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Research Article

Magnetic resonance evaluation of intra dural spinal tumors with histopathology correlation

Uma Maheswara Rao*, Bujji Babu Perisetti, Swetha Reddy, Jyothi Lalitha

Department of Radiodiagnosis, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India

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***Correspondence:**
Dr. Uma Maheswara Rao,
E-mail: mallaumahe@gmail.com

ABSTRACT

Background: Tumors of the spinal cord or canal constitute approximately 15% to 20% of central nervous system tumors. The differential diagnosis of spinal neoplasms is primarily based on location of the lesion relative to the spinal cord and the age, sex and clinical presentation. The aim and objective of the study was to determine the sensitivity of magnetic resonance imaging (MRI) in diagnosing intra spinal tumors and to correlate findings on MRI with histopathological diagnosis.
Methods: This is a retrospective study. The study group included all the patients who presented to our hospital with progressive sensory or motor deficits, para or quadriperesis with or without bladder/bowel Involvement. Only patients with Intra dural lesions such as intradural extra medullary and Intra medullary lesions were included in the study. All the extra dural lesion cases such as vertebral tumors, degenerative/osteoporotic compressions and Trauma related cord compressions were excluded from the study.
Results: Of the forty intradural tumors, 28 were extramedullary and 12 were intramedullary. 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 Hemangioblastoma, Neuroentericcyst and Dermoid cyst. Ependymomas, Astrocytomas and hemangioblastoma were intramedullary lesions and the remaining lesions constituted Intra Dural extra medullary lesions.
Conclusions: MRI was found to be a highly sensitive imaging procedure and the method of choice for intradural tumor evaluation and to differentiate extra medullary from Intra medullary lesions. It is not sensitive enough to differentiate the Intra medullary tumors. Nevertheless, definite diagnosis could be made by histopathology only.

Keywords: MRI, Spinal cord tumors, Intradural lesions, Cord tumor histology

INTRODUCTION

Tumors of the spinal cord or canal constitute approximately 15% to 20% of central nervous system tumors. Primary spinal tumors occur primarily in young1middle aged adults and are less frequently encountered in children and elderly. The sex incidence is roughly equal, although there is a definite, female predilection for Meningiomas. In general spine tumors are most frequently found in the thoracic spine. This is largely explained by the longer length of the thoracic spine relative to the remaining spine. Metastatic involvement of the spine is seen primarily in patients between the ages 50 and 70 years. The differential diagnosis of spinal neoplasms is primarily based on location of the lesion relative to the spinal cord and the

age, sex and clinical presentation.[1] Tumors of the spinal cord can be Intramedullary, Intradural extramedullary and extradural.

Intramedullary

Tumors within the cord are referred to as Intramedullary and account for 11-25% of spinal tumors. Intramedullary neoplasms are, usually associated with fusiform enlargement of the cord with narrowing of the adjacent subarachnoid space.[1] Intramedullary tumors consist of Astrocytomas, Ependymomas and to a lesser extent of Oligodendrogliomas, Hemangioblastomas, Intramedullary metastases and less common disease process such as intramedullary lipomas and neurinomas.[2] In children there is slight predominance of Astrocytomas relative to Ependymomas. In adults there is a slight predominance of Astrocytomas in the cervical region. The incidence of Astrocytomas and Ependymomas in the thoracic region are roughly equal and there is a great preponderance of Ependymomas in and below conus medullaris.

Intradural extramedullary

Tumors between the cord and the dura are referred to as Intradural extramedullary and account for nearly 60%2 of primary spine tumors. These tumorsare associated with displacement of the cord away from the tumor, with widening of the ipsilateral subarachnoid space and narrowing of the contralateral space.[3] Primary Intradural extramedullary tumors most often arise from the perineural coverings of exiting nerve roots or from the meninges and consist of Neurofibromas, Neurinomas and Meningiomas.[2] In the pediatric population, subarachnoid seeding from primary intracranial tumor occurs. Ependymomas and acquired Epidermoids occur less commonly.

Extradural tumors

Extradural tumors account for less than 25% of primary spine neoplasms. However when metastatic disease is included, extradural tumors may account for over half of all spine neoplasms.[4] When these involve the spinal canal there maybe displacement of the cord with narrowing of the subarachnoid space both ipsilateral and contralateral to the lesion.

Clinical presentation

Intramedullary tumors progress slowly and often painlessly. Because they destroy structures near the center of the spinal cord, crossing fibres of pain and temperature are damaged and segmental differential sensory deficit may be discovered. This is noticed early in the upper extremities, where the patient may have reduced pain and temperature sensation in the hands, yet preserved light touch and position sense. Subsequently, long tract signs, weakness and incontinence develop.

Intradural extramedullary tumors grow in relation to a nerve root and therefore chronic progressive radicular pain may precede all other symptoms. The pain is more at night. There is associated gait disturbance, urinary retention or evidence of myelopathy. Extramedullary lesions near the foramen magnum may present with sub occipital or neck pain, upper extremity dysesthesias and loss of dexterity

Extradural tumors usually present as pain over the site of lesion or radiating as a nerve root pattern. The pain often precedes the neurological signs and symptoms by days, weeks, or months.

Effective evaluation of the spine depends upon the capacity to visualize the complex bony structure of the vertebral column but also the ability to assess the Spinal cord, exiting nerve roots and thecal sac that are surrounded and protected by the bony canal.

The aim and objective of the study was to determine the sensitivity of magnetic resonance imaging (MRI) in diagnosing intra spinal tumors and to correlate findings on MRI with histopathological diagnosis.

METHODS

This is a retrospective study. The study group included all the patients who presented to our hospital with progressive sensory or motor deficits, para or quadriperesis with or without bladder/bowel Involvement. All the patients underwent MR evaluation of the spine. Only patients with Intra dural lesions such as Intradural extra medullary and Intra medullary lesions were included in the study. All the extra dural lesion cases such as vertebral tumors, degenerative/osteoporotic compressions and Trauma related cord compressions were excluded from the study. In addition patients with pacemakers and other ferromagnetic devices or prostheses were also excluded from the study.

The study group included forty patients with Intra dural spinal tumors from June 2012 to May 2014 at King George Hospital, Visakhapatnam. The study group comprised 29 males and 11 females in the age group ranging from 2 yrs. - 60 yrs. 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. T1W images were obtained with a TR of 600 msec. and TE of 30msec. T2W were obtained with a TR of 2740msec. and TE of 85msec. 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 512 x 512. Contrast was administered in all the

patients and fat suppressed T1W images were obtained in axial, sagittal and coronal planes.

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. The degree and pattern of enhancement were also used in characterizing the lesions.

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

RESULTS

MRI was performed in forty patients with intraspinal tumors (intradural) in a two year period starting from June 2012 to May 2014. The patients had age groups ranging from 2 yrs – 60 yrs with a mean age of 33yrs. Twenty nine were males and eleven were females. The most commonly encountered isolated and overlapping symptoms were neurological deficit in 33, sensory loss in 25, bowel and bladder dysfunction in 20 and pain in 13 patients.

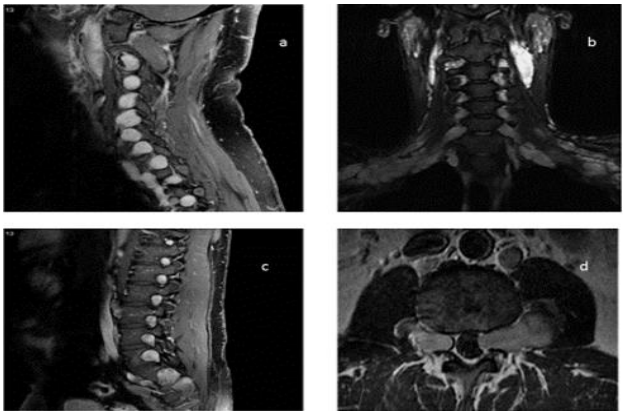

Figure 1: Case of neurofibromatosis A- sag T1W contrast; B- coronal T1W contrast images of cerviacalspine; C- sag T1W contrast; D- axial T1W contrast images of lumbar spine showing multiple neurofibromas.

Of the forty intradural tumors, 28 were extramedullary and 12 were intramedullary. 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 Hemangioblastoma, Neuroentericcyst, and Dermoid cyst. Ependymomas, Astrocytomas and Hemangioblastoma were intramedullary lesions and the remaining lesions constituted Intra Dural extra medullary lesions.

Schwannomas were seen 22/40 cases with distinct male predominance (17:4) and with a mean age of 30yrs. Most commonly they were located in cervical (8), followed by lumbar (6) regions. The other location was craniovertebral (1), Cervicodorsal (2), Dorsal (3) and Dorsolumbar (2) regions. Most of them were located either anterolaterally or posterolaterally. Three were posterior and two were anterior in location. All were solitary lesions except in one case of multiple lesions diagnosed as neurofibromatosis. Neural foraminal extension was seen in five cases all of which were hyper intense on T2WI. Contrast was administered in all cases which revealed moderate, heterogeneous enhancement.

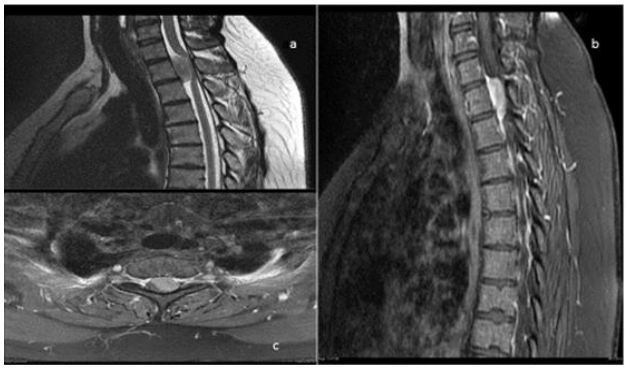

Figure 2: A- sag T2W; B- sag T1Wcontrast; C- axial T1W contrast images showing meningioma.

Meningiomas were encountered in four cases-three in females and one in male in middle age group.. 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 anterolateralin position. Two of four tumors were isointense on T1 and hyper on T2WI, one was iso on both T1 and T2WI, one was hypo on T1W, hyper on T2W images. Contrast study was done on all cases which revealed homogenous enhancement with enhancing dural tail and broad base to the meninges.

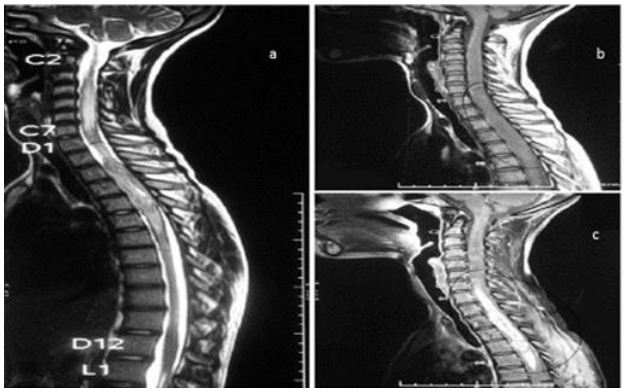

Figure 3: A- sag T2W; B- sag T1W; C- sag T1W contrast images showing astrocytoma.

Ependymomas were seen in seven patients. Six were males and one was female with a mean age of 36years. All were purely intradural in location. Of the seven intramedullary tumours, 2/7were Cervical, 2/7 were

Cervico dorsal, 1/7 was dorsolumbar, and 2/7 were Lumbosacral in location. Cord expansion was seen in all the tumors with iso to hypo intense signal on T1WI and hyper intense signal on T2WI except in one case where the lesion was revealing hyper intense signal on both T1W and T2WI. The T1 hypo intensity was due to intratumoral cyst formation and Hyperintensity was suspected due to Bleed. In 6/7 cases marked homogenous/heterogenous enhancement and 1/7 case mild enhancement was seen with Contrast. Syrinx was noted in three patients, two of them were rostral to the tumor. Both rostral and caudal syrinx was noted in one case.

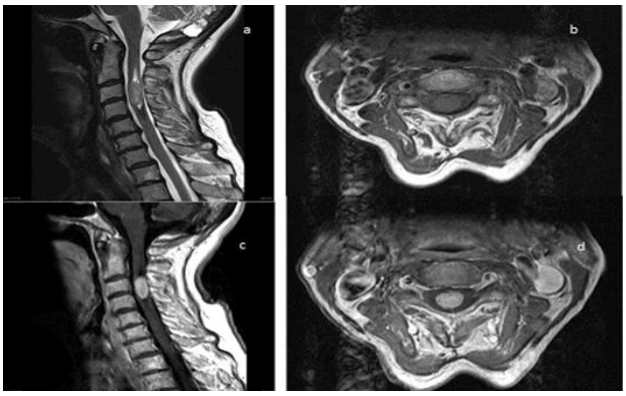

Figure 4: A- sag T2W; B- axial T1W; C- sag T1W contrast; D- axial T1W contrast images showing ependymoma.

Astrocytomas were seen in four patients- three were males and one was female with mean age of 30 yrs. All were purely intramedullary in Cervicodorsal region with multisegment cord expansion. All were showing iso/hypo intense signal on T1W and hyper intense signal on T2WI. All the lesions revealed mild inhomogeneous contrast enhancement.

One case of Hemangioblastoma was seen in a 40 year's female in thoracic region presented initially with sensory symptoms later progressed to paraparesis. The lesion was hyperintense on T2WI with tortuous signal void areas of vascular channels and revealed dense enhancing eccentric tumor nodule.

One case of Dermoid cyst was identified in a 2 years child. The clinching point for diagnosis was presence of fat within the lesion as T1 hyper intense signal getting suppressed on Fatsat sequence.

Last one was a case of Neuroenteric cyst in a middle aged female seen as a well-defined cyst of 9mm diameter located intradurally anterior to the thoracic cord. This was not enhancing with contrast and was following CSF signal-the diagnosis could not be made on MRI.

DISCUSSION

In order to determine the predictive values of MRI finding diagnosing Intraspinal tumors, MR 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 hospital and their pathology was correlated with the signal intensity seen on MRI.

Of the forty intraspinal tumors, 22 were Schwannomas. They all were solitary and Intradural extramedullary in location with widening of thecal sac both above and below the lesion. Neural foraminal extension was seen in 5 cases and multiple lesions were noted in 1case which was diagnosed as Neurofibromatosis. They all revealed T1 iso/hypo T2 hyper intense signal with homogenous/heterogeneous contrast enhancement.

The MR signal intensities observed in our patients were same as those reported by other authors.[2-4] Based on MR signal intensity alone, it was not possible to differentiate between Neurofibromas and Schwannomas and the differentiation was made only by HPE.

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 8 cases and dilated and tortuous vessels were seen in 5.

The histology of these neoplasms explained 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[5] indicated that the presence of an intratumoral cyst was the only explanation for long T2 values and the T2 signal is not based on percentage of anatomy Type A or Type B cells.[5] 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 with T1 hypo intensity of these lesions. The flow related enhancement with slow blood' flow within a vascular malformation of the lesions could be another reason for prolongation of T2.

The heterogeneity of contrast enhancement was attributed to changes of cystic degeneration on HPE. MR signal intensities were correlated with pathological findings in 23 cases of spinal neuroma by Hu et al.[4] They found haton T1 WI, 6 neuromas were slightly hypo intense and the other 17 were isointense to the spinal cord. On T2 W1 all tumors exhibited high signal intensities. Pathologically, 11 of 23 neuromas consisted only of

Antoni A and Antoni B structures. The other 12 neuroma showed dispersed micro necrosis 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 & B structures within the tumor.[14] Histological distinction between benign and malignant neurofibromas are not always easy, since malignancy often develops in benign neurofibromas. 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. Errol Levine et al correlated MR signal of 6/8 cases of Neurofibroma to sis with HPE.[7] All the HPE prove n benign and malignant lesions revealed T1 Hypo and T2 Hyper intense signal and they conclude that MR signal is of limited value in predicting the histological nature of the tumor. An irregular infiltrative tumor border on MR 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.[7] All our tumors had smooth well defined contours and on histopathology all were found to be benign.

Meningiomas were encountered in 4/40 cases in our study out of which 3 were thoracic and 1 was lumbar in location. Of all the four tumors two were isointense on T1W and hyper on T2W, One was isointense on both T1 and T2 and one was hypo on T1W and hyper on T2W. The signal intensities encountered in our study were similar to those described by other authors.[2,3] On contrast administration all were showing homogenous enhancement with enhancing Dural tail in our study.

On histopathology, all tumors showed compact cellularity. Two of them had abundant calcification and were diagnosed as psammomatous Meningiomas. There was evidence of cystic change and necrosis in two lesions which are responsible for T2 hyper intense signal. The iso intensity of the tumors on T1W and T2 WI could be attributed to the compact cellularity of the tumors with less of free water. Though abundant calcifications were seen in two cases, their signal intensity did not differ from those without calcification, indicating that routine T1/T2 Spin echo MR was not sensitive to pick up calcifications. Dural Invasion was clearly demonstrable in all cases on HPE.

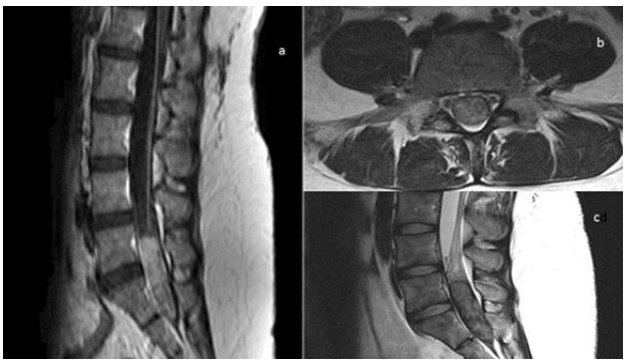

Figure 5: A- sag T1W contrast; B- axial T2W; C- sag T2W images showing myxopapillary ependymoma.

Out of the 32 cases studied by parizelet al, 4 were Meningiomas. Most of these were isointense on T1 and slightly hyper intense on T2WI.[8]

Ependymomas were seen in 7/40 patients of whom 5 were purely intramedullary and two were located in the region of cauda equina of which one had an intramedullary component extending up to L1 level. Of the 169 spinal cord ependymomas included in the Mayo series, 44% were located in the filum terminale; the remainder were termed intramedullary.[9] In the cervical and thoracic cord, they were seen as cord expansion in sagittal and axial planes, whereas at the cauda equina, they appeared as bulky intradural masses.

All the tumors in our study except one were iso to hypo intense on TIWI and hyper intense on T2WI, which is consistent with high water content or cyst formation within the tumor. One tumor was hyper intense on both T1W and T2W suspicious of an intratumoral bleed and proven on HPE.

Five of the 7 tumors showed loose cellular areas and two tumors had compact cellularity. Increased vascularity was noted in 4 of the 7 tumors which could be one of the reasons for the hyper intense signal on T2 due to flow related enhancement. Another cause for hyper intensity on T2 could be attributed to the cyst formation and 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. On HPE classical Ependymoma features were seen in 5 of the 7 tumors which were typically intramedullary in location 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.[10] The tumors were located predominantly in the cervical or Cervico thoracic region. They found that MRI was particularly useful in defining the level of the tumor and in identifying associated spinal cord oedema or cysts.[10]

Out of the 44 patients diagnosed as intramedullary tumors on MR1 by Gulati et al were ependymomas.[11,12] All these lesions were iso to hypo intense on T1W with a well-defined upper and lower margin.[11]

In a survey of 65 tumors of the spinal cord by Brotchi et al, astrocytoma was found to be the most common tumor 21/65 followed by ependymoma.[13] Out of forty, four cases of Astrocytomas were found in our study. All four cases were located in Cervico dorsal region and extended over more than five vertebral segments. All the lesions

were iso /hypo on TIW, and iso/hyper on T2WI with inhomogeneous contrast enhancement.

In one case the diagnosis of intramedullary Hemangioblastoma was made on MRI and confirmed on HPE due to presence of tortuous vascular channels and due to presence of solid cystic tumor component.[12]

One case of fat containing dermoid cyst was identified in a 2 year old child on MRI.[5] On HPE in addition to fat, calcium and other dermal elements were also present-confirming the diagnosis of Benign Teratoma.

Last one was a case of Neuroenteric cyst located intradurally anterior to the thoracic cord.[16] This was not enhancing with contrast and was following CSF signal-the diagnosis could not be made on MRI.

In our study out of 40 cases 28 intradural extramedullary and 12 Intramedullary cases are diagnosed on MRI and confirmed by Histology. This says the differentiation of intradural extramedullary and intramedullary lesions was 100% possible on MR evaluation of intradural spinal tumors.

In 27/28 intradural extramedullary lesions(96.4%) evaluated by MRI, the preop MRI Diagnosis was confirmed on HPE which include 22 cases of Schwannomas, 4 Meningiomas and one Dermoid cyst. In one case (1/28=3.5%) MRI could not characterize the lesion which turned out to be Neuroepithelial cyst on HPE.

Out of 12 intramedullary lesions, only one case (8.3%) of Hemangioblastoma could be diagnosed preoperatively on MRI. In the remaining 11 cases of preoperatively undiagnosed intramedullary lesions (91.6%), 7/11 was Ependymomas and 4/11 was Astrocytoma. On MRI both Ependymomas and Astrocytomas could not be differentiated preoperatively as both of them revealed similar features of cord expansion, T2 hyperintensity and contrast enhancement. But multisegment involvement on MRI was more in favour of Astrocytoma than Ependymoma. Both these tumors were differentiated post operatively by histology only.

Brotchi et al in a study of 65 tumors of the spinal cord predicted the histological diagnosis by MRI in 70% of the cases.[13]

CONCLUSION

In the present study, forty patients with intradural tumors and their MRI signal intensities were correlated with the pathological findings. The age group ranged from 2yrs to 60yrs with 60% belonging to 11-30yrs age group, with a distinct male predominance of 29:11.

Of the 40 intradural tumors, 28 were extramedullary and 12 were intramedullary in location. Fifty percent of the tumors were located in the cervical and dorsolumbar regions. The most common tumor encountered in our study was Schwannoma (22/40) followed by Ependymoma (7/40).

MRI diagnosis of intradural tumors was correlated with Histology in 28 of the 40 tumors of which 27 were intradural extramedullary and one was Intra medullary in location.

MRI could not suggest the nature of the tumor in 1/28 intradural extramedullary and 11/12 intramedullary lesions.

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.

MRI was found to be a highly sensitive imaging procedure and the method of choice for intradural tumor evaluation and to differentiate extra medullary from Intra medullary lesions. It is not sensitive enough to differentiate the Intra medullary tumors.

Nevertheless, definite diagnosis could be made by histopathology only.

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