Original Research Article

MR imaging in spinal cord/ canal tumors

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Abstract

Introduction: A spinal tumor is an abnormal mass of tissue within or surrounding the spinal cord and spinal column, can cause significant morbidity and can be associated with mortality as well accounts for approximately 15% of cranio-spinal tumors.

Aim: The present study was designed to determine the predictive value of Magnetic Resonance Imaging in diagnosing intra spinal tumors and to correlate findings on Magnetic Resonance Imaging with Pathological diagnosis.

Materials and methods: This prospective study was conducted in Osmania General Hospital from 2009 to 2012 over a period of 3 years. The study group included 40 patients. In all patients, data on history, clinical examination and clinical diagnosis was obtained. MRI was performed on a 1.5 Tesla electromagnet (GE Company). The primary pulse sequences included T1 and T2W1 using spin echo and gradient echo techniques. The MR morphology was correlated with surgical and histopathological features.

Results: The patients had age groups ranging from 2 years – 60 years with a mean age of 33 years. Twenty eight were males and twelve were females. The most commonly encountered symptoms were neurological deficit in 33, sensory loss in 25, bowel and bladder dysfunction in 20 and pain in 13 patients. Of the forty intra dural tumors, 28 were extra medullary and 12 were intra medullary present. Most of the tumors were located in the cervical and the dorsolumbar spine accounting for more than 50%. The most common tumor encountered in our study was schwannoma (22/40), followed by ependymoma (7/40), meningioma (4/40), astrocytoma (4/40), one each of Dermoid, arachnoid cyst and round cell tumor. The most commonly located in cervical, Cervicodorsal position (20), followed by lumbar (8), dorsolumbar (5), dorsal (5) and cervicolumbar (1), lumbosacral (1). MRI features of forty patients with intra dural tumors were studied and their signal intensities were correlated with the pathological findings. MRI diagnosis of intra dural tumors was correct in 34 of the 40 tumors. Contrast was useful for better delineation of the tumor and its characterization. However the different types of tumors could not be differentiated by their degree of contrast enhancement.

Conclusion: Magnetic Resonance Imaging was found to be a highly sensitive imaging procedure and the method of choice for intra spinal tumors. Contrast was useful for better delineation of the tumor and its characterization.

Key words

MRI, Spinal tumors, Schwannoma.

Introduction

A spinal tumor is an abnormal mass of tissue within or surrounding the spinal cord and spinal column [1]. Intra spinal tumours may originate from the spinal cord, filum terminale, nerve roots, meninges, intra spinal 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, these lesions 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 feature [1]. Spinal tumors may be referred to by the area of the spine or compartment of the spine in which they occur. The basic areas are cervical, thoracic, lumbar, and sacral regions. Additionally, they are also classified into 3 main categories according to their location with respect to the dural sac and spinal cord: extradural; intradural extramedullary; or intramedullary. Lesions can occasionally compromise more than one compartment1. Today, MR is always considered the procedure of choice for the workup of all spinal tumors [2-6]. 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 tumors1. 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 [7]. MR images are often used as the primary diagnostic imaging tool and are the preoperative study of choice. The need for biopsy may be obviated because of the increasingly accurate preoperative histologic diagnosis, as obtained through MR images. The present study is designed to determine the predictive value of Magnetic Resonance Imaging in diagnosing intraspinal tumors and to correlate findings on Magnetic Resonance Imaging with Pathological diagnosis.

Materials and methods

Magnetic Resonance Imaging (MRI) was performed in forty consecutive patients with spinal cord tumors from 2009-2012 in Osmania General Hospital, Hyderabad. The study group comprised 31 males and 9 females in the age group ranging from 2 years - 60 years. In all patients, data on history, clinical examination and clinical diagnosis was obtained.

MRI was performed on a 1.5 Tesla electromagnet (GE Company). The primary pulse sequences included T1 and T2W1 using spin echo and gradient echo techniques. T1 weighted images were obtained with a TR of 600 m.sec and TE of 30m.sec. T2W1 were obtained with a TR of 600msec. and TE of 85 msec. The spinal cord was imaged in sagittal, coronal and axial planes. Images were obtained with a multislice technique using a slice thickness of 5mm, interslice gap of 6mm and a matrix size of 256 x 256.

On MRI, the location of the mass, its margins,

signal intensity on both T1 and T2, dural attachment, neural foraminal extension and areas of signal void were noted. Contrast was administered in 15 patients. The degree and pattern of enhancement was noted. Involvements of adjacent vertebra were also included.

All patients were subjected to surgery and a detailed operative finding with their histopathology report was taken. The MR morphology was correlated with surgical and histopathological features.

Results

Magnetic Resonance Imaging was performed in forty patients with intra spinal tumors (intra dural) over a period of 2 year starting from august 2009 to September 2011. The patients had age groups ranging from 2 years – 60 years with a mean age of 33 years. Twenty eight were males and twelve were females. The most commonly encountered symptoms were neurological deficit in 33, sensory loss in 25, bowel and bladder dysfunction in 20 and pain in 13 patients (**Table - 1**).

Table - 1: Demographic data.

FEATURE	NO.	%
AGE GROUP (YEARS)		
01-10	2	5
11-20	6	15
21-30	9	22.5
31-40	12	30
41-50	7	17.5
51-60	4	10
SEX		
Male	28	70
Female	12	30
CLINICAL FEATURES		
Neurological deficit	33	82.5
Sensory loss	25	62.5
Bowel/bladder dysfunction	20	50
Pain	13	32.5

Of the forty intra dural tumors, 28 were extramedullary and 12 were intramedullary present. Most of the tumors were located in the cervical and the dorsolumbar spine accounting for more than 50%. The most common tumor encountered in our study was schwannoma (22/40), followed by ependymoma (7/40), meningioma (4/40), astrocytoma (4/40),one each of Dermoid, arachnoid cyst and round cell tumor (**Table - 2**).

Table - 2: Location, level of involvement and characterization of tumor.

CHARACTERISTIC	NO.	%
Location		
Extramedullary	28	70
Intramedullary	12	30
Level of involvement		
Cervical	10	25
Cervicodorsal	10	25
Dorsal	5	12.5
Dorsolumbar	5	12.5
Lumbar	8	20
Lumbosacral	1	2.5
Cervicolumbar	1	2.5
Characterization of tumor		
Schwanomas and Neurofibroma	22 (21+1)	55
Ependymoma	7	17.5
Astrocytoma	4	10
Meningioma	4	10
Dermoid	1	2.5
Arachnoid cyst	1	2.5
Round cell tumor	1	2.5

Schwannoma were seen in twenty one cases with distinct male predominance (17:4). The patients had a mean age of 30 years. The most commonly located in cervical, Cervicodorsal position (20), followed by lumbar (8), dorsolumbar (5), dorsal (5) and cervicolumbar (1), lumbosacral (1). Most of them were located either anterolaterally or posterolaterally. Three were posterior and two were anterior in location. All are solitary lesions. One case of neurofibromatosis type 2 was seen. Neural foraminal extension was seen in five cases all of which were hyper intense. Contrast was administered in one case. The lesion showed

moderate, heterogeneous enhancement.

Meningiomas were encountered in four cases. Three were females and one was males with a mean age of 45.25. Two were thoracic, one was Cervicodorsal and one more was dorsolumbar in location. Those in the thoracic region were posterolateral and the one in Cervicodorsal region was anterolateral. Two of four tumors were isointense on T1 and hyper on T2WI, one was iso on T1 and T2, one was hypo on T1, hyper on T2.Contrast study done on two cases showed homogenous enhancement.

Ependymoma were seen in seven patients. Six were males and one was female with a mean age of 36.4 years. All were purely intramedullary and three were located in cauda equina, of the seven intramedullary tumours two were Cervicodorsal, two cervical, one dorsolumbar, one dorso sacral, and one cervicolumbar in location. All the tumors except two were isointense to hypointense on T1WI and hyper intense on T2WI. Two were hyper intense on both Ti and T2WI suggestive of an intratumoral bleed. Contrast was administered in seven patients. Three cases showed moderate to marked enhancement which was either homogenous or heterogeneous. One tumor showed mild enhancement. Syrinx was noted in three patients, two of them were rostral to the tumor. Both rostral and caudal syrinx was noted in one case.
Astrocytomas were seen in four patients (10) three were males and one was female with mean age of 30 years. All were purely intramedullary in location, and all were Cervicodorsal in location, all were showing iso/hypo on T1 and hyper on T2WI and one case showed mild homogenous enhancement on contrast study (**Figure – 1 to 5**).

Discussion

In order to determine the predictive values of MRI in diagnosing Intraspinal tumors, MRI features of 40 intradural tumors were studied and their signal intensities were correlated with their pathological findings. All the forty patients with intraspinal, intradural tumors underwent surgery at our Institute and their pathology was correlated with the signal intensity seen on MRI.

Figure – 1: Astrocytoma.

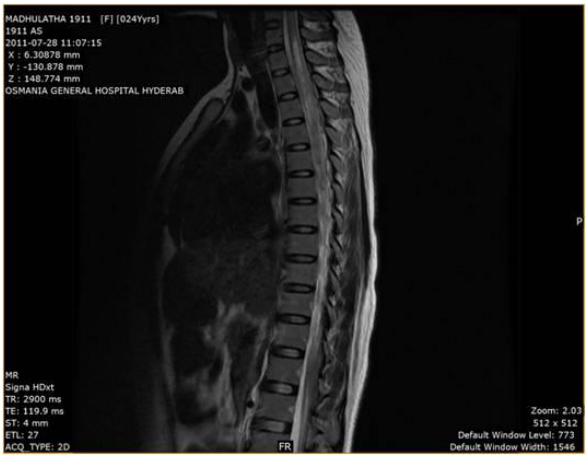
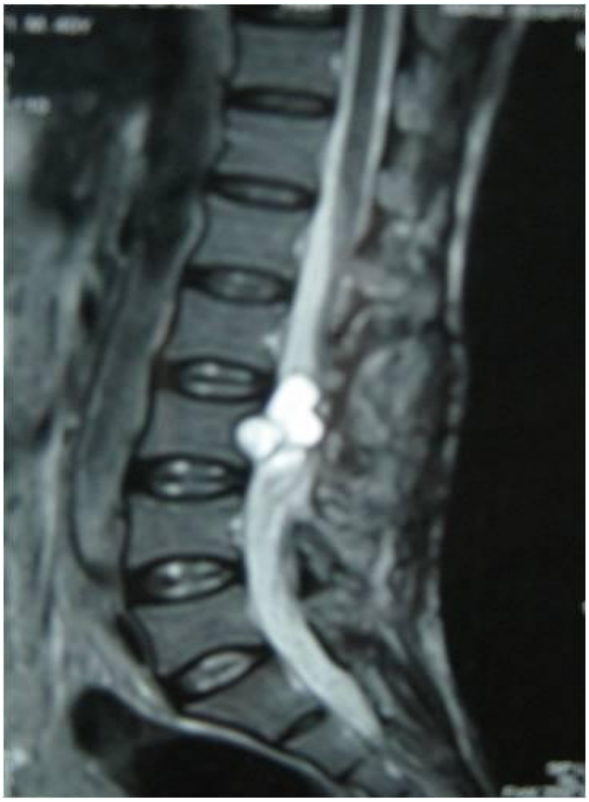


Figure – 2: Neurofibroma.



Of the forty intraspinal tumors, 21 were schwannomas. Most of them were located either anterolaterally or posterolaterally. Neural foraminal extension was seen in 5 cases all of which were cervical in location.

Figure – 3: Meningioma.

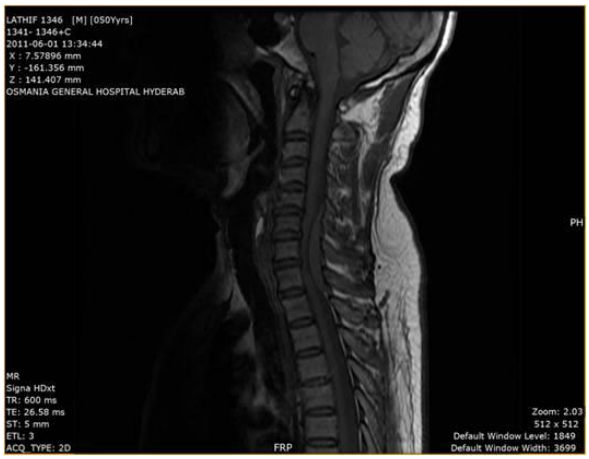


Figure – 4: Ependymoma.

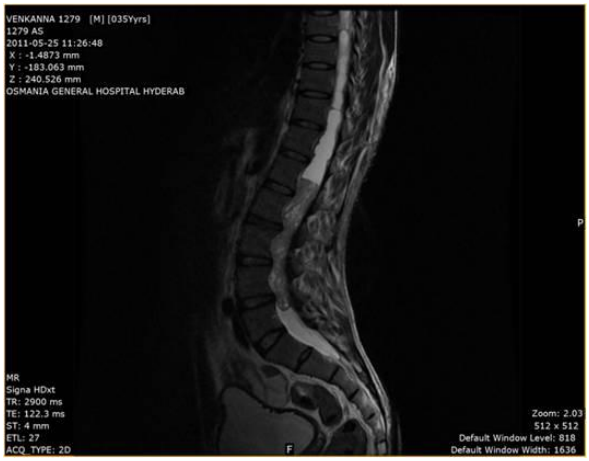
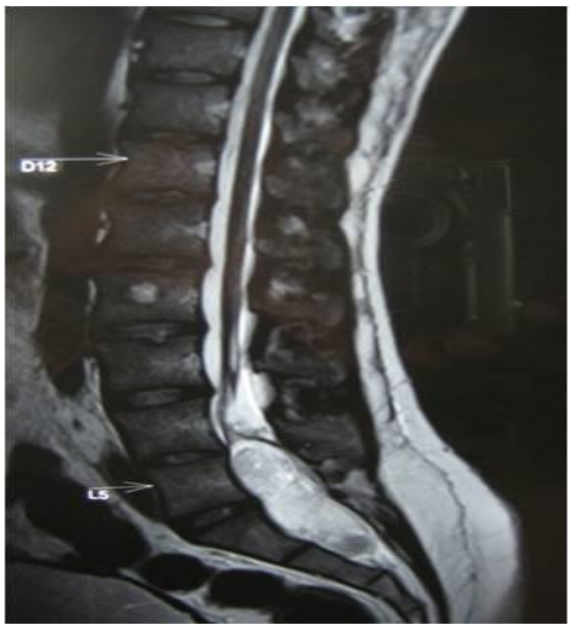


Figure – 5: Dermoid.



The MR signal intensities observed in our patients were same as those reported by Zimmerman RA, et al. [8], Rapoport RJ, et al. [9] and Masaryk TJ, et al. [10]. On TI WI, 7 tumors were isointense and 11 were hypo intense to the spinal cord. On T2 WI all were hyper intense. Based on MR signal intensity alone, it was difficult to differentiate between neurofibroma and schwannoma. In our study, one patient had multiple lesions and expansion of foramina noted which was neurofibromatosis type II.

Pathologically all of the tumors showed Antoni type A and type B tissue with type A tissue predominating in most of the tumors. Cystic necrosis was noted in 5 cases and dilated and tortuous vessels were seen in 8 cases.

The histology of these neoplasms explains their varied MR appearances. Antoni type A tissue is rich in cells and is composed of compact bundles of fibrillated cells. Antoni type B tissue consists of loosely textured stroma and interstitium, which plays an important role in causing long T2 values in these tumors. In our patients, individual tumors showed varying percentages of Antoni A and Antoni B structures whereas T2 signal intensities were almost same in every case. It was difficult to differentiate percentages of Antoni B structures within the tumor. Demachi, et al. [11] indicated that the presence of an intratumoral cyst was the only explanation for long T2 values. In our study cystic changes on pathology were noted in only 8 cases indicating that cyst formation is probably just one of the several factors causing long T2 values of these lesions.

Vascular malformation was seen in 8 lesions. In only two of these were there associated cystic changes indicating that long T2 values of blood and flow related enhancement with slow blood flow within a vascular malformation could be another reason for prolongation of T2. The II tumors which were hypo intense on T1WI probably contained more of free water compared to the 8 lesions which were isointense.

Contrast was administered in 6 patients out of

whom 3 lesions showed moderate enhancement and 3 lesions enhanced markedly. All the 3 lesions which showed marked enhancement with contrast revealed dilated and tortuous vessels on histopathology. The pattern of enhancement was heterogeneous in all except 1 case. Heterogeneity could be attributed to changes of cystic degeneration.

MR signal intensities were correlated with pathological findings in 23 cases of spinal neurinoma by Hu, et al. [12]. They found that on T1 WI, 6 neurinomas were slightly hypointense and the other 17 isointense to the spinal cord. On T2 WI all tumors exhibited high signal intensities. Pathologically, 11 of 23 neurinomas consisted only of Antoni A and Antoni B structures. The other 12 neurinomas showed dispersed micronecrosis and/ or micro cyst formation and vascular malformation in addition to the Antoni A and Antoni B structures. They found that it was difficult to differentiate different percentages of Antoni A and B structures within the tumor.

Demachi, et al. [11] in 1990 reported that it was impossible to establish correlation between Antoni type A and type B tissue in spinal schwannomas on signal characteristics on MR.

Histological distinction between benign and malignant neurofibromas is not always easy, since malignancy often develops in benign neurofibromas. Not all tissue in a malignant neural neoplasm necessarily contains positive histologic features of malignancy. Failure to identify malignancy in a biopsy specimen cannot therefore be taken as an assurance that malignant change is not present in some part of the mass. Eight patients with neurofibromatosis with symptomatic neoplasms were studied by Errol Levine, et al. [13]. MRI was done in 6 patients. All were hypointense on T1 and hyperintense on T2. Since benign and malignant nerve sheath tumors showed similar signal intensity, they conclude that MRI is of limited value in predicting the histological nature of the tumor. An irregular infiltrative tumor border on CT or MRI suggests malignancy but may also be present in benign plexiform neurofibromas. On the other hand, a malignant neoplasm may have a smooth non infiltrating tumor margin. All our tumors had smooth well defined contours.

On histopathology all were found to be benign. Meningiomas were encountered in 4 cases in our study out of which 3 were thoracic and 1 was lumbar in location. Meningiomas are usually located ventrally in the cervical region. In the thoracic and lumbar regions they are either anterolateral or posterolateral. In our study, the cervical meningioma was anterolateral and those in the thoracic region were posterolateral to the cord.

All the four tumors were isointense on T1 and on T2 WI, 3 were isointense and one was iso-hypointense. The signal intensities encountered in our study were similar to those described by Zimmerman RA, et al. [8] and Rapoport RJ, et al. [9]. On contrast administration all were showing homogenous enhancement in our cases.

On histopathology, all tumors showed compact cellularity. Two of them had abundant calcification and were diagnosed as psammomatous meningiomas. There was no evidence of any cystic change and necrosis seen in any of the tumors. The isointensity of the tumors on T1 and T2 WI could be attributed to the compact cellularity of the tumors with less of free water. Cystic degeneration in meningiomas is very rare, which could be another contributory factor for short T2 relaxation times. Though abundant calcifications were seen in two cases, their signal intensity did not differ from those without calcification, indicating that MR was not sensitive to pick up calcifications.

Out of the 32 cases studied by Parizel, et al. [14], 4 were meningiomas. Most of these were isointense on T1 and slightly hyperintense on T2.

Ependymoma was seen in seven patients of whom 5 were purely intramedullary and four

were located in the region of cauda equina of which one had an intramedullary component extending up to C2 level. Cervicodorsal and dorsolumbar were the most common sites. Of the 169 spinal cord ependymomas included in the Mayo series, 44% were located in the filum terminale; the remainders were termed intramedullary15. In the cervical and thoracic cord, they are seen in sagittal and axial planes as expansile lesions of the cord, whereas at the cauda equina, they appear as bulky extramedullary masses.

All the tumors in our study except one were isointense to hypointense on TIWI and hyperintense on T2WI, which is consistent with high water content within the tumor. One tumor was hyperintense on T1 and T2 suggestive of an intratumoral bleed, however on histopathology there was no evidence of any hemorrhage.

5 of the 7 tumors showed loose cellular areas and only 1 tumor had compact cellularity. Increased vascularity was noted in 4 of the 7 tumors which could be one of the reasons for the hyperintense signal on T2 due to flow related enhancement. Another cause for hyper intensity on T2 could be attributed to the clear cytoplasm of the ependymal cells which gives rise to T2 lengthening. Typical rosettes of ependymoma were seen in 2 cases and large areas of necrosis were seen in one case.

Contrast was administered in five patients. All except one showed moderate to marked enhancement which was either homogeneous or heterogeneous. One tumor showed mild enhancement. This tumor was the one which had large areas of necrosis. Syrinx was noted in three patients, two of them were rostral to the tumor. Both rostral and caudal syrinx was noted one case.

Classical ependymoma was seen in 5 of the 7 tumors and two were myxopapillary ependymomas which were seen in the region of the conus medullaris, a site which is typical for these tumors.

A consecutive series of 23 patients with intramedullary spinal cord ependymomas were studied by Mc Cormick, et al. [16]. The tumors were located predominantly in the cervical or cervicothoracic region. They found that MRI was particularly useful in defining the level of the tumor and in identifying associated spinal cord edema or cysts.

Out of the 44 patients diagnosed as intramedullary tumors on MR1 by Gulati, et al. [17], 12 were ependymomas. All these lesions were iso-low intense on T1 WI with a well defined upper and lower margin.

In a survey of 65 tumors of the spinal cord by Brotchi, et al. [19], astrocytoma was found to be the most common tumor 21/65 followed by ependymoma.

4 cases of Astrocytomas were found in the study conducted. Of the four cases two were located in cervico-dorsal region other two in lumbar region. Three of them extended over more than five vertebral segments, and associated with cystic areas. All the lesions are iso /hypo on T1, and hyper on T2 .Contrast study was not done.

A single case of arachnoid cyst was diagnosed it is located in conus medullaris and showing signal intensities of CSF in all sequences ,that is hypo on T1, hyper on T2, distorting shape of conus.

Epidermoid was seen in 1 case and was extramedullary. The frequency of extramedullary epidermoid tumors is low. A cutaneous stigma in the form of dermal sinus was noted in the lumbosacral region. The lesion was iso-hypointense on T1WI and hyperintense on T2W1. No enhancement was seen on contrast. This case was associated with tethering of filum terminale at L5-S1 level. On histopathology tumor was cystic and showed abundance of keratinized material. The presence of keratin in these tumors could be responsible for their hypointense signal on T1 and the cystic nature of the tumor for its hyper intensity on T2WI. On Contrast, these tumors usually do not enhance.

Sometimes they may show a peripheral rim enhancement, which represents the capsule.

Isabelle, et al. [18] reported an intramedullary epidermoid in a 20yr old man with spina bifida occulta. The tumor was heterogeneous with a high intensity portion on T2WI. Intravenous Gadolinium - DTPA demonstrated peripheral enhancement which was thought to be a cystic wall rather than a perilesional reaction.

A pathological diagnosis of round cell tumor was made in 2 yr old female child. The lesion was retroperitoneal Para and prespinal in location extending in to spinal foramina atL3-L5 level and was hypointense on TI and hyperintense on T2WI, contrast study was not done. Based on the age, and histopathological appearance diagnosis of round cell tumor was made. Radiologically diagnosis of tumor of neurogenic origin was given.

A correct preoperative diagnosis of nerve cell tumor was made in 19 cases of schwannoma depending on the signal intensity on MRI. All the tumors were iso to hypointense on TI and hyperintense on T2WI.

All the four cases of Meningiomas were diagnosed preoperatively based on the signal intensity. All were isointense on T1 and T2WI.

Of the 7 cases of ependymomas, a correct diagnosis was made in 5 cases. Four of these were located in the region of cauda equina, out of which one had an intramedullary component extending up to L1. Ependymomas at the cauda equina were differentiated from nerve sheath tumors by their central location, extent and site. Nerve tumors are eccentrically located.

In 4 cases, a diagnosis of astrocytoma was made. The tumor in them extended over more than five vertebral levels and appeared diffuse and infiltrative.

In Epidermoid encountered in study, a correct preoperative diagnosis was made. One had evidence of associated cutaneous stigmata in the form of dermal sinus. The lesion was hypointense on T1 and hyperintense on T2 in lumbar sacral region.

A diagnosis of Neurogenic tumor was made in the case of round cell tumor, based on location and signal intensity on MR, which was hypointense on T1 and hyperintense on T2.

Thus, MRI was useful in predicting the histological diagnosis in 34 of the 40 intradural tumors studied, accounting for 85% of the tumors.

Brotchi, et al. [19] conducted a study of 65 tumors of the spinal cord predicted the histological diagnosis by magnetic resonance imaging in 70% of the cases.

Conclusion

Magnetic Resonance Imaging was found to be a highly sensitive imaging procedure and the method of choice for intra spinal tumors. Contrast was useful for better delineation of the tumor and its characterization. However the different types of tumors could not be differentiated by their degree of contrast enhancement. Nevertheless, accurate diagnosis could only be suggested rather than made definitely.

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