MRI Evaluation of Intramedullary Spinal Cord Tumour & Its Correlation with Histopathological Report

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Abstract:

Objective: *The gold standard for imaging of spinal cord tumor is MRI.*

The goal of imaging is to be 100% sensitive and specific in identifying tumor, giving precise anatomic detail, identify the extent of tumor and relationship with the cord. No single imaging modality accomplishes all of these goals, but understanding the advantages and disadvantages of different imaging modalities will assist the clinician in patient screening and treatment planning.

Materials and Methods: *33 patients of intramedullary spinal tumor were included in study after contrast MRI of spine. Plain and contrast MRI were studied in detail and radiological diagnosis was established. Patients were operated & followed up after the surgery up to histopathological diagnosis. Finally histopathological reports were collected & correlated with MRI diagnosis. All these information were collected in a pre-designed structured data collection sheets.Correlation between MRI findings and histopathological reports was drawn on the basis of 'p' value at 5% level of significance.*

Results: *Sensitivity of MRI in the diagnosis of ependymoma was 94.1%, specificity 87.5%, positive predictive value 88.9%, negative predictive value 93.3% and accuracy 90.9%. Sensitivity of MRI in the diagnosis of astrocytroma was-92.3%, Specificity 95%, positive predictive value 92.3%, negative predictive value 95% and accuracy 93.9%. Sensitivity of MRI in the diagnosis of hemangioblastoma was 100%, Specificity 100 %, positive predictive value100 %, negative predictive value 100% and accuracy 100%.*

Conclusion: *MRI findings of the intramedullary spinal cord tumors of this present study correlated well in most of the cases with the postoperative histopathological reports. MRI is thus the best imaging procedure of suspected tumor of the spinal cord for accurate preoperative diagnosis and correct decision making for the optimal surgical management of the patients.*

Key Words: *MRI, Intramedullary Spinal Tumor, Histopathology, Ependymoma, Astrocytoma, Haemangioblastoma,*

Bang. J Neurosurgery 2013; 3(1): 17-25

Introduction:

Spinal tumor is an abnormal mass of tissue within or surrounding the spinal cord and spinal column, in which cells grow and multiply uncontrollably, seemingly unchecked by the mechanisms that control normal cells[14].

Approximately 20% of all central nervous tumours lie within the spinal canal (Harrop, 2007). Epidemiological study suggests that primary spinal tumours occur with an annual incidence of 2 per 10000 populations[10].

Spinal tumors can be benign or malignant.

Primary tumours originate in the spine or spinal cord and metastatic or secondary tumours result from cancer spreading from another site to the spine[15].

With the increasing availability of new radiological tools such as magnetic resonance imaging (MRI) spinal tumours are discovered more frequently (2).

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Spinal tumors clinico- radiologically divided according to location into three major categories:

- Extradural
- Intradural- extramedullary and
- Intramedullary tumours.

Extradural tumours - Tumour of the osseous spine, extradural space and paraspinous soft tissue are in this group. These lesions are typically attributed to metastatic cancer or schwannomas derived from the cells covering the nerve roots (15).

Intradural extramedullary tumour - These tumour develop in the spinal cord's arachnoid membrane (meningiomas), in the nerve roots that extend out from the spinal cord (schwannomas and neurofibromas) or at the spinal cord base(filum terminale ependymomas). Tumour that are inside dura and outside the spinal cord are considered to be intradural extramedullary tumour (15).

Intramedullary tumour - The tumour grow inside the spinal cord. (15)

Estimates of location suggest that 25% are extradural, 50% are intradural extramedullary and 25% intramedullary (2).

Extradural tumours include benign and malignant (Primary and secondary) osseous tumours, nerve sheath tumour. Benign bone tumour includes hemangioma, osteoid osteoma, osteoblastoma, giant cell tumour, aneurysmal bone cyst (Levine et al,.1998). Most common extradural malignant tumour is metastases which arises from breast, lung, prostate. Other lesions are lymphoma, sarcoma, multiple myeloma (15).

Intradural extramedullary tumours constitute about two third of all spinal tumours (Albanese et al,.2002). Schwannoma (neurolemmoma) and meningioma make up approximately 90% of the total intrdural extramedullary tumour. The remaining 10% are dermoid, epidermoid, angioma, lipoma and arachnoid cyst.

Intramedullary tumor accounts for 25% of all spinal tumour.(2) Intramedullary spinal cord tumours account for approximately 2% of adult and 10% of pediatric central nervous system neoplasm. In adults, 85-90% of intramedullary tumours are the glial subtypes, astrocytoma or ependymoma.

The gold standard for imaging of spinal cord tumor is MRI (6).

The goal of imaging is to be 100% sensitive and specific in identifying tumor, giving precise anatomic detail, identify the extent of tumor and relationship with the cord. No single imaging modality accomplishes all of these goals, but understanding the advantages and disadvantages of different imaging modalities will assist the clinician in patient screening and treatment planning.

The method of choice for the detection and evaluation of spinal lesions is MRI. When there is suspicion of tumor, based on clinical history or any positive appropriate neurological sign, MRI should be performed, unless contraindicated. MRI provides detailed anatomical resolution of the vertebra and surrounding structures and permit direct visualization in multiplanar section along the entire length of the spinal column (1).

Materials and methods:

This observational cross sectional study was carried out in the department of Radiology and Imaging & department of Neurosurgery, BSMMU and DMCH from January 2007- November 2008 on consecutively selected 42 patients irrespective of age and sex after suspicion of intramedullary spinal tumor in contrast MRI of spine. Permission of institutional review board (Ethical committee) was obtained at the beginning of the study and informed written consent was taken from each participant or guardian during the study. At first all the patient were evaluated by detail history clinical examination with special emphasis on nervous system .Subsequently MRI of spine with contrast (either cervical/dorsal/ lumbar, depending upon clinical location) were performed in all cases .Patients who were diagnosed as intramedullary spinal tumor, were selected for study. Seven (07) patients refused to do surgery. Those patients who were operated for intramedullary tumor, were followed up after the surgery up to histopathological diagnosis. Histopathological report was not available in case of two (02) patients. Finally MRI findings and histopathological report were available in case of 33 patients and ultimately they were considered as study sample. The histopathological reports were collected & correlated with MRI findings. All these information were collected in a pre-designed structured data collection sheets.

Data analysis was done by using appropriate statistical formula by using computer software SPSS. Resource personnel in the fields of biostatistics were consulted. Correlation between MRI findings and

histopathological reports was drawn on the basis of 'p' value at 5% level of significance.

Study Technique:

1. Clinical evaluation:

All patients had thorough clinical evaluation which includes- detail history, clinical neurological examination, specially spinal examination to determine the level of lesion, grading of motor weakness, sensory deficit and nature of bowel-bladder involvement.

2. Neuroradiological evaluation and measures of outcome variables:

In all patients preoperative work-up tests included- MR Image of spine (cervical/dorsal/lumbar) with gadolinium contrast.

Findings were noted in the form of following variables-

1. Location of tumor- cervical / dorsal / lumbar.
2. T1, T2 Image characteristics of tumor
3. Pattern of enhancement of tumor following contrast.
4. Tumor size and shape.
5. Cord status:
   A. Cord expansion-focal/ multisegmental.
   B. Associated findings- Syrinx/Hemorrhage/ necrosis/others.
6. Image diagnosis.

Surgical technique: Extent of tumour removal was recorded properly.

Histopathological data:

Pathological specimen were examined by histopathologist.

Results:

Among 33 cases, ependymoma was commonest 18 (54.5%) intramedullary spinal tumor in MRI, followed by astrocytoma (13) and hemangioblastoma (2) which were 39.4% and 6.1% respectively

Maximum intramedullary tumor 15 cases (45.5%) found in the dorsal region followed by cervical region which was 13 cases (39.4%). Cervicodorsal region showed 3 cases (9.1%) and dorsolumbar region showed 2 cases (6%)

In MRI, 18 cases were diagnosed as ependymoma, among which 16 cases were confirmed by histopathology and rests were diagnosed one as astrocytoma, another as hemangioblastoma. Out of 16 histopathologically confirmed cases, 11 had regular and 5 had irregular margin. 6 cases (37.4%) were mixed intense, 5 cases (31.3%) were iso intense and 7 cases (31.3%) were hypo intense lesion. Marked enhancement was present in 14 (87.5%) cases and moderate enhancement was noted in 2 (12.5%) cases.

In MRI, 13 cases were diagnosed as astrocytoma among which 12 cases were confirmed by histopathology and rest one was diagnosed as ependymoma. Out of 12 histopathologically confirmed cases, 4 had regular and 1 had irregular margin, 1 cases were heterogeneous and 4 cases were homogeneous in appearance, 7 cases were hypo intense , 5 cases were iso intense and 1 case was mixed intense in signal intensity in T1WI of which 11 cases show moderate and 2 cases showed marked contrast enhancement. Associated syrinx and cyst were present in 9 cases and 8 cases respectively.

16 cases (48.5%) diagnosed as ependymoma by MRI & confirmed by histopathological evaluation. They were true positive.

02 (6.1%) cases were diagnosed as ependymoma by MRI but not confirmed by histopathological findings. They were false positive.

Of 15 cases of non- ependymoma which were diagnosed by MRI, only 1 (6.7%) was confirmed as ependymoma and 14 (93.3%) cases were non-ependymoma by histopathology.

They were false negative and true negative respectively.

Chi-square test was done to know the association between variables (MRI and histopathological findings).Sensitivity of MRI in the diagnosis of ependymoma was 94.1%, specificity 87.5%, positive predictive value 88.9%, negative predictive value 93.3% and accuracy 90.9%.

12 cases (36.4%) were diagnosed as astrocytoma by MRI and confirmed by histopathological evaluation. They were true positive.

One case (3%) were diagnosed as astrocytoma by MRI but not confirmed by histopathological findings. That was false positive.

Out of 20 cases of non- astrocytomas which were diagnosed by MRI only, one case (5%) was confirmed as astrocytoma and 19 cases (95%) were non-astrocytoma by histopathology.

They were false negative and true negative respectively.

Chi-Square test was done to know the association between variables (MRI and histopathological

findings).Sensitivity of MRI in the diagnosis of astrocytroma was-92.3%, Specificity 95%, positive predictive value 92.3%, negative predictive value 95% and accuracy 93.9%.

Out of 33 cases, 02 cases were confirmed as hemangioblastoma by histopathology as were in MRI. Both had irregular margin and were iso- intense in T1WI and hyper intense in T2WI. Marked contrast enhancement of mural nodule was noted in both cases. Associated syrinx and cyst is noted in one case

They were true positive.

Out of 33 cases, 31 were non-hemangioblastoma, diagnosed by MRI and confirmed by histopathology.

They were true negative.

Fisher exact test was done to know the association between variables (MRI and histopathological findings). Sensitivity of MRI in the diagnosis of hemangioblastoma was 100%, Specificity 100 %, positive predictive value100 %, negative predictive value 100% and accuracy 100%.

Table-I

MRI diagnosis of different types of intramedullary spinal tumors (n = 33)

Intramedullary tumors	Frequency	Percent
Ependymoma	18	54.5
Astrocytoma	13	39.4
Hemangioblastoma	02	6.1
Total	33	100

Table-II

Location of intramedullary spinal tumors according to MRI findings.

Tumor	Location			
	Cervical	Cervicodorsal	Dorsal	Dorsolumbar
Ependymoma	8 (44.4%)	2(11.1%)	6(33.3%)	2(11.1%)
Astrocytoma	4(30.7%)	1(7.8%)	8(61.5)	-
Hemagioblastoma	1(50%)	-	1(50%)	-
Total	13(39.4%)	3(9.1%)	15(45.5%)	2(6%)

Table-III

MRI findings of ependymoma (n=18)

MRI findings	Characteristics	Frequency	Parentage
Margin	Regular	13	72.2
	Irregular	5	27.8
Appearance	Heterogeneous	5	27.8
	Homogeneous	13	72.2
T1WI	Hypo intense	7	38.9
	Iso intense	5	27.8
	Hyper intense	-	-
	Mixed	6	33.3
T2WI	Hyper intense	12	66.7
	Mixed	5	27.8
	Iso intense	1	5.6
Enhancement	Moderate	4	22.2
	Marked	14	77.8
Associated cyst	Present	12	66.7
	Absent	6	33.3
Haemorrhage	Present	10	55.6
	Absent	8	44.4

Table-IV

MRI findings of astrocytoma (n=13)

MRI findings	Characteristics	Frequency	Percentage
Margin	Regular	4	30.8
	Irregular	9	69.2
Appearance	Heterogeneous	9	69.2
	Homogeneous	4	30.8
T1WI	Hypo intenseIso intense	75	53.838.5
	Hyper intense	-	7.7
	Mixed	1	
T2WI	Hypo intense	-	
	Iso intense	1	7.7
	Hyper intense	11	84.6
	Mixed	1	7.7
Enhancement	Moderate	11	84.6
	Marked	2	15.4
Associated syrinx	Present	9	69.2
	Absent	4	30.8
Associated cyst	Present	8	61.5
	Absent	5	38.5

Table-V

Correlation of MRI and histopathological findings in the diagnosis of intramedullary ependymoma.

MRI diagnosis	Histopathological diagnosis		Total
	Ependymoma	Non-ependymoma	
Ependymoma	16	2	18
Non-ependymoma	1	14	15
Total	17	16	33

Chi square value = 18.9, df = 1, p value = 0.001

Table-VI

Sensitivity, specificity, accuracy, positive and negative predictive values of MRI in the diagnosis of intramedullary ependymoma.

Validity test	Percentage
Sensitivity	94.1
Specificity	87.5
Accuracy	90.9
PPV	88.9
NPV	93.3

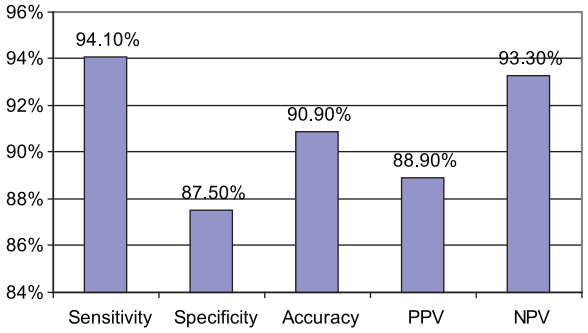

Fig.-1: *Different types of validity test result in the diagnosis of intramedullary ependymoma.*

Table-VII

Correlation of MRI and histopathological findings in the diagnosis of intramedullary astrocytoma.

MRI diagnosis	Histopathological diagnosis		Total
	Astrocytoma	Non-astrocytoma	
Astrocytoma	12	1	13
Non-astrocytoma	1	19	20
Total	13	20	33

Chi square value = 21.6, df = 1, p value = 0.001

Table-VIII

Sensitivity, specificity, accuracy, positive and negative predictive values of the MRI, in the diagnosis of intramedullary astrocytoma.

Validity test	Percentage
Sensitivity	92.3
Specificity	95.0
Accuracy	93.9
PPV	92.3
NPV	95.0

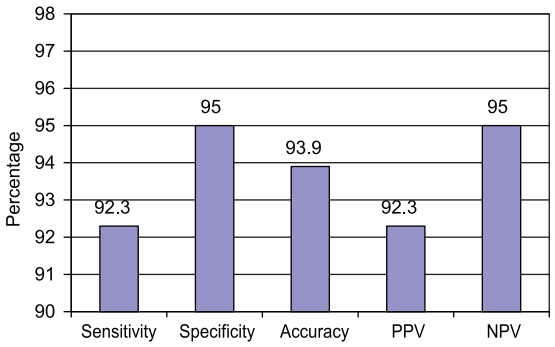

Fig.-2: *Different types of validity test result in the diagnosis of intramedullary astrocytoma.*

Table-IX

MRI findings of hemangioblastoma (n = 2)

MRI findings	Characteristics	Frequency	Percentage
T1WI	Hypo intense	-	
	Iso intense	2	100.0
	Hyper intense	-	
	Mixed	-	
T2WI	Hypo intense	-	
	Hyper intense	2	100.0
	Iso intense	-	
	Mixed	-	
Enhancement	Moderate	-	
Mural nodule	Present	2	100.0
Enhancement of	Absent	-	100.0
mural nodule	Marked	2	
Associated syrinx	Present	1	50.0
	Absent	1	50.0
Associated cyst	Present	1	50.0
	Absent	1	50.0

Table-X

Correlation of MRI and histopathological findings in the diagnosis of intramedullary hemangioblastoma.

MRI findings	Histopathological diagnosis		Total
	Hemangioblastoma	Non-hemangioblastoma	
Hemangioblastoma	2	0	2
Non-hemangioblastoma	0	31	31
Total	2	31	33

Fisher exact test =17.77, df= 1, p value = 0.001

Table-XI

Sensitivity, specificity, accuracy, positive and negative predictive values of the MRI, in the diagnosis of intramedullary hemangioblastoma.

Validity test	Percentage
Sensitivity	100.0
Specificity	100.0
Accuracy	100.0
PPV	100.0
NPV	100.0

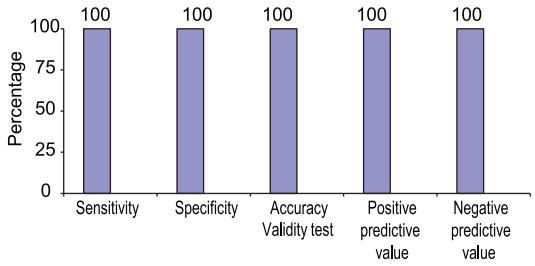

Fig.-2: *Different types of validity test result in the diagnosis of intramedullary hemangioblastoma.*

Discussion:

With the advent of modern imaging technologies such as MRI, it has been easier to diagnose spinal tumors preoperatively accurately (Lohani et al.- 2004). MRI has been the investigation of choice in patient with suspected spinal tumors. In addition to superior tumor resolution, it has the added advantage of delineating the extradural compartment, intradural extramedullary compartment and intramedullary compartment and paraspinous soft tissue involvement as well as compression (11).

This study included 33 patients who were confirmed as intramedullary spinal cord tumors. The mean age was 31.1 years. The highest incidence of intramedullary spinal cord tumor, 39.4% was found in 31-40 years age group followed by 27.3 % between 21-30 years age group.

In this study male female ratio was 1.2: 1.

In the series of Constantini et al. (3), the majority of the children (24 of 27, 89%) had histologically determined low-grade lesions. There were 12 patients with low grade astrocytoma (Grades I-II) eight with gangliogliomas, two with ganglioglioneurocytomas, one with a glioneurofibroma and one child with a mixed astro/oligodendroglioma. Two children had anaplastic astrocytomas (Grade III) and one child had a glioblastoma multiforme.

Cooper et al. (4) treated 51 cases of intramedullary tumour, among them, 24(47.1%) had ependymomas, 18(35.3%) had astrocytomas and the remainder had a variety of less common lesions.

Epstein et al.(5) studied 29 cases of adult intramedullary tumour. The most common tumour were ependymoma 16(55.2%), 10(34.5%) of astrocytoma and remainder were less common tumours. In this study, out of 33 cases 18(54.5%) patients were ependymoma, 13(39.4%) had astrocytoma and 2 (6.1%) had hemangioblastoma.

Constantini et al. (3) observed in their series of 164 intramedullary tumour in children and young adult revealed 79.3% of children had low grade tumours, including astrocytomas (35.4%), gangligliomas (26.8%), different variations of mixed gliomas (6.1%) and ependymoma (11.6%).

Ferrante et al. (8) studied on 45 cases of intramedullary ependymoma, among them mean age of presentation

was 38.8 years and found more common in male patients. Cord ependymoma in 44.0% cases involving the cervical cord alone, an additional 23.0% extending into the upper thoracic region, 26.0% cases involving thoracic cord alone and 6.5% involved either distal thoracic cord or conus medullaris.

In the present study among 18 cases of cord ependymoma, 8 (44.4%) cases found in cervical cord, 6(33.3%) found in thoracic cord and 2(11.1%) found in each of both cervico-dorsal & dorso-lumbar cord.

Epstein et al. (7) series of study of astrocytoma shows mean age of presentation is 29 years and more common in male (58.0%). This series also shows that most commonest site of involvement is the thoracic cord (67.0%), followed by the cervical cord (49.0%) and isolated conus medullaris was seen in about 3.0% of cases.

In this current series the mean age of presentation is 26 years and male are commonly affected (53.8%). Most commonly involved thoracic cord (61.5%) followed by cervical (30.7%) and cervico-dorsal cord (7.8%).

Murota et al. (12) studied 18 cases of cord hemangioblastoma and shown hemangioblastoma constitute 7.2% of spinal cord neoplasm with no gender predilection.

Neumann et al. (13), a 10 years study of hemangioblastoma with special reference to von-Hippel Lindau syndrome shown, these slowly growing lesions involve thoracic cord most commonly (50.0%), followed closely by the cervical cord(40.0%), most cord hemangioblastoma are solitary and occur in patient younger than 40 years.

In this study, though the number of cases was 2, showing 6.1% of cord neoplasm, male and female was equally affected, 50.0% occurring in cervical cord and 50% occurring in thoracic cord and mean age of presentation is 34.5 years.

Sensitivity of MRI in the diagnosis of intramedullary ependymoma was 94.1%, specificity 87.5%, accuracy 90.9%, positive predictive values 88.9% and negative predictive values 93.3% in the present study.

In the study by Ferrante et al. (8) sensitivity was 95.3%, specificity 90.6%, accuracy 92%, PPV 89.3% and NPV was 90.12%.

According to the study by Constantini et al. (3) sensitivity, specificity, accuracy, PPV and NPV were 95.2 %, 89.1%, 88.9%, 91.4% and 94.6% respectively.

The validity of MRI in identifying in the diagnosis of intramedullary astrocytoma sensitivity 92.3%, specificity 95.0%, accuracy 93.9%, positive and negative predictive values were 92.3% and 95.0% respectively.

In the Epstein et al. (7) study sensitivity, specificity, accuracy, PPV and NPV of MRI for intramedullary astrocytoma were 92.1%, 96.6%, 95.8%, 93.1% and 94.5% respectively.

In the research of intramedullary astrocytoma by Cooper et al. (4) MRI showed sensitivity 93.7%, specificity 97.1%, accuracy 94.3%, PPV 91.9% and NPV 94.8%.

Sensitivity of MRI, in the diagnosis of intramedullary hemangioblastoma was 100.0%, specificity 100.0%, accuracy 100.0%, positive predictive values 100.0% and negative predictive values 100.0% in the present study.

According to the study by Murota et al. (12) sensitivity, specificity, accuracy, PPV and NPV of MRI for intramedullary hemangioblastoma were 96.2 %, 95.1%, 92.9%, 97.4% and 96.6% respectively.

Conclusion:

MRI findings of the intramedullary spinal cord tumors of this present study correlated well in most of the cases with the postoperative histopathological reports. Sensitivity of MRI in the diagnosis of intramedullary ependymoma was 94.1%, specificity 87.5%, accuracy 90.9%, positive predictive values 88.9% and negative predictive values 93.3%. The validity of MRI in identifying in the diagnosis of intramedullary astrocytoma sensitivity 92.3%, specificity 95.0%, accuracy 93.9%, positive and negative predictive values were 92.3% and 95.0% respectively. Sensitivity of MRI, in the diagnosis of intramedullary hemangioblastoma was 100.0%, specificity 100.0%, accuracy 100.0%, positive predictive values 100.0% and negative predictive values 100.0% in the present study.

MRI thus can be regarded as a primary imaging modality in the diagnosis of different types of intramedullary spinal cord tumours – either ependymoma, astrocytoma or hemangioblastoma.

The study was performed in a short period of time with only 33 cases. Due to lack of availability of MRI and due to cost effective ratio many of the patients

could not performed the procedure despite clinically diagnosed as spinal tumor.

MRI is unquestionably the best imaging procedure of suspected tumor of the spinal cord for accurate preoperative diagnosis and correct decision making for the optimal surgical management of the patients.

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