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A Study of MRI Evaluation of Spinal Cord Tumors with Histo-Pathological/ Cytological Correlation in Eastern India

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Abstract: Various benign and malignant tumors can affect spinal cord and structures around it. They can present with trivial symptoms like backache but can lead to neurological deficits and various disabilities if not diagnosed and treated accordingly. Out of the available imaging modalities, MRI is the commonly used method for diagnosis. Aim of our study was to assess the distribution, features, localization and extent of spinal cord tumors by MRI and to correlate the tissue characterization by MRI with histo-pathology. 114 no of patients diagnosed as having spinal cord tumors by MRI and who underwent surgery were included in the study. The study was conducted in the departments of Radio diagnosis, Neurosurgery, and Pathology at SCBMCH, Cuttack from September 2013 to October 2016. Type of study is retrospective analytical. Out of the 114 patients with spinal cord lesions, 57% were male and 43% were female. Around 8% of the patients were in the pediatric age group and 92% were adults. In the pediatric age group, 33.3% of the cases were males and 66.7% were females. In the adults, 59% were males and 41% were females. Majority of the tumors were seen in the Intradural-Extramedullary compartment accounting for 52.6 % of the cases, followed by extradural tumors (23.7%) and intramedullary tumors (15.8%). Rest tumors were mix compartment tumors. Schwannoma was the commonest spinal cord tumor accounting for 28.9% of the tumors. Other tumors in decreasing order of frequency were meningiomas (15.8%), ependymomas (12.3%), hemangioma (11.4%), neurofibromas (10.5%), metastases (9.6%), astrocytomas (3.5%), hemangioblastoma (2.6%), arachnoid cyst (1.8%), one each (0.9%) of lipoma, PNET, epidermoid cyst, and multiple myeloma. Ependymoma was the commonest intramedullary tumor accounting for 38.9% of the intramedullary tumors. Schwannoma was the commonest intradural-extramedullary tumor accounting for 43.3% of them. Hemangioma was the commonest extradural tumor accounting for 48.1% of them. Out of 114 cases, MRI diagnosed 102 cases correctly. Out of the 12 wrongly diagnosed cases, 6 were intradural extramedullary, 3 were extradural and 3 was intramedullary in location. MRI correctly diagnosed 89.47% of the spinal cord tumors. MRI could correctly diagnose 90% of the intradural extramedullary tumors, 83.33% of the intramedullary tumors, and 88.89% of the extradural tumors. MRI misdiagnosed 12 cases. Two of the cases diagnosed on MRI as neurofibromas were found to be schwannomas on histopathological/Cytological examination and vice versa. Similarly two cases of astrocytoma came out ependymoma, two of ependymoma came out to be schwannoma and one as astrocytoma. Also one case each of meningioma, ewing sarcoma and metastasis came out to be neurofibroma, PNET and multiple myeloma respectively. MRI can accurately assess the distribution, features, localization, extent and the tumor type in case of the spinal cord tumors.

Keywords: Spinal cord tumors, intradural, extramedullary, magnetic resonance imaging.

INTRODUCTION

Nowadays, MRI is the most commonly used modality for spinal tumor diagnosis [1]. Central nervous system includes brain and spinal cord. Spinal cord tumors are not common. They account for 2-4% of all central nervous system neoplasms [2, 3]. Spinal cord tumors are classified based on their location into extradural, intradural extramedullary and intramedullary tumors [1, 4, 5]. Extradural tumors arise outside the dural sac, mainly from the spinal column.

They consist of a number of primary bone tumors, the commonest being hemangiomas. Secondary tumors or metastases are more common than primary tumors in the extradural location. These lesions deviate the thecal sac toward the spinal cord resulting in subarachnoid space narrowing [4, 5]. Intradural extramedullary tumors are within the dural sheath but outside the spinal cord [4, 5]. Neurofibroma and meningioma are the common primary tumors in this location. In these lesions, there is widening of the subarachnoid space [4]. Intramedullary tumors are present within the spinal cord. These tumors result in cord expansion and narrowing of subarachnoid space [3, 4]. Most of the intramedullary tumors are malignant and 90-95% are gliomas. Common glial tumors are ependymoma, astrocytoma. In adults, ependymomas are the commonest glial tumors and in children, astrocytomas are the most common [6]. Spinal tumors present with symptoms like back pain, progressive paraparesis, sensory loss, sphincter dysfunction [6, 7].

Aim of study was to assess the distribution, features, localization and extent of spinal cord tumors by MRI and to correlate the tissue characterization by MRI with that of histopathological/cytology examination

METHODS

Source of data

The study was conducted in the Department of Radio-diagnosis, Neuro-Surgery and Pathology, S.C.B. Medical College.

Study period

September 2013 to October 2016.

Study design

Retrospective analytical study

114 no of patients diagnosed as having spinal cord tumors by MRI and underwent surgery were included in the study. History was taken from the patients. The patients were clinically examined. Those patients diagnosed as having spinal cord tumors were followed up till surgery for confirmatory Histo-pathological/Cytological diagnosis.

Inclusion criteria

Patients of all age groups belonging to either sex with spinal cord tumors diagnosed by MRI of spine were included in the study.

Exclusion criteria

Those patients with spinal symptoms/pathology due to infections, prolapsed intervertebral disc, and trauma were excluded from the study.

Magnetic resonance imaging machine & technique

All the MRI scans of the spinal cord in this study were performed using GE Signa HDX MR Machine with a 1.5 tesla field strength magnet. Precontrast images were taken followed by postcontrast images with intravenous administration of 0.1 mmol/kg of body weight of gadolinium. The standard imaging protocol used was as below.

Table-1: MRI Protocol

Sequence	TR	TE	FOV (cm)	Slice thickness (mm)	Inter slice gap (mm)	Imaging Matrix	NEX
T2 SAG	2760	110.0	32 x 32	4	1	512 x 256	3
T1 SAG	760	15	32 x 32	4	1	256 x 256	2
T2 AX	2720	85	20 x 20	4	0.5	512 x 256	2
T1 AX	780	20	20 x 20	4	0.5	512 x 256	2
COR STIR	3750	26	32 x 32	4	0.5	512 x 512	2
PC T1 SAG FAT SAT	760	15	32 x 32	4	1	256 x 256	4
PC T1 COR FAT SAT	700	15	32 x 32	4	1	512 x 512	4
PC T1 AX FAT SAT	640	20	20 x 20	4	0.5	512 x 256	3

Statistical Analysis

The obtained data were analyzed by using a software statistical package for the social science (SPSS version 20). Frequency and descriptive analyses were used to describe the data. Any difference or correlation was considered significant if p value less than 0.05.

RESULTS

Out of the 114 patients with spinal cord lesions, 65 patients (57%) were male and 49 were female (43%). Male female ratio was 1.33:1.Around 8% of the patients were in the pediatric age group and 92% were adults. In the pediatric age group, (3 out of 9) 33.3% of the cases were males and (6 out of 9) 66.7% were females. In the adults, 59% (62 out of 105) were males and 41% (43 out of 105) were females (table-2,3).

Schwannoma was the commonest spinal cord tumor accounting for 28.9% of the tumors. Other tumors in decreasing order of frequency were meningiomas (18 in no,15.8%), ependymomas (14 in no,12.3%), hemangioma (13 in no,11.4%), neurofibromas (12 in no,10.5%), metastases (11 in no,9.6%), astrocytomas (4in no ,3.5%), hemangioblastoma (3 in no,2.6%), arachnoid cyst (2 in no, 1.8%), one each (0.9%) of lipoma, PNET, epidermoid cyst, and multiple myeloma (table-3).

Majority of the tumors were seen in the intradural extramedullary compartment accounting for 52.6 % of the cases, followed by extradural tumors (23.7%) and intramedullary tumors (15.8%). Rest tumors were mix compartment tumors. Ependymoma was the commonest intramedullary tumor accounting for 38.9% (7 out of 18) of the intramedullary tumors. Schwannoma was the commonest intradural extramedullary tumor accounting for 43.3% (26 no. out of 60) of them. Hemangiomas were the commonest extradural tumor accounting for 48.1% (13 in no, out of 27) of them (table-4,5,6,7,8,9,10,11).

Out of 114 cases, MRI diagnosed 102 cases correctly. Out of the 12 wrongly diagnosed cases, 6 were intradural extramedullary, 3 were extradural and 3 was intramedullary in location. MRI correctly diagnosed 89.47% of the spinal cord tumors. MRI could correctly diagnose 54 out of 60 (90%) of the intradural extramedullary tumors, 15 out of 18 (83.33%) of the intramedullary tumors, and 24 out of 27(88.89%) of the extradural tumors.(table-12)

MRI misdiagnosed 12 cases. Two of the cases diagnosed on MRI as neurofibromas were found to be schwannomas on histopathological examination and vice versa. Similarly two cases of astrocytoma came out ependymoma, two of ependymoma came out to be schwannoma and one as astrocytoma. Also one case each of meningioma, ewing sarcoma and metastasis came out to be neurofibroma, PNET and multiple myeloma respectively (table-14).

Table-2: Age and Gender Distribution

Age(Years)	**Male**		**Female**		**Total**			**No**	**%**
	No.	%	No	%	No	%	Male	65	57
0-18	3	4.6	6	12.2	9	7.9	Female	49	43
19-30	9	13.8	4	8.2	13	11.4	Total	114	100
31-40	13	20	10	20.4	23	20.2			
41-50	18	27.7	21	42.86	39	34.2			
51-60	13	20	7	14.3	20	17.5			
>60	9	13.8	1	2.04	10	8.8			
TOTAL	65	100	49	100	114	100			

Out of the 114 patients with spinal cord lesions, 65 patients (57%) were male and 49 were female (43%). Around 8% of the patients were in the pediatric age group and 92% were adults. In the pediatric age group, (3 out of 9) 33.3% of the cases were males and (6 out of 9) 66.7% were females. In the adults, 59% (62 out of 105) were males and 41% (43 out of 105) were females.

Table-3: Age and Gender Distribution of Individual Tumors

	Tumors	%	Sex		Age (Years)						
			M	F	0-10	11-20	21-30	31-40	41-50	51-60	>60
1	Schwannoma (33)	28.9	17	16	1	1	5	9	11	6	
2	Meningioma (18)	15.8	6	12	-	-	-	3	8	4	3
3	Ependymoma (14)	12.3	7	7	1	1	2	2	5	1	2
10	Hemangioma (13)	11.4	6	7	-	1	1	3	7	1	-
4	Neurofibroma (12)	10.5	9	3	1	1	-	1	4	2	3
6	Metastasis (11)	9.6	9	2	-	2	-	1	2	5	1
5	Astrocytoma (4)	3.5	4	0	-	-	1	1	-	1	1
7	Hemangioblastoma (3)	2.6	2	1	-	-	1	1	1	-	-
12	Arachnoid Cyst (2)	1.8	1	1	-	-	-	-	2	-	-
8	Lipoma (1)	0.9	1	0	-	-	-	1	-	-	-
9	PNET (1)	0.9	1	0	-	1	-	-	-	-	-
11	Epidermoid Cyst (1)	0.9	1	-	-	-	1	-	-	-	-
13	Multiple Myeloma(1)	0.9	1	-	-	-	-	1	-	-	-

Only Meningioma showed female predominance. Hemangioma was slightly commoner in female. Ependymoma and Arachnoid cyst showed no sex predilection. Rest of the tumors was commoner in males than females.

Table-4: Regional Distribution of the Spinal Cord Tumors

Intramedullary	No	Intradural Extramedullary	No	Extradural	No	Both Intra-Extradural	Both Intra-Extra Medullary
Ependymoma	7	Schwannoma	26	Metastases	8	Neurofibroma-3	Ependymoma-1
Astrocytoma	4	Meningioma	17	PNET	1	Schwannoma-5	
Hemangioblastoma	3	Neurofibroma	8	Schwannoma	2		
Lipoma	1	Arachnoid Cyst	2	Hemangioma	13		
Epidermoid Cyst	1	Ependymoma	6	Meningioma Neurofibroma	1 1		
Metastatic	2	Metastatic	1	Multiple Myeloma	1		
TOTAL	18		60		27	8	1

Majority of the tumors were seen in the intradural extramedullary compartment accounting for 52.6 %.

In adults, intradural extramedullary tumors (50.9%) and were more common. In the pediatric age group, extradural tumors accounted for 3.5% of the cases and were commoner (Table-5).

Table-5: Distribution of Lesions in Adult & Pediatric Age Group

	Intramedullary		Intradural Extramedullary		Extradural		Both Intra-Extradural	Both Intra-Extramedullary
	No	%	No	%	No	%	No, %	No, %
Adults	16	14	58	50.9	23	20.2	7=6.1%	1 =0.9%
Pediatric	2	1.7	2	1.7	4	3.5	1=0.9%	-

Table-6: Distribution of Extradural Tumors in Adults

Extradural Tumors	Number	% of Adult Extradural Tumors (Total No=23)	% of Adult Spinal Tumors(Total No=105)
Hemangioma	12	52.2	11.4
Metastases	7	30.4	6.7
Schwannoma	2	8.7	1.9
Multiple Myeloma	1	4.3	0.9
Meningioma	1	4.3	0.9

In adults, Hemangioma accounted for around fifty-two percent of extradural tumors and metastases, schwannoma, multiple myeloma and meningioma accounted for rest of the tumors. The pediatric age group, 4 cases were seen extradurally. They are PNET, neurofibroma, metastasis and hemangioma.

Table-7: Distribution of Intradural Extramedullary Tumors in Adults

Intradural Extramedullary Tumors	No	% of Adult Intradural Extramedullary Tumors (Total=58)	% of Adult Spinal Tumors (Total =105)
Schwannoma	25	43.1	23.8
Meningioma	17	29.3	16.2
Neurofibroma	8	13.8	7.6
Ependymoma	5	8.6	4.8
Arachnoid Cyst	2	3.4	1.9
Metastatic	1	1.7	0.9

Out of 58 intradural extramedullary tumors in adults, schwannomas were the commonest followed by meningioma, neurofibroma,Ependymoma, arachnoid cyst and metastasis.

In the pediatric age group, two cases were noted in the intradural extramedullary compartment and those were schwannoma and ependymoma.

Table-8: Distribution of Intramedullary Tumors in Adults

Intramedullary Tumors	No	% of Adult Intramedullary Tumors (16)	% of Adult Spinal Tumors (105)
Ependymoma	6	37.5	5.7
Astrocytoma	4	25	3.8
Hemangioblastoma	3	18.7	2.8
Epidermoid Cyst	1	6.3	0.9
Lipoma	1	6.3	0.9
Metastatic	1	6.3	0.9

In the intramedullary compartment in adults, ependymomas were the commonest tumors followed by astrocytoma. One case each of hemangioblastoma, epidermoid cyst and lipoma were seen.

In the pediatric age group two cases of intramedullary tumors were found, one was ependymoma, other one metastatic.

Table-9: Distribution of Intradural Extramedullary Tumors

Tumors (60)	Cervical	Thoracic	Lumbo-sacral
Schwannoma (26)	8	17	14
Meningioma (17)	3	13	1
Neurofiroma (8)	2	4	2
Ependymoma(6)		3	3
Arachnoid Cyst (2)	-	2	-
Metastatic(1)			1

Schwannoma was commonest intradural extramedullary tumor followed by meningioma with thoracic as the common location.

Ependymoma was commonest intramedullary tumor with conus as the common site (Table-10).

Commonest extradural lesion was hemangioma followed by meningioma (Table-11).

Table-10: Distribution of Intramedullary Tumors

Tumors (18)	Location		
	Cervical	Thoracic	Conus Medullaris
Ependymoma (7)	1	-	6
Astrocytoma (4)	1	2	1
Hemangioblastoma (3)	-	2	1
Metastatic(2)	-	1	1
Epidermoid Cyst (1)	-	1	-
Lipoma (1)	1	1	-

Table-11: Distribution of Extradural Tumors

Tumors (27)	Site	
	Thoracic	Lumbar Sacral
Hemangioma (13)	8	5
Metastases (8)	5	3
Schwannoma (2)	1	1
Meningioma(1)	1	-
PNET(1)	1	-
Neurofibroma(1)		1
Multiple Myeloma(1)	1	

Table-12: Histo-pathological/Cytological Examination with MRI Correlation

	Lesions	HP/C Diagnosis	MRI Diagnosis
1.	Schwannoma	33	30
2.	Meningioma	18	18
3	Ependymoma	14	10
4	Hemangioma	13	13
5	Neurofibroma	12	10
6.	Metastases	11	11
7	Astrocytoma	4	3
8	Hemangioblastoma	3	3
9.	Arachnoid Cyst	2	2
10	Epidermoid Cyst	1	1
11	Lipoma	1	1
12.	Multiple Myeloma	1	-
13.	PNET	1	-
	Total	114	102

Out of 114 cases, MRI diagnosed 102 cases correctly. Out of the 12 wrongly diagnosed cases, 6 were intradural extramedullary, 3 were extradural and 3 was intramedullary in location.

Table-13: Age Range of Common Tumors

TUMOUR	No	Minimum	Maximum	Mean	Std. Deviation
SCHWANNOMA	33	7	56	39.4545	12.01585
MENIMGIOMA	18	34	90	51.9444	13.78180
EPENDYMOMA	14	5	70	41.2143	18.03065
HEMANGIOMA	13	13	56	41.3846	12.50026
NEUROFIBROMA	12	8	68	46.5000	19.07640
METASTATIC	11	16	65	46.0909	16.47698

Table-14: Cases wrongly diagnosed by MRI

Sl. No	Age (Years)/Sex	HP/C Diagnosis	MRI Diagnosis
1	40/M	Astrocytoma	Ependymoma
2	40/F	Schwannoma	Neurofibroma
3	55/F	Neurofibroma	Schwannoma
4	56/M	Neurofibroma	Meningioma
5	34/M	Multiple Myeloma	Metastatic
6	15/M	PNET	Ewing Sarcoma
7	36/M	Schwannoma	Ependymoma
8	35/F	Schwannoma	Neurofibroma
9	35/F	Schwannoma	Ependymoma
10	5/F	Ependymoma	Astrocytoma
11	58/F	Ependymoma	Astrocytoma
12	8/M	Neurofibroma	Schwannoma

MRI wrongly diagnosed 12 cases

DISCUSSION

Out of the 114 patients with spinal cord tumors, 65 (57%) were males and 43% (57) were females. 7.9% of the patients were in the pediatric age group and the rest (92.1%) were adults. In the pediatric age group, 33.3% were males and 66.7% were females. In the adults, 59% were males and 41% were females (Table-2). Study conducted by Chung *et al.* [1] mentioned that out of the spinal tumor patients, 46.2% were males and 53.8% were females and 97.4% were adults.

Schwannomas (28.9%) were the commonest of spinal cord tumors. Others in decreasing order were Meningiomas (15.8%), Ependymomas (12.3%), Hemangioma (11.4%), Neurofibromas (10.5%), Metastases (9.6%), Astrocytomas (3.5%), Hemangioblastoma (2.6%), Arachnoid cyst (1.8%), one each (0.9%) of Lipoma, PNET, Epidermoid cyst, and Multiple myeloma (table-3). Chung *et al*. [1] reported schwannomas as the commonest tumor, similar to our study, followed by meningiomas, neurofibromas, hemangiomas, arachnoid cysts.

In our study, Meningioma showed female predominance. Hemangioma was slightly commoner in female. Ependymoma and Arachnoid cyst showed no sex predilection. Rest of the tumors was commoner in males than females. The male to female ratio of the different tumors in our study was as follows, schwannoma 1.06:1, meningiomas 1:2, neurofibroma 3:1, hemangioblastoma 2:1, ependymoma and arachnoid cyst 1:1,hemangioma 1:1.17 astrocytoma 4 males, metastases 4.5:1 (table-3). In the study by Chung *et al.* [1], the male:female ratio in different tumors was schwannoma 1.1:1, meningioma 1:4, neurofibroma 1:1, arachnoid cyst 1:1.

According to our study, intradural extramedullary tumors (60 out of 114, 52.6%) were the commonest, followed by extradural tumors (27 out of 114, 23.68%) and intramedullary tumors (18 out of 114, 15.79%). Rest were mix compartment tumors (9 out of 114, 7.9%) (table-4).In the study by Chung *et al.* [1], intradural extramedullary tumors were the commonest

In our study, out of 105 adult patients, intradural extramedullary tumors accounted for 58 cases (50.9%) and were more common than Intramedullary (14%) and extradural tumors (20.2%). Both intra-extradural cases were 7 in no & 6.1%, and intra-extramedullary was one case (0.9%) (Table-5). In the pediatric age group, extradural tumors accounted for 4 in no. and were commoner than intradural extramedullary and intramedullary tumors comprising two cases each.

We found that, in adults, intradural extramedullary tumors were predominant comprising of 58 cases (50.9%). Among the intradural extramedullary tumors in adults, schwannomas (23.8%) were the commonest followed by meningioma (16.2%),

neurofibroma (7.6%), Ependymoma(4.8%) and arachnoid cyst (1.9%) (table 6, 7, 8). Chung et al. [1] reported schwannomas as the commonest intradural extramedullary lesion followed by meningioma and neurofibroma.

In our study, in the intramedullary region in adults, ependymomas (5.7%) were the commonest tumors followed by astrocytomas (3.8%), hemangioblastoma (2.8%), epidermoid cyst (0.9%), lipoma(0.9%) and metastasis (0.9%) (table-8). Parizel *et al*. [8] also reported that ependymomas and astrocytomas are the two commonest tumors in adults. Engelhard *et al*. [9] also reported that ependymomas were the commonest intramedullary tumors.

According to our study, in the extradural compartment in adults, hemangioma (11.4%) were the most common lesions followed by metastases (6.7%), schwannoma (1.9%), multiple myeloma (0.9%) and meningioma (0.9%).

In the pediatric age group, 4 cases were seen extradurally. They are PNET, neurofibroma, metasatsis and hemangioma. Two cases were in the intradural extramedullary compartment, one was schwannoma and other one was ependymoma. Two intramedullary tumors were also seen, those were ependymoma and metastatic.

We found that, Schwannomas were the commonest of tumors (28.9%). Out of the 33 cases, 26 cases were intradural Extramedullary, 5 of mix extra-intradural and 2 were extradural in location. Schwannomas were the most common intradural extramedullary spinal cord tumors. They showed slight male predominance with male-female ratio of 1.06:1. The age group range was 7 to 56 years and the mean age was 39.45 (with standard deviation 12) years. The commonest site was the thoracic region followed by lumbosacral, and cervical regions (table 3,4,9,13).

In our study, meningiomas were the second commonest tumors accounting for 15.8%. These tumors showed female predominance with male-female ratio of 1:2. The age group range was 34 to 90 years. The mean age was 51.9 years (with standard deviation of 13.78). All of them except one, were intradural extramedullary in location. One was Extradural in location. The commonest site of the tumors was the thoracic region followed by the cervical region (table 3,4,9,13). Regarding meningiomas, Chung *et al.* [1] reported similarity to our study.

Ependymoma was the third commonest tumors in our study comprising 12.3% of the spinal cord tumors. Ependymomas were the commonest intramedullary tumors. No gender predilection was seen. The age range of the patients varied from 5 to 70 years. The mean age was 41.2 (with standard deviation 18) years. Out of them, 7 cases were Intramedullary, 6 intradural Extramedullary and one both intra-extramedullary in location. Lumbosacral was commonest location followed by thoracic (table 3,4,10,13). Kahan *et al.* [10] mention the lumbosacral spine as the commonest site for ependymoma.

According to our study, extradural hemangioma was the 4th common, accounting for 11.4% of the spinal cord tumors. These tumors showed slight female predominance with male-female ratio of 1:1.17. The age group range was 13 to 56 years. The mean age was 41.38 years (with standard deviation of 12.5) (table 3,4,11,13)..

In our study, neurofibromas was 5th common spinal cord tumors and accounts for 10.5% of the tumors. They were the third most common intradural extramedullary tumors. Here male predilection was noted with M:F ratio 3:1. The age range of the patients varied from 8 to 68 years and the mean age was 46.5(with SD of 19) years. Out of them, 8 cases were intradural extramedullary, one in Extradural and 3 both intra-extradural in location. Thoracic was the commonest location (table 3,4,9,13).. Chung *et al.* [1] reported the thoracic region as common location for neurofibroma.

Metastases were the 2nd most common extradural spinal cord tumors in our study. They accounted for 9.8% of all spinal cord tumors. Here also male predilection was noted with M:F = 4.5:1. The age range of the patients varied from 16 to 65 years and the mean age was 46 (with SD of 16.5) years. Out of 11 patients 8 were Extradural, two were Intramedullary and one was Intradural Extramedullary (table 3,4,11,13). The Intramedullary lesions were from cerebellar medulloblasoma as primary. Intradural Extramedullary lesion was from soft tissue sarcoma primary. Extradural lesions had lungs (3 in no.), prostate (3 in no), colon (1 in no.) and thyroid (1 in no.) as primary site. Lesions involved multiple vertebra bodies, few of posterior elements and few with soft tissue component. Chung *et al*. [1] reported a case of extradural metastasis in dorsal spine in a 59 year old male with primary as prostate carcinoma. Stimac *et al.* [11] reported 7 cases of metastases in the extradural compartment. The primary tumor was in the prostate in 3 cases, in the breast in 2 cases, one each in colon and lung.

In our study, Astrocytomas were the second most common intramedullary tumors. They accounted for 3.5% of all the spinal cord tumors. All were reported in males aged 30, 40, 60 and 75years. In one case, the lesion was in the cervical cord, two in the thoracic cord and one at conus region. Seo *et al.* [12] mention that out of 19 patients with astrocytomas, 11 were males and 8 were females and 69% of tumors were located in the

cervical region. According to Williams *et al*. [13] astrocytoma was commonest intramedullary tumor.

In our study, we found 3 cases of hemangioblastoma accounting for 2.6% of the spinal cord tumors. Two were male and one was female. One lesion was at D6-D8 level in a 31 year male, in the other male patient of 30 year age the lesion was at L1 level. The female was 45 year aged with lesion at D12 level. Chu *et al.* [14] reported 32 tumors of hemangioblastoma of which 24 were intramedullary in location.

We found two cases of arachnoid cyst accounting for 1.8% of the spinal cord tumors, one was noted intradural extramedullarily in a 50 year old male patient and the other one in a 50 year old female at D7-11 and D11-12 level respectively. Chung *et al*. [1] reported 2 cases of arachnoid cyst. Both the lesions were located in the sacral region. One was in a male and the other in a female.

One case of intramedullary lipoma was found in our study accounting for 0.9% of the spinal cord tumors. It was seen at C7 to D3 level. Lee *et al.* [15] reported that spinal cord lipomas are very rare accounting for around 1% of spinal cord tumors. Kim *et al.* [16] reported 3 cases of intramedullary lipomas. Williams *et al*. [13] reported 1 case of a intramedullary lipoma.

One case of PNET accounting for 0.9% of spinal cord tumors was found in our study. It was noted extradurally at D2-D3 level. Papadatos *et al.* [17] mention a case of an exophytic spinal PNET in a 23 year old woman.

One case of intramedullary epidermoid cyst accounting for 0.9% of the spinal cord tumors was noted in a 29 year old male. It was noted intramedullarily at D3-D4 level. Kikuchi *et al.* [18] reported a case of intramedullary epidermoid cyst in a 44-year old man in the thoracic region.

One case of multiple myeloma accounting for 0.9% of spinal cord tumors was found in our study. It was noted extradurally at multiple levels from D1-D12 level in a 34 year old male.

Out of 114 cases, MRI diagnosed 102 cases correctly. Out of the 12 wrongly diagnosed cases, 6 were intradural extramedullary, 3 were extradural and 3 was intramedullary in location. MRI correctly diagnosed 89.47% of the spinal cord tumors. MRI could correctly diagnose 54 out of 60 (90%) of the intradural extramedullary tumors, 15 out of 18 (83.33%) of the intramedullary tumors, and 24 out of 27(88.89%) of the extradural tumors.

The specificity of MRI in diagnosing schwannoma was 90.9% (30 out of 33). MRI was able to diagnose all cases of meningioma accurately. The specificity of MRI in diagnosing neurofibroma was 83.3% and for ependymoma it was 71.4% (table 14).

MRI misdiagnosed 12 cases. Two of the cases diagnosed on MRI as neurofibromas were found to be schwannomas on histopathological examination and vice versa. Similarly two cases of astrocytoma came out ependymoma, two of ependymoma came out to be schwannoma and one as astrocytoma. Also one case each of meningioma, ewing sarcoma and metastasis came out to be neurofibroma, PNET and multiple myeloma respectively (table 15).

CONCLUSION

MRI can accurately assess the distribution, features, localization, and extent of spinal cord tumors. MRI can accurately characterize the tumor tissue in 89.47% of the spinal cord tumors, 90% of the Intramural Extramedullary tumors, 83.33% of the intramedullary tumors, and 88.89% of the extradural tumors.

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