predominantly involves thoraco-lumbar junction [9,10]. However, compared to other systems, spinal tuberculomas are rare and constitute only 0.2% to 0.5% of all CNS tuberculomas [11,12].

The clinical presentation of spinal space occupying lesions (SOLs) is determined by the location of the lesion, and in nearly all clinical instances pain is the predominant presenting symptom and may manifest as back pain, radicular pain, or central pain. Radiological imaging identifies majority of non-neoplastic SOLs however, evaluation of primary spinal cord tumours warrants multi-disciplinary approach comprised of Neurosurgeons, Radiologists and Pathologists.

Although many studies reported epidemiological trends of Central Nervous System (CNS) tumours in Indian population, there are very few reports which focussed on frequencies and pattern of distribution of only spinal space occupying lesions in rural population.

Aims of the study: 1. To study the morphological spectrum of Spinal SOLs and determine the relative frequency of spinal SOLs based on histologic type, anatomical location and vertebral level of involvement and compare it with national and international literature. 2. To correlate radiological diagnosis with histopathological diagnosis and determine the measure of agreement between the diagnostic modalities.

Materials and Methods

The present study was a retrospective **descriptive** study conducted at the department of pathology, Kamineni Institute of Medical Sciences and its allied health care centers over a period of 3 years sfrom January 2017 to December 2019.

Ethics statement*:* The study was approved by Institutional review board of kamineni Institute of Medical Sciences. Helsinki principles were respected during the study period and the patients' confidential data was analysed. Due to the retrospective nature of the study, written informed consent was waivered. Pathologic data of the patients were de-identified and analysed anonymously.

Inclusion criteriae: During the study period all the eighty-nine consecutive spinal SOLs reported in all the age groups and both the sexes were included.

Exclusion criteriae: Spinal SOLs without relevant elaborate clinical details and radiological findings were excluded from the study.

Methodology: Haematoxylin and eosin stained histopathology slides of all surgically treated spinal SOLs were retrieved from the archives of pathology department and reviewed independently by two pathologists. Sections were recut from paraffin blocks where ever needed. Data pertaining to clinical presentation, CT and MRI findings and other lab investigations performed were obtained from the patient records available at the medical records department and were analysed. Modified McCormick's grade was used to evaluate the neurological and functional status of the cases under study. All tumours were morphologically classified in accordance with WHO classification of CNS tumours [13], and their incidence assessed based on anatomical and vertebral level of involvement. Histopathological findings are correlated with radiological diagnosis and measure of agreement was determined using kappa statistics.

Statistical analysis: Data analysis was done using statistical software IBM SPSS version 20. Categorical data were expressed as frequency and percentage. Chi-square was used to check the statistical significance of the data. A p value < 0.05 was considered statistically significant. To understand the extent of association or correlation between radiologic and histopathologic diagnosis and kappa statistics were calculated.

Results

Interpretation of the results: There were total of eighty-nine cases which fulfilled Inclusion criteria.

1. ***Prevalence of spinal SOLs (Fig.1A,1B):*** Eighty-nine **s**pinal SOLs were analyzed during the study period. Majority were neoplastic SOLs (63) accounting for 70.7% of total spinal SOLs and 24.7% of total CNS tumors (360).
2. ***Age and sex incidence (Table-1):*** Majority of the cases reported were in the 20-40 years' patient group when the patient age was stratified in 20 years' interval. Second commonest group was 40-60 years, accounting for 22.2% of spinal neoplasms mainly encompassing meningioma. Above 60 years' group included meningioma and metastatic tumors and greater chunk of congenital malformations and vascular malformations were reported below 20 years of age. Age wise clustering of spinal neoplasms was found to be statistically significant ($P = 0.00$, $X^2 = 50.20$). Male preponderance was noticed among all the spinal lesions except in meningiomas where females outnumbered males.
3. ***Clinical presentation (Table-2):*** Back pain was the most common clinical presentation accounting for 42.6% cases followed by paraplegia (30.3%) and paresthesia (21.3%). Bowel and bladder symptoms were reported in 8.9% and 6.7% of cases. Duration of symptoms before seeking consultation ranged from 20 days to 18 months with average duration of symptoms of 5 months.
4. ***Morphological distribution of Spinal SOLs (Table-3):*** Neoplastic lesions encompass the largest proportion, accounting for 70.7% of total spinal SOLs and of these 11 cases were malignant. There were twenty-six non-neoplastic spinal SOLs, tuberculosis being the major contributor (61.5%). Among the Neoplasms, NSTs comprising of schwannoma and neurofibroma, was the most common histopathological diagnosis accounting for 36.5% of cases, followed by Meningioma (27%) and Gliomas (19%). In addition, there were osseous lesions accounting for 11.1% and included three cases of plasmacytoma, two cases of aneurysmal bone cyst and one case of chordoma. Three cases of secondary tumors metastatic to the spine and a case of intradural extra-medullary Ewing's sarcoma were also reported. Among three cases of metastatic secondary tumours 2 cases were in women with known primary lung

adenocarcinoma and one was reported in male with primary prostate adenocarcinoma.

5. ***Distribution of Spinal SOLs based on anatomic location*** was analyzed to assess the significance of location on the overall prognosis (Table-4, Fig. 2A, 2B). In our study spinal neoplasms were predominantly in the intradural extra-medullary location and non-neoplastic SOLs were clustered in extradural location. This distribution is statistically significant (P = 0.04, $X^2 = 6.07$). Among the neoplasms there were 21 extradural, 31intradural extra-medullary and 11 intradural intramedullary tumors. NSTs and meningioma were predominantly in intradural extra-medullary, and gliomas were intradural intramedullary. Two cases of metastatic tumors were extradural and one was in intradural extra-medullary location. Also, there was statistically significant predominant distribution of malignant tumours in the extradural and benign tumours in the intradural extra-medullary location (P = 0.04, $X^2 = 6.28$). Contrary to prevalent site predilections, a case of intradural extra-medullary Ewing's sarcoma was reported in our study. 50% of cases of spinal tuberculosis were localized to extradural followed by 31.3% of cases in intradural extra-medullary location.
6. ***Distribution of spinal SOLs based on level of vertebrae:*** In our study thoracic vertebrae (27/63) was the most common site of involvement, followed by cervical vertebra (11/63) and least representation was of sacrum, where only a single case of chordoma was reported (Table-5). Among NSTs, predominant lumbar vertebral involvement was reported for schwannoma and cervical involvement for neurofibroma. Gliomas and meningiomas were predominantly distributed along thoracic vertebrae. Malignant tumours were localized to thoracic vertebrae (7/11). Ewing's sarcoma involved cervical vertebrae and metastatic tumors predominantly involved thoracic and lumbar vertebrae. Non-Neoplastic SOLs showed similar pattern of involvement with majority distributed in thoracic and lumbar vertebrae. Based on the level of vertebral involvement the distribution of spinal neoplastic SOLs (p= 0.06, $X^2 = 30.06$) and malignant spinal tumors (p= 0.08, $X^2 = 9.61$) was not found to be statistically significant.
7. To evaluate the degree of association between radiological and histopathological diagnosis, the data was presented in the form of bivariate tables and kappa statistics was estimated and interpreted (Tables 6, 7, 8). Almost perfect agreement was reported for extradural spinal SOLs (Kappa value: 0.84, standard error: 0.07) and moderate agreement was evidenced for intradural intramedullary (Kappa value: 0.60, Standard error: 0.168) and intradural extra-medullary SOLs (Kappa value: 0.51, Standard error: 0.115). These results were found to be statistically significant ((p<0.001). Concordance rates were superlative for non-neoplastic SOLs and malignant tumors and intermediate for benign SOLs and tuberculosis.

Table 1: Age Incidence and Gender wise distribution of Neoplastic Spinal SOLs.

Neoplastic lesions	Age incidence				Sex Incidence		
	< 20 Yrs.	20-40 Yrs.	40-60 Yrs.	> 60Yrs.	Male	Female	M:F
NST (23)	3(13.0%)	18 (78.3%)	2 (8.7%)	0	16	7	2.3:1
Gliomas (12)	3 (25%)	8 (66.7%)	1 (8.3%)	0	8	4	2:1
Meningioma (17)	1 (5.9%)	4 (23.5%)	10 (58.8%)	2 (11.8%)	6	11	1:1.8
Osseous (07)	2 (28.6%)	4 (57.1%)	1 (14.3%)	0	5	2	2.5:1
Others (04)	0	1 (25.0%)	0	3 (75.0%)	2	2	1:1
Total (63)	**9 (14.2%)**	**35(55.6%)**	**14(22.2%)**	**5(7.9%)**	**37(58.7%)**	**26(41.3%)**	**1.4:1**
Non-Neoplastic lesions	**Age incidence**				**Sex Incidence**		
	< 20 Yrs.	**20-40 Yrs.**	**40-60 Yrs.**	**> 60Yrs.**	**Male**	**Female**	**M:F**
Tuberculosis (16)	4 (25.0%)	10 (62.5%)	2 (12.5%)	0	11	5	2.2:1
Abscess (04)	0	3 (75.0%)	1 (25.0%)	0	2	2	1:1
Cavernous haemangioma (01)	1 (100%)	0	0	0	1	0	
Myelocoele (03)	3 (100%)	0	0	0	2	1	2:1
Meningomyelocoele (02)	2 (100%)	0	0	0	1	1	1:1
Total (26)	**10(38.4%)**	**13(50%)**	**3(11.5%)**	**0**	**17(65.4%)**	**9(34.6%)**	**1.9:1**

Table 2: Clinical Presentation of Spinal SOLs.

Clinical Presentation	Number	Percentage
Back pain	38	42.60%
Paraplegia	27	30.30%
Paraesthesia	19	21.30%
Back Swelling	5	5.60%
Walking Difficulty	11	12.30%
Bladder Symptoms	8	8.90%
Bowel Symptoms	6	6.70%

Table 3: Morphological Distribution of Spinal SOLs.

Neoplastic Spinal SOLs n=63(70.8%)	Histological Diagnosis	Number	Percentage
NSTs n=23 (36.5%)	Schwannoma	19	30.2%
	Neurofibroma	4	6.3%
Gliomas n=12 (19.0%)	Diffuse Fibrillary Astrocytoma	5	7.9%
	Pilocytic Astrocytoma	2	3.2%
	Anaplastic Astrocytoma	1	1.6%
	Glioblastoma Multiforme	1	1.6%
	Ependymoma	3	4.8%
Meningioma n=17 (27.0%)	Meningothelial Meningioma	9	14.3%
	Fibroblastic Meningioma	4	6.3%
	Transitional Meningioma	3	4.8%
	Angiomatous Meningioma	1	1.6%
Osseous (7) n= 07 (11.1%)	Plasmacytoma	4	6.3%
	Chordoma	1	1.6%
	Aneurysmal cyst	2	3.2%
Others (4) n= 04 (6.4%)	Extra-osseous Ewing's Sarcoma	1	1.6%
	Metastatic Tumours	3	4.8%
TOTAL (Neoplastic SOLs)		**63**	**100.00%**
Non-Neoplastic Spinal SOLs n=26(29.2%)	**Histological Diagnosis**	**Number**	**Percentage**
Infectious	Tuberculosis	16	61.54%
	Abscess	4	15.38%
Vascular malformation	Cavernous haemangioma	1	3.85%
Congenital abnormality	Myelocoele	3	11.54%
	Meningomyelocoele	2	7.69%
TOTAL (Non-neoplastic SOLs)		**26**	**100.00%**

Table 4: Distribution of Spinal SOLs based on Anatomic Location.

Neoplastic Spinal SOLs	Extradural	Intradural Extramedullary	Intradural Intramedullary	Total (Percentage)
NSTs	06(26.1%)	17(73.9%)	0	23(100%)
Glioma	0	01(8.3%)	11(91.7%)	12(100%)
Meningioma	06(35.3%)	11(64.7%)	0	17(100%)
Osseous	07(100%)	0	0	07(100%)
Others	02(50.0%)	02(50.0%)	0	04(100%)
Total	**21(33.3%)**	**31(49.2%)**	**11(17.5%)**	**63(100%)**

Non-Neoplastic Spinal SOLs	Extradural	Intradural Extramedullary	Intradural Intramedullary	Total (Percentage)
Tuberculosis	08(50%)	05(31.3%)	03(18.7%)	16(100%)
Abscess	03(75%)	01(25%)	0	04(100%)
Cavernous haemangioma	0	01(100%)	0	01(100%)
Myelocoele	03(100%)	0	0	03(100%)
Meningomyelocoele	02(100%)	0	0	02(100%)
Total (Percentage)	**16 (61.5%)**	**07 (26.9%)**	**03 (11.5%)**	**26(100%)**

Table 5: Distribution of Spinal SOLs based on Level of Vertebrae

Neoplastic Spinal SOLs	Cervical	Cervico-Thoracic	Thoracic	Thoraco-Lumbar	Lumbar	Sacral	Total
NSTs	07(30.5%)	03(13.0%)	04(17.4%)	03(13.0%)	06(26.1%)	0	23(100%)
Gliomas	02()16.7%)	0	07(58.3%)	01(8.3%)	02(16.7%)	0	12(100%)
Meningioma	01(5.9%)	03(17.6%)	09(52.9%)	04(23.6%)	0	0	17(100%)
Osseous	0	0	05(71.4%)	0	01(14.3%)	01(14.3%)	07(100%)
Others	01(25.0%)	0	02(50.0%)	0	01(25.0%)	0	04(100%)
Total (Percentage)	**11(17.5%)**	**06(9.5%)**	**27(42.9%)**	**08(12.7%)**	**10(15.9%)**	**01(1.5%)**	**63(100%)**
Non-Neoplastic Spinal SOLs	**Cervical**	**Cervico-Thoracic**	**Thoracic**	**Thoraco-Lumbar**	**Lumbar**	**Sacral**	**Total**
Tuberculosis	03(18.7%)	02(12.5%)	06(37.5%)	01(6.3%)	04(25%)	0	16(100%)
Abscess	0	01(25%)	02(50%)	01(25%)	0	0	04(100%)
Cavernous haemangioma	0	0	01(100%)	0	0	0	01(100%)
Myelocoele	0	0	01(33.3%)	0	2(66.7%)	0	03(100%)
Meningomyelocoele	0	0	0	0	02(100%)	0	02(100%)
Total (Percentage)	**03(11.5%)**	**03(11.5%)**	**10 (38.5%)**	**02(7.7%)**	**08(30.8%)**	**0**	**26(100%)**

Table 6: Radiological-Histopathological Correlation Analysis of Extradural and Intra dural Extra medullary Spinal SOLs.

Radiological Histopathological correlation of Extradural Spinal SOLs		HISTOPATHOLOGICAL DIAGNOSIS								
		Plasmacytoma	Aneurysmal Bone Cyst	Chordoma	Metastatic Tumour	Nerve sheath tumour	Meningioma	Tuberculosis	Non-neoplastic SOLs	Total
RADIOLOGICAL DIAGNOSIS	Plasmacytoma	4	0	0	0	0	0	0	0	4
	Aneurysmal Bone Cyst	0	2	0	0	0	0	0	0	2
	Chordoma	0	0	1	0	0	0	0	0	1
	Metastatic Tumour	0	0	0	1	0	0	2	0	3
	Nerve sheath tumour	0	0	0	1	4	1	0	0	6
	Meningioma	0	0	0	0	2	5	0	0	7
	Tuberculosis	0	0	0	0	0	0	6	0	6
	Non-neoplastic SOLs	0	0	0	0	0	0	0	8	8
	Total	4	2	1	2	6	6	8	8	37

Radiological Histopathological correlation of Intra dural Extra medullary Spinal SOLs.		HISTOPATHOLOGICAL DIAGNOSIS								
		Nerve sheath tumour	Meningioma	Ewing's sarcoma	Ependymoma	Metastatic tumour	Capillary hemangioma	Tuberculosis	Abscess	Total
RADIOLOGICAL DIAGNOSIS	Nerve sheath tumour	12	3	1	0	0	0	0	0	16
	Meningioma	5	6	0	0	0	0	2	0	13
	Ewing's sarcoma	0	2	0	0	0	0	0	0	2
	Ependymoma	0	0	0	1	0	0	0	0	1
	Metastatic tumour	0	0	0	0	1	0	0	0	1
	Capillary haemangioma	0	0	0	0	0	1	0	0	1
	Tuberculosis	0	0	0	0	0	0	3	0	3
	Abscess	0	0	0	0	0	0	0	1	1
	Total	**17**	**11**	**1**	**1**	**1**	**1**	**5**	**1**	**38**

Table 7: Radiological-Histopathological Correlation Analysis of Intra dural Intramedullary Spinal SOLs.

Radiological-Histopathological correlation of Intradural Intramedullary SOLs.		HISTOPATHOLOGICAL DIAGNOSIS				
		Low grade Astrocytoma	High grade Astrocytoma	Ependymoma	Tuberculosis	Total
RADIOLOGICAL DIAGNOSIS	Low grade Astrocytoma	4	0	0	1	5
	High grade Astrocytoma	0	2	0	0	2
	Ependymoma	3	0	2	0	5
	Tuberculosis	0	0	0	2	2
	Total	**7**	**2**	**2**	**3**	**14**

Table 8: Radiological and histopathological correlation of Spinal SOLs based on kappa statistics.

Anatomical level of vertebra	Symmetric measures	kappa value	Std. error	p-value
1. Extradural SOLs	Measure of agreement	0.814	0.07	0.01
	No of valid cases	37		
2. Intradural Extra medullary	Measure of agreement	0.51	0.115	0.01
	No of valid cases	38		
3. Intradural Intramedullary	Measure of agreement	0.603	0.168	0.01
	No of valid cases	14		

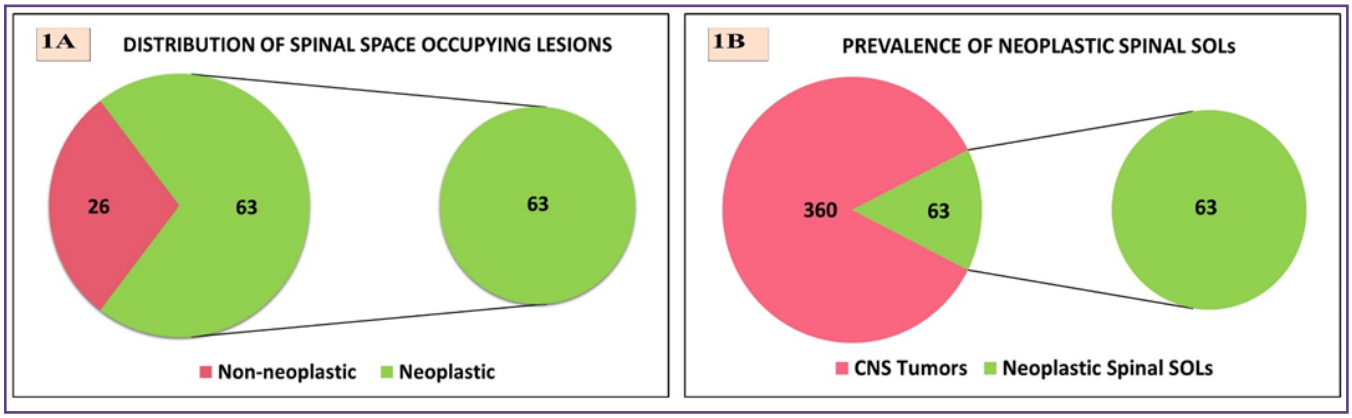

Fig. 1A: Distribution of Neoplastic and Non-Neoplastic Spinal SOLs. 1B: Prevalence of neoplastic spinal SOLs as compared to total CNS tumors reported during the study period.

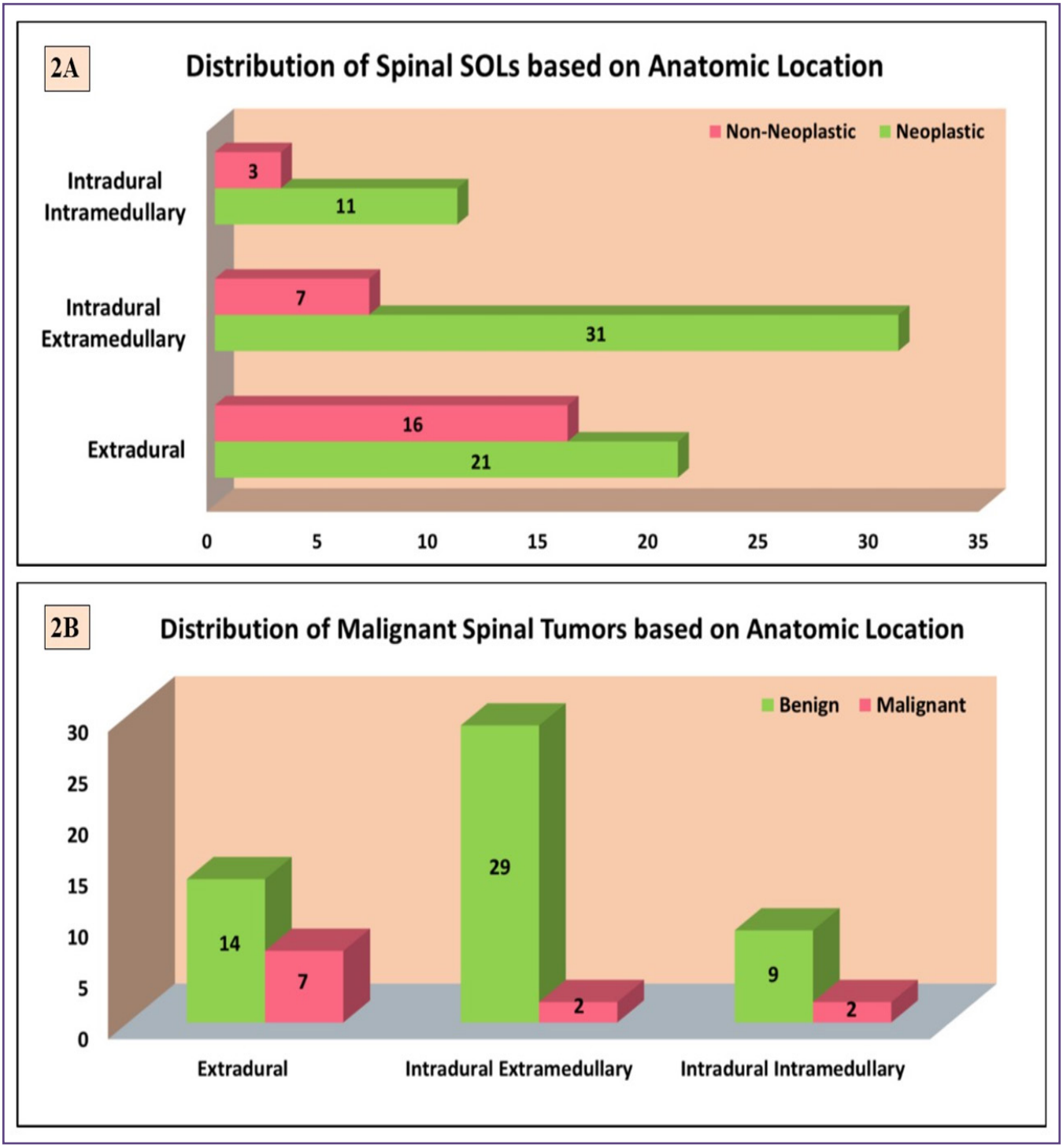

Fig. 2A: Distribution of Spinal SOLs based on anatomic location (p=0.04, X^2 = 6.07) 2B: Distribution of spinal malignancies based on anatomic location (p=0.04, X^2 = 6.28).

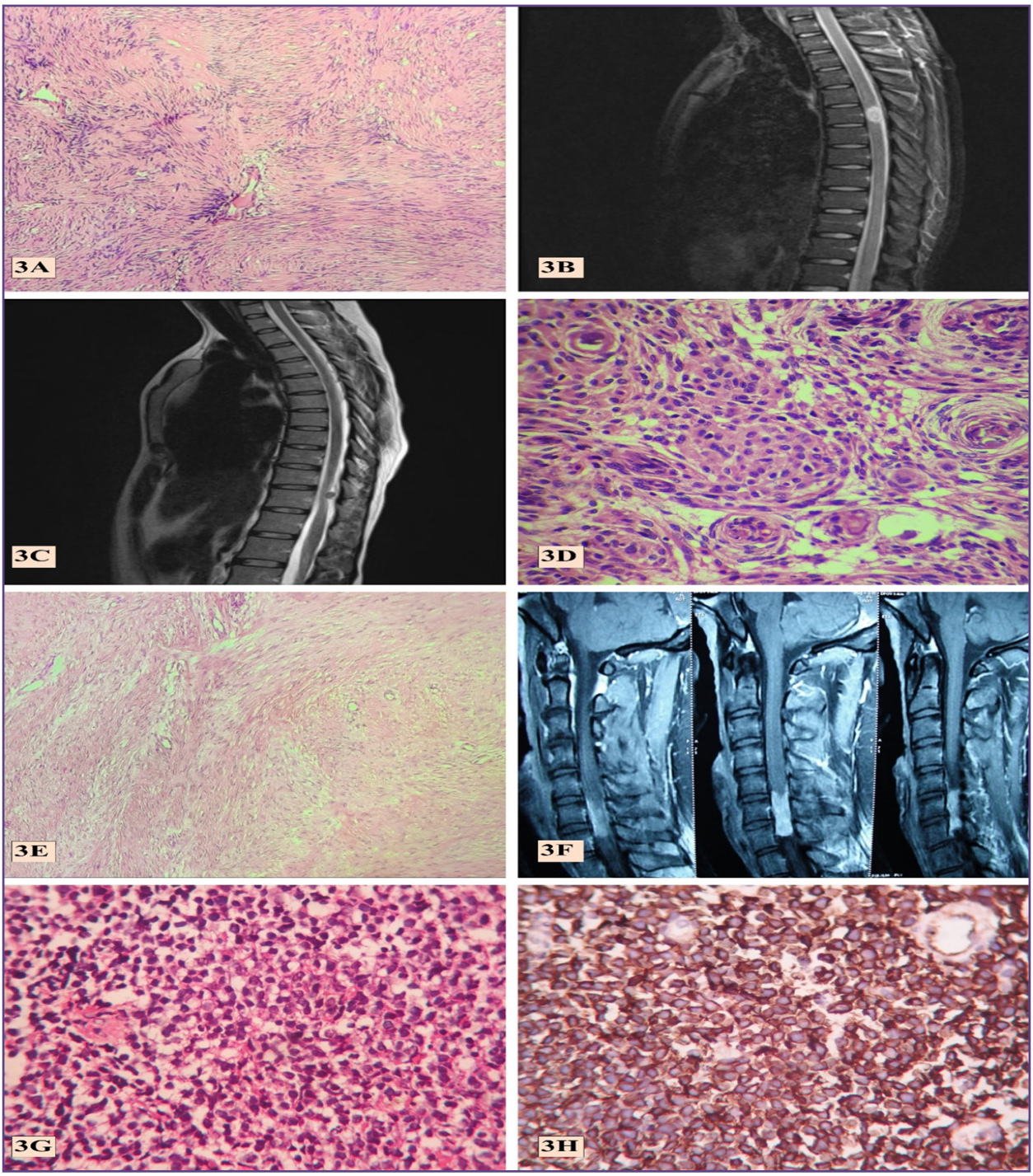

Fig. 3: Intradural Extra Medullary Spinal Neoplastic SOLs. 3A: Schwannoma with Verocay Bodies. H/E 100X. 3B: A well-defined T1 isointense, T2 hyperintense intradural extra medullary lesion at the D6 vertebral level suggestive of schwannoma. 3C: Well defined focal iso to hypointense intradural extra medullary lesion at the level of D10-D11 vertebra suggestive of Meningioma. 3D: Meningothelial meningioma comprised of syncytial sheets and whorls of meningothelial cells H/E 400X. 3E: Neurofibroma comprised of spindle cells with wavy nuclei. H/E 100X.3F: T1 weighted contrast enhanced sagittal MRI revealing intradural extra medullary spinal mass at C5-C7 vertebrae 3G: Intradural Extra medullary Ewing's Sarcoma with discrete round to oval cells. H/E 100X. 3H: Immunohistochemical staining for CD-99/MIC-2, showing strong diffuse membranous positivity 100X.

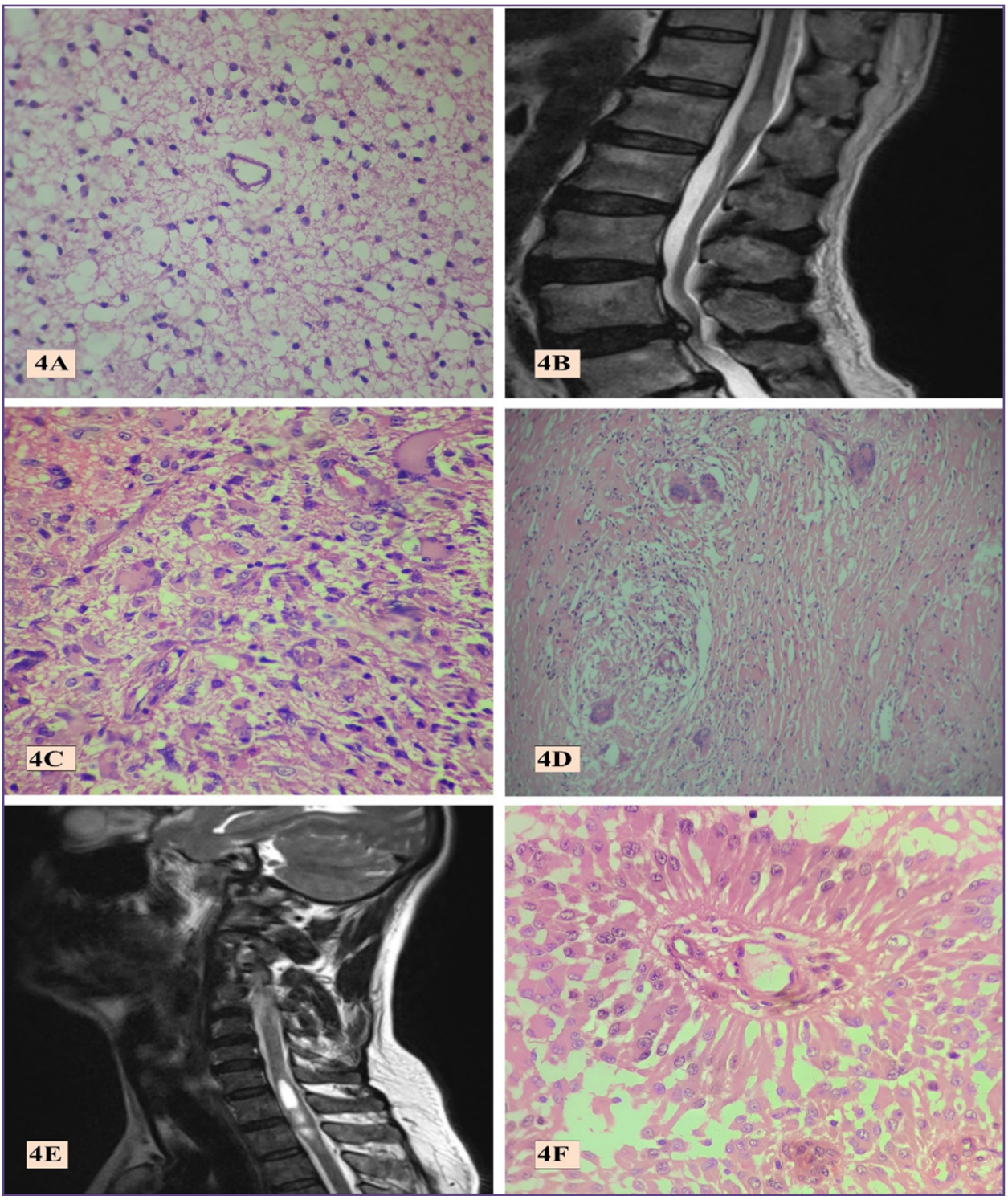

Fig. 4: Intradural Intramedullary Spinal Neoplastic SOLs. 4A: Diffuse Fibrillary Astrocytoma H/E 100X. 4B: A well-defined intramedullary T1 isointense and T2 hyper-intense L1 lesion suggestive of low-grade Astrocytoma.4C: Glioblastoma Multiforme with marked nuclear pleomorphism. H/E 400X. 4D: Case of Spinal tuberculosis with epithelioid granulomas and multinucleate giant cells H/E 100X. 4E: T2 weighted sagittal MRI reveal intramedullary hyper-intense lesion suggestive of Ependymoma.4F: Ependymoma with perivascular pseudo-rosettes H/E 400X.

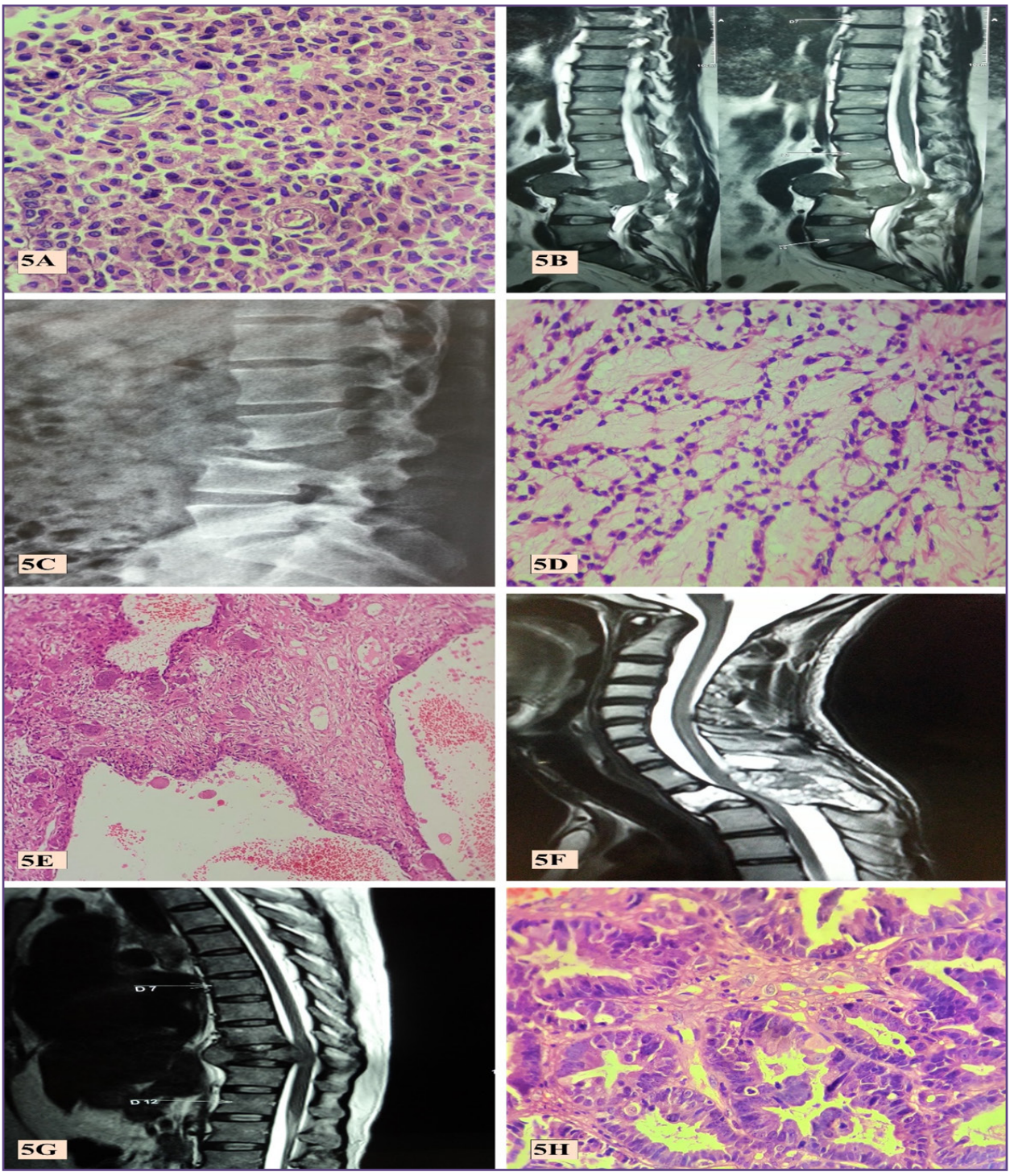

Fig. 5: Extradural Spinal Neoplastic SOLs 5A: Plasmacytoma comprised of diffuse sheets of neoplastic plasma cells. H/E 400X. 5B: T2 weighted sagittal images reveal wedge compression fracture at L3 Vertebral body suggestive of plasmacytoma. 5C: X-Ray lateral view revealing similar features. 5D: Chordoma with chords and single cells dispersed in extracellular myxoid matrix. H/E 100X. 5E: ABC with large blood-filled cysts rimmed by fibroblasts and multinucleate giant cells. H/E 100X. 5F: T2 weighted sagittal images reveal expansile isointense to hyper intense, cystic lesion with internal septations at D1-D2 vertebrae. Suggestive of ABC 5G: T2 weighted sagittal images reveal wedge compression fracture at D10 vertebral body suggestive of metastatic carcinoma.5H: Metastatic adenocarcinoma comprised of pleomorphic neoplastic glands. H/E 400X

Discussion

Spinal SOLs are a heterogeneous group of neoplastic and non-neoplastic entities. Comprehensive evaluation of spinal SOLs warrants multidisciplinary approach comprising of neurosurgeons, neuroradiologists and Neuropathologists. Based on the presenting symptoms and signs, clinical evaluation by neurosurgeons and neurologists helps in identifying the spinal origin of the lesions, neuro-radiologists narrow down the vast list of differential diagnosis, and the histopathologist unequivocally clinches the final diagnosis which helps in planning further management and prognostication. With a few exceptions a standard pattern of distribution observed was that the primary spinal tumours are typically intradural in location whereas extradural tumours are typically due to metastatic disease [7]. Primary tumours of the Spinal cord and its meninges are unique as greater proportion of them are benign and demonstrate a dramatic recovery in functional status upon early diagnosis and prompt surgical intervention [14]. However, delay in diagnosis and initiation of optimal management has devastating effects that threaten the patient's mobility or even life. In view of the significance of early diagnosis and the decisive role of histopathological examination we undertook this study.

We analyzed eighty-nine spinal SOLs diagnosed during the study period in our institute and its allied health centers. Spinal neoplasms encompassed the largest number of cases, accounting for 70.7% of total spinal SOLs. Majority of the cases were reported in the 20-40 years' age group. These finding are concordant with study done by Gadgil et al. [15] and Moein.p et al [16]. Male preponderance was noticed among all the spinal lesions except in meningiomas where female predominance is evident. In contrast to findings of western world [2,4,18,19], where meningioma outnumbered NSTs, our study was concordant with reports from Asian countries [3,5,6] which revealed high frequencies of NSTs than meningioma. Majority of the benign spinal tumors were distributed in the intradural extra-medullary location and involved thoracic vertebrae. Malignant tumors predominantly involved extradural location and were clustered along the thoracic and lumbar vertebrae.

Twenty-three NSTs accounting for 36.5% of total spinal neoplasms were reported in our study. These results are concordant with reference studies [1,16,17]. These tumors are predominantly reported in males and were common in 20-40 years' age group. Radiological and pathological evaluation of NSTs revealed concordance rates of 70.7% for intradural extra-medullary tumors and 66.7% for extradural tumors. Nineteen schwannomas **(Fig.3A)** were reported in our study and majority were in the intradural extra-medullary location and predominantly involved lumber vertebrae These results are concordant with finding of hirano et al. [20]. On MRI these well circumscribed tumors were isointense to hypointense on T1 weighted images and hyperintense on T2 weighted images with variable contrast enhancement (Fig.3B). Four solitary neurofibromas (Fig.3E) were also reported in our study and predominantly involved intradural extra-medullary location and distributed along the cervical vertebrae. (Results are concordant with study of hirano et al). All the cases on MRI presented as well circumscribed lesions that were hypo to isointense on T1 weighted and hyperintense on T2 weighted images with uniform contrast enhancement. Most patients with a neurofibroma are asymptomatic, with pain as a rare clinical manifestation. None of the cases of neurofibroma were associated with neurofibromatosis or evident malignant transformation. These tumors were amenable to surgical resection and demonstrated significant post-operative functional recovery of greater than 2 grades on Modified Mc Cormicks scale. Recurrence was reported in 2 cases of neurofibroma and a case of large cellular schwannoma on follow up. As evidenced in the literature, recurrence was more common in neurofibroma as they are clustered in cervical region with lower rates of gross total resection.

Meningiomas are the second most common group reported in our study accounting for 27.0% of total spinal neoplasms. Similar results were recorded by Kaye et al (29.7%) and Schellinger et al (28.9%). Meningioma are predominantly reported in 40-60 years' age group. Universal phenomenon of female preponderance in meningioma reported in many national and international references is also reflected in our study [21,22]. Patients predominantly presented with localized or radicular pain, motor deficits, and sensory deficits. Various morphological variants of meningioma are reported which include 9 cases of meningothelial meningioma **(Fig.3D)**, 4 cases of fibroblastic meningioma, three cases of transitional meningioma and a case of angiomatous meningioma. These tumors predominantly involved intradural extra-medullary location and thoracic vertebrae and these results are concordant with reference studies [20,23]**.** On MRI all the cases presented as hypo to iso intense circumscribed masses on T1 weighted and hyper to isointense on T2 weighted images with uniformly contrast enhancement **(Fig.3C).** Thirteen cases were amenable to total to near total surgical excision and recurrence was reported in 4 young males with large tumors on follow up. Except for the recurrent cases, majority of cases demonstrated significant post-operative functional recovery of greater than 2 grades on Modified Mc Cormicks scale. Evaluation by the two principle diagnostic modalities of radiology and pathology revealed concordance rates of

54.5% for intradural extra-medullary meningioma and 83.3% for extradural meningioma. Near perfect degree of agreement between diagnostic modalities was reported for extradural tumors and moderate degree of agreement for intradural extra-medullary meningioma.

Twelve Gliomas were reported in our study accounting for 19.0% of total spinal neoplasms and these findings were similar to reference studies of Lalitha VS et al. [17] and Suh et al. [24]. Male to female ratio is 2:1 and majority of the cases were clustered in 20-40 years' age group. Seven cases of low-grade astrocytoma (Fig.4A) and 2 cases of high-grade astrocytoma were reported in our study and presented with back pain and motor dysfunction. All cases of astrocytoma were distributed in the intradural intramedullary location and correlated with location centric distribution of astrocytoma reported by Craciunas et al. [25]**.** There was clustering of cases at thoracic vertebrae similar to the findings of Craciunas et al. We had a case of Glioblastoma multiforme (Fig.4C) in 44 years old male who succumbed to illness during the study period. Primary GBM of the spinal cord is quite rare, representing 3% of all intramedullary spinal cord tumors and only a few case reports are evidenced in the literature [26]. Three cases of Ependymoma were reported, two in intradural intramedullary and one case in intradural extra-medullary location. In contrast to reference studies of Craciunas et al [25], Adam et al. [27], and Milano et al [28], compared to ependymoma, more astrocytomas are reported in our study. In general gliomas are hypo to isointense on T1 weighted images and hyper intense on T2 weighted image with variable contrast enhancement (Fig.4B). The distinction of astrocytoma from ependymoma in not possible on MRI alone and histopathological analysis plays a significant role in establishing the diagnosis and determining the prognosis. Ependymomas are often low grade with benign indolent course and are amenable to complete surgical resection but astrocytoma often infiltrate along the spinal cord segments and complete resection is rare with varied prognosis. Previous reference studies [1,2,4,18] have noted that spinal gliomas are more frequent in children than adults and this probably explains lower incidence of astrocytoma in our study which resulted from lower percentage of patient cohort below 20 years of age analyzed in our study. Of all the Spinal SOLs evaluated post-operative functional recovery was the least for this group and within the group it was worse for astrocytomas than ependymomas. Radiological and pathological correlation revealed concordance rates of 57.1% for low grade astrocytomas and 100% for high grade astrocytomas and intramedullary ependymomas and there was moderate degree of agreement between the two diagnostic modalities for all the intradural intramedullary SOLs.

Among the Extra-Dural spinal SOLs, we reported four cases of solitary plasmacytoma, two cases of ABCs and a case of classic chordoma. In our study three cases of plasmacytoma (Fig.5A) were localized to thoracic vertebrae and other one to the lumbar vertebra. And all the four cases of plasmacytoma, after surgical excision and histopathological evaluation, underwent radiotherapy with significant functional improvement on follow-up. Two cases of ABC (Fig.5E) are seen in 10-20 years' age group with slight female preponderance and localized to the thoracic vertebrae and these cases responded well to surgical management alone with excellent recovery of functional capacity. A case of classic chordoma involving the sacrum was also reported, which comprised of sheets and cords of round to oval cells dispersed in a myxoid background (Fig.5D). After surgical excision and histopathological evaluation, case was referred to higher cancer center for further management and follow-up of the patient was interrupted. Near perfect degree of agreement between the two diagnostic modalities was reported for all the extradural spinal SOLs in our study. The frequencies of extradural spinal SOLs in our study were similar to the study done to analyze the trends of spinal tumors in Northern India by Rajnish Kumar Arora et al [14]. However, due to small number of extradural spinal SOLs analyzed in our study, it does not necessarily reflect the epidemiological trend in our area of study and represents only the referral pattern.

In contrast to location centric distribution of spinal tumors, we reported a rare case of Intradural extra-medullary extra-osseous Ewing's sarcoma in a 22-year-old man who presented with inability to walk and numbness in both lower limbs. MRI findings suggested a possibility of nerve sheath tumour (Fig.3F) but histopathological analysis revealed a malignant round cell tumour, immunohistochemistry revealed strong membranous CD-99 positivity and diffuse cytoplasmic positivity for vimentin (Fig.3G, 3H). Though common in extradural location, Ewing's sarcoma in intradural extra-medullary space is pretty rare and only a few case reports are evidenced in the literature. This particular case was recently published as a case report [29]. We also reported three cases of secondary tumors metastatic to the spine, two cases were in women with known primary lung adenocarcinoma (Fig.5H) and one was reported in male with primary prostate adenocarcinoma and all these cases succumbed to illness during our study period. In view of small number of spinal metastatic tumours presented in our study, we need to analyse greater number of cases to determine the true demographic frequency in our population.

Twenty-six non-neoplastic SOLs were reported in our study. Spinal tuberculosis constituted the greater proportion, accounting for 61.5% of total non-neoplastic SOLs. Male preponderance was seen and more than half of the cases are in the 20-40 years' age group. Spinal tuberculosis **(Fig.4D)** was predominant in extradural location and majority involved the thoracic vertebrae followed by lumbar vertebrae. Similar results were reported by Gadgil et al. [15]. We also had three cases of intramedullary spinal tuberculosis, two cases involved thoracic vertebrae and one case involved lumbar vertebrae. Predominant thoracic vertebral level of involvement of intra medullary tuberculomas was also reported by Thacker et al [30]. Backache was the most common symptom. Assessment of radiological and pathological correlation of spinal tuberculosis revealed concordance rates of 75% for extradural, 60% for intradural extra-medullary and 66.7% for intradural intramedullary lesions. In our study we also reported a case of intradural extra-medullary cavernous hemangioma involving the thoracic vertebra and three cases of extradural abscess. Among the congenital malformations, we reported three cases of meningocele and two cases of meningo-myelocele distributed in extradural location and predominantly involving lumbar vertebrae. Similar findings were reported by Binayke et al. [31] and Odebode et al [32].

Conclusion

Our study comprises of one of the largest cohorts of SOLs analysed in rural India. Comprehensive assessment of clinical, radiological and histopathological features was accomplished, and predictive and prognostic significance was determined. As evidenced in various national and international literature anatomic location centric distribution of spinal SOLs was also reported in our study with a notable exception of Ewing's Sarcoma which was centered in the intra dural extra-medullary location. Majority of the benign spinal cord tumors were distributed in the intra dural extra-medullary location and involved thoracic vertebrae. Malignant tumors predominantly involved extradural location and were clustered along the thoracic and lumbar vertebrae. Similar to other Asian studies, NSTs was the most common histopathological diagnosis and spinal tuberculosis was the most common non-neoplastic SOL. Radiological and Pathological correlation revealed near perfect agreement in extra-dural tumours and moderate agreement for extra-medullary and intramedullary spinal tumours. In view of paucity of international reference literature and no evident national references for assessment of degree of agreement between diagnostic modalities in spinal SOLs, we suggest evaluation at other medical centres with a larger cohort of cases to verify and validate our results. Though rapid advancements in radiology improved initial diagnostic evaluation, we conclude that histopathological evaluation is still the gold standard for diagnosis, planning the treatment and predicting prognosis of primary spinal cord tumours.

Abbreviations

SOLs: Space Occupying lesions

NSTs: Nerve sheath tumours.

CNS: Central Nervous System.

ABC: Aneurysmal Bone Cyst.

Conflict of Interest

The authors declare no conflict of interest.

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