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MRI in the Evaluation Spinal Cord Tumors with Histopathological Correlation

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Abstract
Spinal cord tumours are relatively slow growing tumours and can present with a wide variety of symptoms. If they are not diagnosed early and treated immediately they can lead to neurological deficits and disability. CT & MRI are the commonly used modalities for diagnosis of spinal tumours. The advent of Magnetic Resonance Imaging (MRI) has revolutionised the diagnosis and management of spinal cord tumours unless there is a contraindication.

Objectives: *To study the demographic profile and assess the distribution, features, localization, extent of spinal cord tumors by MRI and to correlate the tissue characterization by MRI with that of histopathological examination.*

Material & Methods*: A prospective study was conducted on 87 patients who were diagnosed to have spinal cord tumor by Magnetic Resonance Imaging irrespective of age & sex from a period of October 2013 to October 2016.Those patients with spinal symptoms and pathology due to infection, prolapsed intervertebral disc and trauma were excluded from the study. All patients were followed up till surgery or biopsy for confirmatory histopathological diagnosis. The final diagnosis were correlated followed by analysis of the present study by comparing with previous similar studies from various literature.*

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. Pre contrast images were followed by post contrast images with intravenous administration of 0.1mmol/kg of body weight of Gadolinium. The standard imaging protocol used was T1,T2 sagittal, axial, coronal and T1 post contrast fat suppressed axial ,sagittal, coronal planes.

Results: *Out of 87 patients with spinal cord tumors, 47 patients (54%) were males and females made up around 46% (40 patients).The male and female ratio was 1.17:1. Around 5.7% of the patients were in the pediatric age group and the rest were adults. Our study showed that intradural extramedullary tumours 55/87(63%) were the commonest, followed by extradural tumours 17/87(19%) and intramedullary tumours 15/87(17%). Among intradural-extramedullary tumors Schwannoma was the commonest spinal cord tumor accounting for 57.4% of the tumors. Other tumors in decreasing order of frequency were meningiomas (22.%), neurofibromas (14.8%). Ependymomas was the commonest intramedullary tumors accounting for (61.5%) followed by hemangioblastoma (15.4%) & astrocytoma (7.6%).*

MRI proves to be best initial modality of imaging in evaluation of suspected tumours of the spine regardless of the space in which they may lie & morphologic characterization of the tumour in 93.1% of the spinal tumours. In the extradural space MRI is the most sensitive technique for the detection of tumours in the vertebral bodies.

Keywords: *Spinal cord tumours, MRI, Adult, Pediatric.*

Introduction

A spinal tumour is an abnormal mass of tissue within or surrounding the spinal cord & spinal column. Incidence of spinal tumours is 1.1cases per 100,000 population. They account for 2-4% of all central nervous system neoplasm.[1,2]

Intraspinal tumours may originate from the spinal cord, filum terminale, nerve roots, meninges, intraspinal vessels, sympathetic chain, or vertebrae. They can be benign or malignant, primary or secondary, and may result in serious morbidity. Intraspinal tumours are relatively uncommon lesions. However thes lesion can cause significant morbidity and can be associated with mortality as well. In establishing the differential diagnosis for a spinal lesion, location is the most important features.[3]

Spinal cord tumours are classified based on their location with respect to the dural sac and spinal cord, into extradural, intradural extramedullary and intramedullary tumours. This categorization helps in localization and finally the differential diagnosis of the spinal cord tumours. Lesions can occasionally compromise more than one compartment.[4]

Extradural tumours arise outside the dural sac, mainly from the spinal column. They consist of a number of primary bone tumours which are relatively rare, the commonest being hemangiomas. Secondary tumours or metastasis are more common than primary tumours in the extradural location. These lesions deviate the thecal sac toward the spinal cord resulting in subarachnoid space narrowing.[5.6]

Intradural extramedullary tumours are within the dural sheath but outside the spinal cord. Neurofibroma and Meningioma are the common primary tumours in this location. Previously secondary tumours or leptomeningeal metastases used to be rare but now they are increasing in incidence. In these lesions there is widening of the subarachnoid space as the cerebrospinal fluid caps the mass.[5,6]

Intramedullary tumours are present within the spinal cord itself. Here primary tumours are far more frequent than secondary tumours. These tumors result in cord expansion and narrowing of subarachnoid space.[2,5] Most of the intramedullary tumours are malignant and 90-95% are gliomas. Common glial tumours are ependymoma, astrocytoma. In adults, ependymomas are the commonest glial tumours and in children, astrocytomas are the most common.[7] Non glial neoplasms like hemangioblastomas, paragangliomas, metastases, lymphoma and primitive neuroectodermal tumours are less common.[2]

Now a-days MR is always considered the procedure of choice for the workup of all spinal tumors.[8,9] It permits high-resolution imaging of not only the osseous structures but also the soft-tissue structures in multiple orthogonal planes through the use of varying pulse sequences. MR imaging plays an integral role in evaluation and improving anatomic delineation and early diagnosis of spinal tumors[3]

Routine MR Sequences to be acquired are sagittal and axial unenhanced T1- and T2-weighted images, sagittal STIR, coronal T2 weighted images and contrast enhanced axial and sagittal T1-weighted images. Contrast-enhanced images can be important for tumor detection, delineation, characterization, and grading. They help differentiate the tumor from the spinal cord, nerve roots, or thecal sac as well as from peri- tumoral edema or cysts. They are also crucial to ensure correct staging and treatment planning. MRI also plays an important role in follow-up and to monitor response to treatment.[10] Hence MRI has virtually replaced all other modalities while evaluating spinal tumours.

Material & Methods

A prospective study was done on 87 patients who were diagnosed to have spinal cord tumours by MRI in the Department of Radiodiagnosis, SCB Medical College & Hospital from October 2013 to October 2016. They were followed up till surgery or biopsy for confirmatory histopathological diagnosis except 2 patients with multiple

metastasis and known primaries, FNAC correlation was used. Those patients with spinal symptoms due to infections, prolapsed intervertebral discs, trauma and patients with MRI incompatible devices and claustrophobia were excluded. The paediatric patients were given sedatives (syp. trichlorophos, inj. midazolam) as and when required by anaesthesiologist. All the MRI scans were performed using 1.5 Tesla GE Signa HDX MR machine. Precontrast images were followed by postcontrast images with intravenous administration of 0.1mmol/kg of body weight of Gadolinium. The standard imaging protocol used was T1,T2 saggital, axial, coronal and T1 post contrast Axial, sagittal, coronal planes. The MRI and histopathological diagnosis were correlated followed by analysis of the present study by comparing with previous similar studies from various literature.

Results

The study comprised of 87 patients diagnosed as having spinal cord tumors by clinical examination and MRI examination of the spinal cord.

Table 1: Age & Sex Distribution

Age In Yrs	Male		Female		Total	
	NUMBER	%	NUMBER	%	NUMBER	%
0-18	1	20	4	80	5	5.7
19-30	13	81.2	3	18.75	16	18.3
31-40	10	50	10	50	20	22.9
41-50	10	43.4	13	56.5	23	26.4
51-60	12	60	8	40	20	22.9
>60	1	33.3	2	66.6	3	3.4
Total	47	54.0	40	45.9	87	100

Out of 87 patients with spinal cord tumors, 47 patients (54%) were males and females made up around 46% (40 patients). The male and female ratio was 1.17:1. Around 5.7% of the patients were in the pediatric age group and the rest were adults. In the pediatric age group, 20% of the cases were males and 80% were females.

Table -2: Age & Sex Distribution of Individual Tumors

SL.NO	Tumors With Numbers	%	Sex		Age In Years						
			M	F	0-10	11-20	21-30	31-40	41-50	51-60	>60
1	Schwannoma(40)	45.9	21	19	1	1	7	8	10	13	0
2	Meningioma (12)	13.7	5	7	-	-	-	4	4	4	-
3	Neurofibroma(8)	9.1	6	2	-	-	4	2	-	1	1
4	Ependymoma(8)	9.1	5	3	-	-	3	2	2	1	-
5	Astrocytoma(3)	3.4	1	2	1	1		1			-
6	Metastasis (4)	4.5	3	1	-	-	-	-	1	1	2
7	Hemangioblastoma(2)	2.2	1	1	-	-	-	1	1	-	-
8	Lipoma(2)	2.2	1	1	-	-	-	1	1	-	-
9	Pnet (2)	2.2	-	2	1	1	-	-	-	-	-
10	Hemangioma(2)	2.2	1	1	-	-	-	1	1	-	-
11	Epidermoid Cyst(1)	1.1	1	-	-	-	-	-	1	-	-
12	Arachnoid Cyst(2)	2.2	1	1	-	-	-	-	2	-	-
13	Chordoma (1)	1.1	1	-	-	-	1	-	-	-	-

Meningioma showed female predominance. Metastasis showed male predilection.

Table 3: Compartmental Distribution of the Spinal Cord Tumors

Sl.No	Intramedullary	No	Intradural Extramedullary	No	Extradural	No
1	Ependymoma	8	Schwannoma	32	Metastasis	4
2	Astrocytoma	3	Meningioma	12	Pnet	2
3	Hemangioblastoma	2	Neurofibroma	8	Schwannoma	8
4	Lipoma	2	Arachnoid Cyst	2	Hemangioma	2
5			Epidermoid Cyst	1	Chordoma	1
	Total	15		55		17

Out of 87 cases, majority of the tumors were seen in the intradural extramedullary compartment.(63%)

Table 4: Distribution of Lesions in Adult & Pediatric Age Group

	Intramedullary		Intradural Extramedullary		Extradural	
	NO	%	NO	%	NO	%
Adults	13	15.8	54	65.8	15	18.2
Pediatric	2	40	1	20	2	40

Out of 82 adult patients, intradural extramedullary tumors accounted for 54 cases (65.8%)and were more commoner than intramedllary and extradural tumors.

In the pediatric age group intramedullary & extradural tumors accounted for 40% (2in No) of the cases and were commoner than intradural extramedullary tumors.

Table 5: Distrbution of Extradural Tumors in Adults

Extradural Tumors	Number	% Of Adult Extradural Tumors(15)	% Of Adult Spinal Tumors (82)
Schwannoma	8	53.3	9.7
Metastasis	4	26.6	4.8
Hemangioma	2	13.3	2.4
Chordoma	1	6.6	1.2

In adults schwannoma accounted for 53.3 % of extradural tumors.

Table 6: Distribution of Intradural Extramedullary Tumors In Adults

Intradural Extramedullary Tumors	No	% Of Adult Intradural Extramedullary Tumors(54)	% Of Adult Spinal Tumors(82)
Schwannoma	31	57.4	37.8
Meningioma	12	22.2	14.6
Neurofibroma	8	14.8	9.7
Arachnoid Cyst	2	3.7	2.4
Epidermoid Cyst	1	1.8	1.2

Out of 54 intradural extramedullary tumors in adults schwannoma were the commonest followed by meningioma, neurofibroma and arachnoid cyst.

In the pediatric age group, only one tumor was noted in the intradural extramedullary compartment and that was schwannoma.

Table-7 Distribution of Intramedullary Tumors in Adults

Intramedullary Tumors	No	% Of Adult Intramedullary Tumors (13)	% Of Adult Spinal Tumors (82)
Ependymoma	8	61.5	9.7
Astrocytoma	1	7.6	1.2
Hemangioblastoma	2	15.3	2.4
Lipoma	2	15.3	2.4

In the intramedullary compartment in adults, ependymomas were the commonest tumors followed by hemangioblastoma and lipoma. One case of astrocytoma seen. In the pediatric age group 2 cases of astrocytoma seen.

Table-8: Distribution of Symptoms

Symptoms		Spinal Cord Tumors(87)	Schwannoma (40)	Meningioma (12)	Neurofibroma (8)	Ependymoma(8)	Astrocytoma (3)	Metastases (3)	Others (13)
Back Or Neck Pain		42	19	6	4	5	2	1	5
Extremity Symptoms	Pain	26	10	3	4	4	2	-	3
	Paresthesia	30	15	5	2	2	2	-	4
	Weakness	40	19	3	5	5	2	2	4
	Paralysis	14	8	1	1	1	-	2	1
Bladder & Bowel Symptoms		20	11	2	1	1	1	1	3

Back pain was the commonest symptoms followed by extremity weakness. In cases of neurofibroma patients extremity weakness was the commonest symptom.

Table-9: Imaging Characteristics of Intradural Extra medullary Tumours

Tumors (55)	Cervical	Thoracic	Lumbosacral	T1w1 Iso	T1w1 Hypo	T2w1 Hyper	T2w1 Iso	Heterogeneity	Cystic Areas	Cord Edema	Target Sign	Cord Compressio	Neural Foramen Widening	Nerve Root Compression	Dural Tail	Homogenous Enhancement	Heterogenous Enhancement
Schwannoma (32)	7	16	9	20	12	32	-	28	20	6	1	21	27	27	-	4	28
Meningioma (12)	3	9	-	12	-	1	11	1	-	1	-	10	-	2	10	12	-
Neurofibroma (8)	3	3	2	5	3	8	-	3	2	-	5	8	6	5	-	5	3
Arachnoid Cyst (2)	-	2	-	-	2	2	-	0	2	-	-	2	-	-	-	-	-
Epidermoid Cyst (1)	-	-	1	-	1	1	-	-	1	-	-	-	-	-	-	-	-

Most of the intradural extramedullary tumours were isointense on T1W1 images and hyperintense on T2W1 images. Majority of the meningiomas appeared isointense on T2W1 images. Most of the schwannomas showed heterogenous enhancement. All of the meningiomas showed homogenous enhancement.

Table 10: Imaging Characteristics of Intramedullary Tumors

Tumors (15)	Location			T1w1			T2w1 Hyperintense	Heterogenous	Cystic Areas	Hemorrhage	Cord Oedema	Cord Enlargement	Nerve Root Compression	Syringohydromyelia	Homogenous Enhancement	Heterogenous Enhancement
	Cervical	Thoracic	Conus Medullaris	Hypointense	Isointense	Hyperintense										
Ependymoma(8)	3	-	5	5	3	-	8	8	7	-	5	8	5	3	-	8
Astrocytoma(3)	2	1	-	2	1	-	3	3	3	-	3	3	1	-	-	3
Hemangioblastoma (2)	1	1	-	1	1	-	2	2	2	-	-	2	-	-	-	2
Lipoma(2)		1	1	-	-	1	1	-	-	-	-	1	-	1	-	-

All the cases of ependymoma were heterogenous in appearance and three of them showed hemorrhagic foci within. One case of epidermoid cyst was seen and showed no contrast enhancement. Lipoma was seen in one patient and it appeared hyperintense on T1W1 images.

Table 11: Imaging Characteristics of Extradural Tumors

Tumors(17)	Site		T1w1				T2w1hyperintense	Heterogenous	Cystic Areas	Cord Oedema	Cord Compression	Nerve Root Compression	Neural Foramen Widening	Vertebral Body Collapse Or Scalloping	Homogenous Enhancement	Heterogenous Enhancement
	Thoracic	Lumbar	Hypointense	Isointense	Hyperintense	T2w1isointense										
Metastases(4)	2	2	4	-	-	-	4	2	-	2	2	2	-	4	-	4
Chordoma (1)	1	-	1	-	-	-	1	1	1	1	1	1	-	-	-	1
Pnet (2)	2	-	-	2	-	-	2	2	2	-	2	-	-	-	-	2
Schwannoma(8)	8	-	-	8	-	-	8	8	8	-	8	8	8	-	-	8
Hemangioma(2)	2	-	-	-	2	-	2	-	-	-	2	2	-	-	2	-

Metastases were associated with vertebral body collapse. One case of Chordoma was seen and it appeared hypointense on T1W image and hyperintense on T2W1 image. Heterogenous enhancement was noted in all the cases except in a case of hemangioma which showed homogenous enhancement.

Table 12: Histopathological Examination and MRI Correlation

Sl.No	Lesions	HPE Diagnosis	MRI Diagnosis
1	Schwannoma	40	39
2	Meningioma	12	12
3	Neurofibroma	8	9
4	Ependymoma	8	7
5	Astrocytoma	3	4
6	Metastasis	4	6
7	Hemangioblastoma	2	2
8	Epidermoid Cyst	1	1
9	Arachnoid Cyst	2	2
10	Lipoma	2	2
11	Hemangioma	2	2
12	Chordoma	1	-
13	Pnet	2	1

Out of 87 cases, MRI diagnosed 81 cases correctly. Out of the 6 wrongly diagnosed cases 3 were intradural extramedullary, 2 were extradural and 1 was intramedullary in location. Overall MRI was able to correctly diagnose 91.67% of the intradural extramedullary tumors, 90% of the intramedullary tumors, and 66.67% of the extradural tumors.

Table 13 Cases Misdiagnosed by MRI

Sl.No	Age In Years/Sex	Hpe Diagnosis	MRI Diagnosis
1	40/F	Schwannoma	Neurofibroma
2	55/F	Neurofibroma	Schwannoma
3	15/M	Pnet	Ewing Sarcoma
4	35/F	Schwannoma	Neurofibroma
5	22/M	Chordoma	Metasatsis
6	58/F	Ependymoma	Astrocytoma

MRI misdiagnosed 6 cases, 2 of the cases diagnosed as neurofibroma were found to be schwannomas on histopathological examination. MRI misdiagnosed PNET, neurofibroma, chordoma and ependymoma as Ewing sarcoma, schwannoma, metastasis and astrocytoma respectively.

Discussion

Spinal cord can be affected by a wide variety of lesions ranging from tumours, infection, demyelination and compressive myelopathies. MRI can show the lesions better than any other modality. In case of spinal cord tumours, MRI can localize the tumour and also demonstrate spinal cord or nerve root compression better. It can also detect hemorrhage, necrosis, solid, cystic components of the tumour. It can also differentiate between peritumoral and tumoral cysts.

This study was undertaken with the objectives of determining the distribution, morphology and tissue character of spinal cord tumours and to correlate the findings with histopathological examination. Our study was conducted from October 2013 to October 2016 on 52 patients who were diagnosed of having spinal cord tumours by clinical and MRI examnation. All patients were followed up for confirmation by HPE (except 2 patients with multiple metastasis and known primaries, FNAC correlation was used).

Table 1 shows the age & sex distribution of spinal cord tumors. Out of 87 patients with spinal cord tumors, 47 patients (54%) were males and females made up around 46% (40 patients).The male and female ratio was 1.17:1. Around 5.7% of the patients were in the pediatric age group and the rest were adults. In the pediatric age group,20% of the cases were males and 80% were females.

Chung et al.[4] conducted a retrospective study at Korea of MR images for spinal cord tumour in 39 patients. Of the 39 patients,18 (46.2%) were males

and 21 (53.8%) were females. 38(97.4%) patients were adults and one (2.6%) patient was a child.

Table 2 shows the frequency, age and sex distribution of the various tumors found in our study. Schwannomas 40/87 (45.9%) were the commonest. Other tumours in decreasing order of frequency were meningiomas 12/87(13.7%), neurofibromas 8/87(9.1%), ependymomas 8/87(9.1%), astrocytomas 3/87(3.4%), metastases 4/87(4.5%), hemangioblastoma, lipoma, PNET, hemangioma, 2/87 (2.2%) one of each. Meningiomas showed female predominance.

Chung et al[4] reported schwannomas 19/39 (48.7%) as the commonest tumor in their study, followed by meningiomas 5/39(12.8%), neurifibromas 4/39(10.3%), hemangiomas 3/39 (7.7%), arachnoid cyst 2/39(5.1%) and one each (2.5%) of giant cell tumor of the tendon sheath, ganglioneuroma, lymphoma, neuroblastoma, metastatic tumour from the prostate, arteriovenous malformation. The male:female ratio in different tumors was schwannoma 1.1:1,meningioma 1:4, neurofibroma 1:1,arachnoid cyst 1:1,hemangiom 3 females,one male each of giant cell tumour of tendon sheath, neuroblastoma, lymphoma, metastasis, one female each of ganglioneuroma and arteriovenous malformation.

Table 3 shows the compartmental distribution of the spinal cord tumours. Our study showed that intradural extramedullary tumours 55/87(63%) were the commonest, followed by extradural tumours 17/87(19%) and intramedullary tumours 15/87(17%) and In the study by chung et al.(4) intradural extramedullary tumours 36/39 (92.3%) were the commonest.3 cases (7.7%) were extrdural tumours and no intramedullary tumours.

Table 4 shows the distribution of the tumours in adult and pediatric age groups. Out of 82 adult patients, intradural extramedullary tumours accounted for 54 cases(65.8%) and were more common than intramedullary and extradural tumors. Intramedullary tumours accounted for 13 cases (15.8%) and extradural tumours were 15 in number (18.2%). In the pediatric age group intramedullary & extradural tumors accounted for 40% (2in No) of the cases and were commoner than intradural extramedullary tumors.

As per distribution of compartment of spinal cord tumours (table 5,6,7) in adults, intradural extramedullary tumours were predominant comprising of 54 cases(65.8%).Among the intradural extramedullary tumours in adults , schwannomas (57.4%) were the commonest followed by meningioma (22.2%), neurofibroma (14.8%) and arachnoid cyst 2 (3.7%) in number. Many studies including the one by Chung et al.[4] reported schwannomas as the commonest intradural extramedullary lesion followed by meningioma and neurofibroma.

In the intramedullary compartment in adults, ependymomas (9.7%) were the commonest tumour followed by hemangioblastoma(2.4%),and lipoma (2.4%). Parizel et al.[11] also reported that ependymomas and astrocytomas are the two commonest tumours in adults. Engelhard et al(12) also reported that ependymomas (23.7%) were the commonest intramedullary tumours in their series.

In the extradural compartment in adults, schwannoma (9.7%) were the most common lesions followed by metastasis (4.8%) and hemangioma (2.4%).

In the pediatric age group PNET were the two cases seen extradurally. Only one tumour schwannoma in intradural extramedullary compartment & two intramedullary astrocytoma noted in the pediatric age group.

According to distribution of symptoms in our study (table-8) back pain (42/87) was the commonest symptom followed by limb weakness (40/87), paresthesia (30/87), limb pain (26/87), bladder and bowel symptoms (20/87) and limb paralysis (14/87).Engelhard et al (12)in 2010 reported pain as the commonest symptom in their study followed by limb weakness, paresthesia, paralysis and urinary incontinence.

Among individual tumours (table 9,10,11) schwannomas were the commonest spinal cord tumours accounting for 45.9%.Schwannomas were the most common intradural extramedullary spinal cord tumours (57.4%). The commonest site

was the thoracic region followed by lumbosacral and cervical regions.4 cases had multiple schwannomas. On T1W1 images 20 cases were isointense and 12 were hypointense relative to the spinal cord. On T2W1 images all 32 cases were hyperintense.28 cases were heterogenous and 4 were homogenous. All of the tumors were well defined and 20 cases showed cystic areas. One case demonstrated target sign.21 cases showed cord compression and 27 cases showed nerve root compression and neural foramen widening .28 case showed heterogenous enhancement on post contrast T1W1 images. Chung et al.[4] reported 19 cases of schwannomas out of 39 cases of spinal cord tumours. All cases appeared hypointense on T1W1 images and hyperintense on T2W1 images .9 cases showed heterogenous enhancement,7 cases showed homogenous enhancement and 3 cases showed rim enhancement.

In our study meningiomas were the second commonest tumors accounting for 13.7% (12/87) of the cases. These tumors showed female predominance .The age group range was 40-60 years. The mean age was 48.3 years. All of them were intradural extramedullary in location. Back pain was the commonest presenting symptom followed by parasthesia. The commonest site of the tumor was the thoracic region followed by cervical region. All the 12 cases were isointense to the spinal cord on T1W1 images, 11 cases were isointense and 1 case was hyperintense on T2W1 images. All of them were well defined and only one was heterogenous in appearance. None of the cases demonstrated cystic areas within. 10 cases showed cord compression and 2 cases showed nerveroot compression. None of the cases showed neural foramen widening or vertebral body scalloping. On post contrast T1W1 images all the 12 cases showed homogenous intense enhancement. Dural tail was noted in 10 cases. Chung et al[4] reported 5 cases of intradural extramedullary meningioma out of 39 spinal cord tumors with a M:F ratio = 1:4. 4 lesions were located in the thoracic region and one was located in the sacral region. All the lesions were isointense on T1W1 images and 4 were isointense and 1 was hypointense on T2W1 images. All tumors demonstrated homogenous intense enhancement.

In our study neurofibromas along with ependymomas were the third most common spinal cord tumors account for 9.1% of the tumors. Neurofibromas were the third most common intradural extramedullary tumors. Slight male predilection was noted with M:F= 3:1. Ependymomas shows male predominance.

Chung et al.[4] reported 4 cases of intradural extramedullary neurofibromas in 39 spinal cord tumor cases. The patient were aged 8 to 39 years. M:F ratio was 1:1.1 was located in the cervical region,2 were in the thoracic region and 1 was in the lumbar region.50% were isointense,50% were intermediate in intensity on T1W1 images. All were hyperintense on T2W1 images. All lesions demonstrated homogenous enhancement.

Kahan et al[13] reported the MR characteristics of spinal ependymomas in 26 patients.14 patients were male and twelve were female. Their ages ranged from 19 to 77 years with a mean age of 44 years.9 occurred in the cervical spine,1 at the cervico-thoracic junction,2 in the thoracic ,2 at the thoraco-lumbar junction, and 12 in the lumbosacral spine.100% of the cervical and thoracic ependymomas caused symmetric cord expansion. 3 (11.5%) of 26 cases had recognizable osseous changes on MRI. 16(61.5%) of 26 cases had associated cysts.19% had hemorrhagic areas, 34.6% had associated syringohydromyelia.77% of the cases were isointense or hypointense on T1W1 images and 92% were hyperintense on T2W1 sequences.38% of the cases demonstrated homogenous enhancement,31% heterogenous enhancement and 19% rim enhancement.

Astrocytomas were the second most common intramedullary tumors. They accounted for 3.4% of all the spinal cord tumors.2 cases were in reported in paediatric age group and one case noted in adult of age group of 31-40 yrs. All patients presented with back pain radiating to the extremity, extremity pain, weakness and paralysis.

One of them also had bowel & bladder symptoms. Seo et al.[14] studied 19 patients with primary intramedullary astrocytomas.11 were males and 8 were females. Age of the patients ranged from 2 to 63 years. Mean age was 27.84 years. On T1W1 images 37% were isoointense, 58% were hypointense and 5% were hyperintense. On T2W1 images 95% were hyperintense and 5% were isointense. 13 (69%) were located in the cervical region, 26% in the thoracic cord and 5% in the conus medullaris and distal thoracic cord.37% of them were associated with surrounding edema. Cystic changes was noted in 37% of the cases.32% did not enhance, 26% showed focal nodular enhancement, 16% showed patchy enhancement,26% showed in homogenous diffuse enhancement.

Metastases were the most common extradural spinal cord tumors. They accounted for 4.5% (4 cases) of all spinal cord tumors. All 4 patients were above 40 yrs. Two patients presented wi weakness, 2 were having paralysis and one patient with urinary retention. On MR images 2 lesions were found at D1, D5 and 2 lesions at L1,L3 levels extradurally. On T1W1 images they appeared hypointense. On T2W1 images ,they appeared hyperintense. All the lesions were ill defined and heterogenous. These lesions were associated with spinal cord compression and collapse of vertebrae, and erosion of pedicle and lamina. These lesions showed heterogenous enhancement on post contrast images. FNAC of the lesions revealed metastatic adenocarcinoma. Primary tumour was found in the lung and one lesion with primary in prostate.

Chung et al[4] reported one case of metastasis with extradural mass formation & spinal cord compression at T4-T7 level in a 59 year old male. The primary tumour was present in the prostate. It showed intermediate signal on both T1W1 and T2W1 images. The lesion demonstrated heterogenous contrast enhancement.

In our study, we found two cases of hemangioblastoma accounting for 2.2% of the spinal cord tumors. It was present in the intramedullary compartment. The patients were among 30-50 year age group presented with back pain radiating to lower limbs followed by lower limb weakness, paresthesias and paralysis. On MR imaging ill defined T1W1 isiintense, T2W1 hyperintense heterogenous lesions with flow voids within was noted intramedullarily at C5-6 and D6-D7 level causing spinal cord enlargement and adjacent nerve root compression. On postcontrast T1W1 images the lesions demonstrated heterogenous intense enhancement. One female aged 32 yrs with neck pain & numbness in upper extremity having cysts in liver,pancreas, kidney and a small solitary tumour in intramedullary tumour in cervical cord suggestive of association with VHL.

Chu et al[15] reported 32 tumours of hemangioblastoma in 12 patients. Five had VHL disease and 4 of them had multiple tumors and one had a solitary tumor. The 7patients without VHL disease had one tumour each.10 (31%) tumors were in the cervical region, 2 in the cervico-thoracic region, 16(50%) in the thoracic region, 2 in the lumbar region and one in the sacral region .Of the 32 tumors, 24 were intramedullary in location. On T1W1 images 16 tumors were isotense, 5 were hypointense. On T2W1 images 14 were hyperintense, 3 were isointense,4 were mixed intensity. All tumors showed intense enhancement. Vascular flow voids were found in 7 tumors.

Two cases of intramedullary lipoma was found in our study accounting for 2.2% of the spinal cord tumors ,one at D8-9 level and another at conus level, presented with numbness in both feet, paresthesia from below the chest level followed by weakness of both lower limbs and difficulty in defecation. On MR imaging, a well defined T1W1 hyperintense, T2W1 hyperintense homogenous lesion showing no enhancement was noted causing cord enlargement, central canal compression and associated with syringe-hydromyelia. The lesion was suppressed on fat sat and STIR images. Lee et al.[16] reported that spinal cord lipomas are very rare accounting for around

1% of spinal cord tumors. They presented 6 cases of intramedullary lipoma. The patients ages ranged from 8 to 45 years.3 tumors were in the cervical region, 2 were in the cervicothoracic region, and 1 was in the thoracic region.

Two case of PNET accounting for 2.2% of spinal cord tumors was found in our study. These patients presented with paresthesias, paralysis of both lower limbs and bowel and bladder disturbances. On MR imaging an ill defined T1W1 isointense, T2W1 hyperintense heterogeneous lesion showing intense heterogeneous enhancement was noted extradurally at D2-D3, D5-6 level causing cord and nerve root compressions and neural foramen widening. One lesion was misdiagnosed as Ewing sarcoma on MRI but HP revealed PNET.

Papadatos et al.[17] presented a case of an exophytic spinal PNET in a 23 year old woman that, radiologically, simulated an extramedullary nerve sheath tumors, meningioma or metastatic tumor deposit. MR imaging revealed a 2 cm well circumscribed, posteriorly located, intradural, extramedullary lesions compressing the cord at the T9 and T10 levels. A metastatic work up was negative.

Two cases of extradural hemangioma accounting for 2.2% of the spinal cord tumors, presented with back and lower limb pain. On MR imaging 2 well defined T1W1 hyperintense, T2W2 hyperintense homogenous lesions showing intense homogenous enhancement were noted in the D3 and D7 vertebral bodies extending extradurally and causing cord and nerve root compression at both levels.

Chung et al[4] reported 3 cases of hemangiomas, 2 in the thoracic and 1 in the lumbar regions.2 of the lesions were hyperintense,1 was hypointense on T1W1 images. All were hyperintense on T2W images. Homogenous intense enhancement was noted in all cases.

Rovira et al.[18] reported 3 cases of extradural lumbar hemangiomas. All the lesions were isointense, hyperintense relative to the intervertebral disc on T1W1 and T2W1 images respectively. One out of 2 cases showed homogenous enhancement on contrast administration. None of 3 lesion had bone involvement.

One case of intradural extramedullary epidermoid cyst accounting for 1.1% of the spinal cord tumors was noted in a 42 year old male patients who presented backache, pain and paresthesias in both lower limbs, followed by lower limb weakness and bladder bowel symptoms. On MR imaging an ill defined T1W1 hypointense, T2W hyperintense heterogenous cystic lesion showing no contrast enhancement was noted intramedullarily at L3-L4 level causing spinal cord enlargement. MRI diagnosis of epidermoid cyst was confirmed by histopathological examination.

Kikuchi et al[19] reported a case of intramedullary epidermoid cyst in a 44 year old man in the thoracic region. The lesion was hypointense on T1W images and slightly in homogenous with high signal on T2W1 images. No contrast enhancement was noted. On diffusion weighted images, intensity of the mass remained high.

Two cases of arachnoid cyst accounting for 2.2% of the spinal cord tumours was noted intradural extramedullarily compartment, presented with back pain. On MR imaging well defined T1W1 hypointense, T2W1 hyperintense homogrnous cystic lesion was noted in the intradural extramedullary location at D7 and D11 level of two patients respectively, causing cord compression. No enhancement was noted was noted on post contrast imaging.MR diagnosis was arachnoid cyst and HP report also revealed the same.

Chung et al.[4] reported 2 cases of arachnoid cyst. Both the lesions were located in the sacral region (intradural extramedullary location).One was noted in a male and the other in a female. On T1W1 images both the lesions appeared hypointense. Both the lesions were hyperintense on T2W images. Contrast study was not performed.

One case of chordoma accounting for 1.1% of the spinal cord tumors in the extradural compartment

in a 25 year old male patient. He presented with back pain and lower limb weakness. On MR imaging an ill defined T1W1 hypointense ,T2W1 hyperintense heterogenous lesion was noted extradurally at D8-D10 level causing spinal cord & nerve root compression. The lesion enhanced heterogenous on postcontrast images confirmed by histopathology study. Chordomas arise from remnants of the notochord(20).50% arise in the sacrum, 35% in the clivus, and 15% in the vertebrae.[21,22] On MRI 75% of chordomas are isointense to cord on T1-weighted images and 25% are hypointense. The lesions are high signal on T2-weighted images.[23] 75% of cases show internal septations and a surrounding capsule of low signal intensity. Areas of hemorrhage and cystic changes can be seen. Prominent postcontrast enhancement is seen.[24]

Out of 87 cases, MRI diagnosed 81 cases correctly. Out of the 6 wrongly diagnosed cases, 3 were intradural extramedullary, 2 were extradural and 1 was intramedullary in location. Overall MRI was able to correct diagnose 91.67% of the spinal cord tumours.MRI was able to correctly diagnose 91.67% of the intradural extramedullary tumors, 90% of the intramedullary tumors and 66.67 % of the extradural tumors.

The sensitivity and specificity of MRI in diagnosing schwannoma were 91.7% and 96.4% respectively. MRI was able to diagnose all cases of meningioma accurately. The sensitivity and specificity of MRI in diagnosing neurofibroma were 80% and 95.7%.The sensitivity and specificity of MRI in diagnosing ependymoma were 80% and 100%.

MRI misdiagnosed 6 cases, 2 of the cases diagnosed as neurofibromas were found to be schwannomas on histopathological examination. MRI misdiagnosed one case each of PNET, neurofibroma, chordoma and ependymoma as Ewing sarcoma, schwannoma, metastasis and astrocytoma respectively.

Sometimes schwannomas and neurofibromas can be difficult to differentiate by imaging. Target sign on T2W1 images which is commonly seen in neurofibromas can also be noted in schwannomas occasionally. Even though several imaging features can help us in differentiating ependymoma from astrocytoma, sometimes it may not be possible to do so. The MR imaging features of PNET is non specific. Therefore it may be difficult to give accurate diagnoses in these cases.

Conclusion

MRI is an important imaging modality which can accurately assess the distribution, features, localization and extent of spinal cord tumors.MRI can accurately characterize the tumor tissue in 88.46% of the spinal cord tumors, 91.67% of the intradural extramedullary tumors, 90% of the intradural tumors and 66.67% of the extradural tumors. Advanced MRI techniques may help in better tissue characterization. MRI is the investigation of choice in spinal cord tumor evaluating as it is safe, accurate and non invasive.

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