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# DIAGNOSTIC EFFICACY OF MRI IN EVALUATION OF CNS LESIONS WITH HISTOPATHOLOGICAL CORRELATION

Radiodiagnosis

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## ABSTRACT

**Background:** A space-occupying lesion of the brain is usually due to malignancy but it can be caused by other pathologies such as infective, inflammatory, vascular, and traumatic. Intracranial space occupying lesions (ICSOLs) are a collective term for any lesion which occupies space within the intracranial fossa and causes raised intracranial pressure. The high morbidity and mortality associated with them necessitate their early diagnosis so as to plan the intervention that is required. MRI is the most helpful imaging tools for the early detection. 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 diagnosis, as obtained through MR images.

**Aims of study:** To determine the diagnostic efficacy of MRI in evaluation of CNS lesions assuming postoperative histopathology as a gold standard.

**Methodology:** This retrospective cohort study was conducted on 50 patients who came to the Department of Radiodiagnosis at Geetanjali Medical College and Hospital with clinically suspected CNS pathologies in the study period 2015-2017. MRI of the brain was followed by surgical resection of the lesion and finally histopathological diagnosis was obtained. The data was retrospectively reviewed and co-related.

**Result:** Multiplanar MRI was of great value in identifying the precise anatomic location and extent of the lesions. 56% (n=23) of intra cranial lesions were intra-axial while 44% (n=18) of neoplasms were extra-axial. The most common lesion was glioma (32%, n=16) followed by meningioma (24%, n=12). Overall diagnostic accuracy of MRI in CNS lesions was 77.8% and Positive Predictive Value was 91.3% and sensitivity was 84%.

**Conclusion:** MR images are certainly the preoperative modality of choice in the evaluation of CNS space occupying lesions. MR images can narrow the differential diagnosis and guide surgical resection. Multiplanar MRI helps in determining proper localization & extent of lesion, which is of great value for the surgeon.

## KEYWORDS

CNS lesions, Intracranial space occupying lesions (ICSOLs), Multiplanar MRI, High-grade glioma, Meningioma.

## INTRODUCTION

The brain and spinal cord together make up the central nervous system (CNS). The spinal cord begins at the occipital bone & extends down to the space between the 1st & 2nd lumbar vertebrae; it does not extend the entire length of the vertebral column.

A space-occupying lesion of the brain is usually due to malignancy but it can be caused by other pathologies such as infective, inflammatory, vascular, and traumatic. Almost half of intracerebral tumours are primary but the rest have originated outside the CNS and are metastases.

Distributions of tumor types vary substantially by age group and among the developing/developed countries. They are wide-ranging in their histological appearance and have an even wider range of clinical symptoms and prognostic features. High-grade glioma (30.5%) and meningioma (29.4%) are the most common types of adult primary brain tumors (data taken from the Swedish cancer registry).[1]

Cerebral neoplasm arises from brain, spinal cord and meningeal cells. Not only malignant cerebral neoplasm, benign tumor could also lead to death due to mass effect on vital structures.

Intracranial space occupying lesions (ICSOLs) are a collective term for any lesion which occupies space within the intracranial fossa and causes raised intracranial pressure. The lesion can cause focal brain damage, obstruction of cerebrospinal fluid flow, or general symptoms related to raised intracranial pressure such as seizures or false localizing signs. The high morbidity and mortality associated with them necessitate their early diagnosis so as to plan the intervention that is required.

Computed tomography (CT) and Magnetic Resonance Imaging (MRI) are the most helpful imaging tools for the early detection. 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 diagnosis, as obtained through MR images.

Over the last decade, advanced magnetic resonance (MR) techniques that produce image contrast reflecting attributes of tissue physiology and microstructure have begun to be widely applied in clinical brain tumor imaging at major academic centers. These techniques are all adapted from, and must be interpreted in the context of, conventional MRI techniques based on the fundamental physical properties of tissue protons - proton density, T1,T2, T2*, and delayed permeability that produce image contrasts reflecting gross anatomy.[2]

### Goals of imaging include

(1) Initial differential diagnosis, to aid in the distinction of newly diagnosed brain tumors from non-neoplastic conditions such as tumefactive demyelination and ischemia and to aid in the differentiation of glioma from extra-axial neoplasm and metastasis;
(2) Preoperative therapeutic planning, to provide an estimate of tumor grade and to guide biopsy, resection, and local ablative therapy; and
(3) Therapeutic follow-up, to monitor disease progression and therapeutic response, including the differentiation of recurrent tumor from delayed radiation necrosis.

These goals are related to but distinct from the scientific goals of advanced imaging that include a better understanding of the pathophysiology of brain tumor and improved prediction of therapeutic response.[2]

Treatment strategies differ significantly from one type of brain tumour to another. Furthermore, brain biopsy is an invasive procedure and, unlike a biopsy taken from other organs, means a major operative procedure. Every effort should be made to non-invasively establish an accurate preoperative diagnosis to help in treatment planning and determining the prognosis of brain tumours. Solitary metastases that are surgically accessible must be differentiated from malignant glioma. Among the tumours that need to be diagnosed non-invasively are those that are not accessible to biopsy or surgery, and those that can primarily be treated with radiotherapy and/or cytotoxic therapy, such as lymphomas. Providing an accurate, non-invasive diagnosis of such tumours could result in less invasive procedures (such as brain biopsy)

and enable rapid initiation of tumour therapy, which would not only benefit patients but also reduce overall costs.

In view of the above, this study is undertaken to characterize the MR images in patients with space occupying CNS lesions, which were then verified at post operative biopsy along with measuring the overall diagnostic accuracy, positive predictive value and sensitivity of MRI in these lesions.

## AIMS AND OBJECTIVES

- To determine the diagnostic efficacy of MRI in evaluation of CNS lesions assuming postoperative histopathology as a gold standard.
- To study and characterize various CNS lesions on pre and post contrast MR images.

## MATERIAL AND METHODS

This **r**etrospective cohort study was conducted on 50 patients who came to the Department of Radio-diagnosis at Geetanjali Medical College and Hospital with clinically suspected CNS pathologies in a study period within years 2015-2017 were subjected to the study.

MRI of the brain was followed by surgical resection of the lesion and finally histopathological diagnosis was obtained. The data was retrospectively reviewed and co-related.

## INCLUSION CRITERIA:

1. Patients referred to the department of radio diagnosis for clinically suspected CNS pathologies who underwent both MRI and histopathology.
2. Cases of all age group irrespective of sex.

## EXCLUSION CRITERIA:

1. Patients with absolute contraindication of MRI (pace-maker or any kind of metallic implants/prosthesis patients those with claustrophobia).
2. Patients who have an allergy to the IV contrast media used in MR scans
3. Patients having renal impairment.
4. Patients without histopathology report.

**Technique of MRI examination:** Patients were subjected to MRI scan of the brain on superconductive SIEMENS - Magnatom Avanto 1.5 Tesla. The head coil was used for the scan. MRI protocol at 1.5T included the entire scanning of brain from nasion to inion. Both non contrast and contrast enhanced images were obtained. In addition to a conventional MRI protocol (T2,T1,FLAIR), sequences like DWI, ADC and spectroscopy, etc were used as per requirement. MRI findings with diagnosis were recorded.

## RESULTS

In our study of 50 cases of suspected CNS pathologies were studied with MRI. Below the age of 18 years accounted for only 7 cases (14%) and the adult population formed 43 (86%) cases.

Multiplanar MRI was of great value in identifying the precise anatomic location and extent of the lesions. Various MRI sequences helped in characterization of lesion & determining its content. Use of contrast proved further useful.

**TABLE 1: LOCATIONS OF LESIONS**

| Intracranial lesions | Number of cases | Percentage (%) |
|---|---|---|
| Intraaxial | 23 | 56.1 |
| Extraaxial | 18 | 43.9 |
| Total | 41 | 100 |
| Spinal Lesions | | |
| Extra dural | 2 | 22.2 |
| Intradural extramedullary | 5 | 55.6 |
| Intradural intramedullary | 2 | 22.2 |
| Total | 9 | 100 |

In our study, 56% (n=23) of intra cranial lesions were intra-axial while 44% (n=18) of neoplasms were extra-axial. Thus, intra-axial lesions were more common in present study [Table 1].

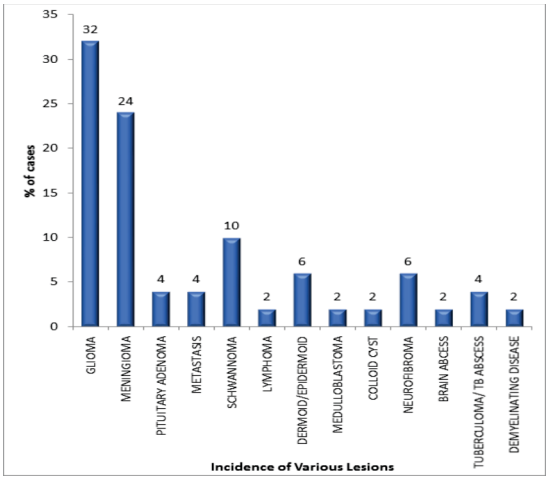
There were 9 intra spinal lesions in our study, out of which intradural extra medullary were most common, i.e. 56% (n=5) while intradural intra medullary and extradural comprised of 2 cases each [Table 1].

**TABLE 2 SURROUNDING EDEMA**

| LESION | TOTAL | No. OF CASES | % |
|---|---|---|---|
| GLIOMA | 16 | 16 | 100 |
| MENINGIOMA | 12 | 6 | 50 |
| PITUITARY ADENOMA | 2 | 0 | 0 |
| METASTASIS | 2 | 0 | 0 |
| SCHWANNOMA | 5 | 0 | 0 |
| LYMPHOMA | 1 | 0 | 0 |
| DERMOID/EPIDERMOID | 3 | 0 | 0 |
| MEDULLOBLASTOMA | 1 | 0 | 0 |
| COLLOID CYST | 1 | 0 | 0 |
| NEUROFIBROMA | 3 | 0 | 0 |
| BRAIN ABCESS | 1 | 0 | 0 |
| TUBERCULOMA/ TB ABSCESS | 2 | 0 | 0 |
| DEMYELINATING DISEASE | 1 | 1 | 100 |
| TOTAL | 50 | 23 | 46 |

The most common lesion encountered in our study was glioma (32%, n=16). 2nd most common lesion found was meningioma (24%, n=12). (Table 2).

**FIGURE 1: INCIDENCE OF VARIOUS LESIONS**




In present study highest incidence of gliomas (32%) was noted. 2nd higher incidence of Meningioma (24%) were noted (Figure 1).

**TABLE 3 DIAGNOSTIC ACCURACY OF MRI ASSUMING HISTOPATHOLOGY AS GOLD STANDARD**

| LESION | Histo-Pathology Diagnosis | MRI DIAGNOSIS | | | |
|---|---|---|---|---|---|
| | | True Positive (TP) | False Positive (FP) | False Negative (FN) | Accuracy |
| Glioma | 16 | 15 | 1 | 1 | 88.2 |
| Meningioma | 12 | 11 | 1 | 1 | 84.6 |
| Pituitary Adenoma | 2 | 2 | 0 | 0 | 100 |
| Metastasis | 2 | 2 | 0 | 0 | 100 |
| Schwannoma | 5 | 3 | 1 | 2 | 50 |
| Lymphoma | 1 | 1 | 1 | 0 | 50 |
| Dermoid/ Epidermoid | 3 | 3 | 0 | 0 | 100 |
| Medullo Blastoma | 1 | 1 | 0 | 0 | 100 |
| Colloid Cyst | 1 | 1 | 0 | 0 | 100 |
| Neurofibroma | 3 | 1 | 0 | 2 | 33.3 |
| Brain Abscess | 1 | 1 | 0 | 0 | 100 |
| Tuberculoma/ Tb Abscess | 2 | 1 | 0 | 1 | 50 |
| Demyelinating Disease | 1 | 0 | 0 | 1 | 0 |
| Total | 50 | 42 | 4 | 8 | **77.8** |

Our study showed the overall diagnostic accuracy of MRI in CNS lesions to be 77.8% and Positive Predictive Value as 91.3% and overall

sensitivity to be 84% (Table 3).

## DISCUSSION

Magnetic resonance imaging is a non-invasive, reproducible and highly accurate method, which demonstrates size, location configuration, extent and relationship of the lesion to the adjacent structures. By analysing the MR features of neoplasms one can have high specificity of MRI in identifying the nature of the lesion and if possible it's histological type.

In our study, the intraaxial location was common than the extraaxial location but it was lesser when comparing with the study done by Baker HL et al[6]. Glioma was the commonest intracranial lesion with an incidence of 32%. The incidence of the Glioma was comparable with Baker HL et al[6] and Jaiswal J et al[7]. Cases in our study showed heterogenous imaging on TI & T2W Images and T1W post contrast similar as that of Bruce L Dean[8]. (Table 4)

**TABLE 4 MRI FINDINGS IN GBM**

| MRI Findings | Bruce L Dean et al[8] | Present Study |
|---|---|---|
| TI & T2W Images | Heterogenous | Heterogenous |
| Heterogenous post cont. enhancement | 83% | 100% |
| Surrounding edema | 78% | 100% |
| Mass effect | Common | 100% |
| Intratumoral hemorrhage | Common | Seen 6/7 cases |

Our study showed a higher incidence of post contrast heterogeneity and surrounding edema and similar T1 & T2W imaging findings as compared to Bruce L Dean et al[8] study (Table 4).

In the present study, six cases of oligodendrogliomas were studied. Age ranged between 20-60 yrs, which corresponded with age incidence reported in literature[3].

The mean age of patients diagnosed with oligodendroglial tumors in our study is slightly higher than TMH study, but comparable to Central brain tumor registry of the United States data.[10]

Isointense signal on MRI finding were slightly more as compared to Zimmerman et al[9], study. In our study, 2 cases (4%) of pituitary adenomas were evaluated by MRI, both the cases were macroadenoma (>10mm). Daniel G Schwartzberg[11] reports that pituitary adenomas account for 10-20% of intracranial tumors and microadenomas are more common than macroadenomas. A study by Walter Kucharczyck et al[4] suggested that coronal images are the most sensitive predictor of location and extent of adenoma. That seems to be the case in our study too. Incidence of schwannoma was 10% (n=5) out of which one was intracranial while 4 were spinal.

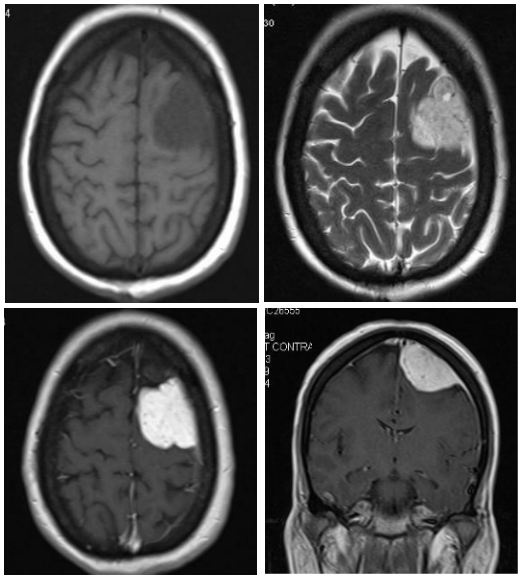
There are 2 cases of epidermoid and one case of dermoid in our study. The incidence of epidermoid in our study was higher than the percentage reported in William G Obana et al[12], which may be attributed to different demographics.

MRI findings showed hypo in T1, hyper in T2 and restriction seen in DWI in our study which were similar to Donatella Tampieri et al[5].

The study has tried to understand the correlation between the histopathology and MRI findings in a variety of CNS lesions. The study has been able to identify the relation between the two. However, the question remains regarding the applicability of the sample selected for identifying the correlation. By selecting a small sample, the results generated cannot ideally be generalized to the large population.

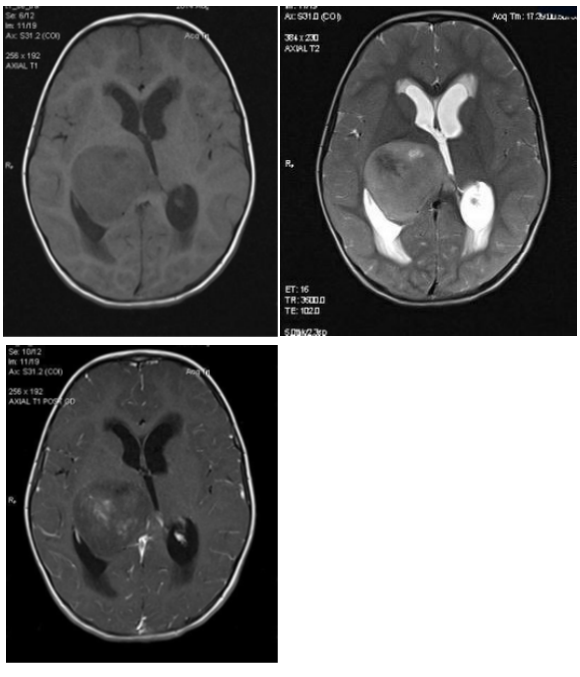
## CONCLUSION

Overall diagnostic accuracy of MRI in CNS lesions was 77.8% and Positive Predictive Value was 91.3% and sensitivity was 84%. Thus MR images are certainly the preoperative modality of choice in the evaluation of CNS space occupying lesions. MR images can narrow the differential diagnosis and guide surgical resection. Multiplanar MRI helps in determining proper localization & extent of lesion, which is of great value for the surgeon. It also helps in evaluation of mass effect, perilesional edema and associated anatomic distortion. Superior contrast resolution is provided via multiple sequences which exploit the various tissue characteristics of normal and pathological structures. MRI has a high spinal soft tissue resolution that can avoid bone artifacts. This method can obtain a more accurate reliable localization and qualitative diagnosis based on the specific features of different tumors as compared to CT which also has an added radiation risk. In some tumours, these benefit might preclude brain biopsy, which is an invasive procedure that would otherwise be required to establish the final diagnosis; it might also avoid delay in initiating tumour therapy.



**Meningioma**

Well defined extra axial dura based abnormal lesion (40 x 34 x 33mm) involving left superior frontal region appearing hypointense on T1, heterogeneously hyperintense on t2W sequence and DWI with strong enhancement on post contrast study. The lesion causes buckling of adjacent cerebral cortex.



**HIGH GRADE GLIOMA**

Intra-axial ill defined lesion appearing mildly hyperintense to mixed signal intensity on T2 WI with few hypointense (on all sequences) areas within it. This lesion shows mild heterogeneous enhancement on post contrast study. Findings suggest possibility of High grade glioma.

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