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## DIAGNOSTIC IMAGING OF INTRACRANIAL NEOPLASMS: HOW FREQUENT ARE INDICATIVE FINDINGS IN CT AND MRI?

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### ABSTRACT

**Objective:** This study aims to compare the ability of computed tomography and magnetic resonance imaging for detection, characterization and localization of intracranial neoplasms.

**Material & Methods:** Total 60 cases with clinical suspicion of intracranial neoplasm of all age groups and either sex were evaluated. All MR images were obtained with a 1.5-T superconducting system (SIEMENS) using a circularly polarized head coil. Pre and post contrast CT was done in all cases on 64 Slice Helical Siemens Somatom CT scanner machine.

**Results:** CT proved to be superior in demonstrating calcifications and a typical tumor density. On the other hand, MRI was better suited for identifying the extraaxial location of tumors, the broad contact of tumors to the meninges, tumor capsules and contrast enhancement adjacent to the tumors. Both methods provided nearly equal results in demonstrating mass effects, hyperostoses, intensive and homogeneous contrast enhancement, and smooth tumor contours after contrast administration. On the whole, neither of the two methods demonstrated a universal superiority for the diagnosis of intracranial neoplasms. Rather, each method displayed distinct advantages.

**Conclusion:** Application of a diagnostic algorithm that integrates advanced imaging features with conventional imaging findings may help the practicing radiologist make a more specific diagnosis for an intracranial tumor.

**Key words:** Computed tomography, intracranial neoplasm, intratumoral calcification, Magnetic resonance imaging, supratentorial.

### INTRODUCTION

Intracranial neoplasms can be detected at an early stage with the help of diagnostic modalities. The goals of diagnostic imaging in the patient with suspected intracranial tumour include:

1. Detection of the presence of a neoplasm.
2. Localization of the extent of tumour. (Including definition of involvement of key structures & assessment of the presence and severity of secondary changes.)
3. Characterization of neoplasm.<sup>1</sup>

In 1970, CT emerged as primary diagnostic screening modality for the detection of intracranial disease. Areas of structural abnormality appeared on CT as regions of altered tissue radiographic density. Accuracy of localization with CT exceeded the accuracy that could be achieved by cerebral angiography or any other invasive diagnostic procedures.<sup>2</sup>

Since introduction of Magnetic Resonance Imaging (MRI) as clinically practicable diagnostic modality in 1980, it has rapidly earned recognition as the optimal screening technique for the

detection of most intracranial neoplasms. Early experience suggested that 3% to 30% more focal intracranial lesions could be identified on MRI than on CT.

Compared with CT, MRI using spin echo, gradient echo and combination of spin and gradient echo pulsing sequences before and after intravenous administration of paramagnetic contrast agents provides inherently greater contrast resolution between structural abnormalities and adjacent brain parenchyma and has fuelled the development of MR from an in vitro laboratory tool to an in vivo diagnostic instrument. Even with current state of the art equipment utilizing very high magnetic fields and rapidly switching gradient coils, MR nevertheless suffers two disadvantages:

1. MRI requires significantly large image acquisition time.
2. Abnormalities involving cortical bone, intratumoral calcification and hyperacute haemorrhage are more clearly & accurately assessed with CT.

As both CT & MRI are helpful in the diagnosis of intracranial neoplasms. Hence this study is undertaken to compare the role of computed tomography and magnetic resonance imaging in intracranial neoplasms

## **MATERIAL & METHODS**

Sixty patients with clinical suspicion of intracranial neoplasm attending the various surgical and medicine outpatient departments (OPDs) & wards of our hospital were included in the study.

### **COMPUTED TOMOGRAPHY (CT)**

Pre and post contrast CT was done in all cases on 64 Slice Helical Siemens Somatom CT scanner machine, time of which is 0.4 seconds.

### **MAGNETIC RESONANCE IMAGING (MRI)**

All the studies were conducted on 1.5 Tesla super conducting magnet, SIEMENS, Head coil was

used. Parameters used for analysis were shown in **Table 1**

## **RESULTS**

SIXTY CASES comprising of various type of primary and secondary neoplasms were studied. Since, metastases showed fewer incidences in our study because most of the patients with a known primary were subjected to one imaging modality either CT or MRI. So, these patients were excluded from the study as our study was based on comparative evaluation of CT and MRI in intracranial neoplasms. Overall observations were following:

**Table II** summarizes the general comparison of various features of intracranial neoplasms as follow: CT failed to demonstrate the lesion in two cases and showed only hydrocephalus whereas MRI showed the lesion in medulla .MRI demonstrated the CSF cleft and pial vessels in 8 out of 10 cases of meningioma & in two cases of dural based metastases & acoustic schwannoma, however these findings were not demonstrated on CT.

Tumor extension into sellar region was noted in 12 cases with MRI while it was observed with 8 cases on CT. There were 18 cases of posterior fossa tumors in our series of 60 cases. MRI displayed the full extent including the inferior extent in 18/18 cases whereas; CT demonstrated the full extent in 10 cases only. In two cases of dural based metastases inferior extent of the base of skull lesion was better demonstrated by MRI.

Extension into internal auditory canal & left orbit in cases of acoustic schwannoma & dural based metastases respectively were better demonstrated on MRI than CT.

MRI showed peritumoral edema in 30 cases while on CT it was observed in 26 cases. Intratumoral hemorrhage was seen in 6 cases with MRI, while on CT it was observed in two cases. CT was able to detect only acute intratumoral hemorrhage while MRI demonstrated both acute & chronic intratumoral haemorrhages. Better demonstration of

acute intratumoral hemorrhage was seen with CT than MRI.

Calcification was noted in 12 cases on CT. MRI failed to depict the calcification in all cases. Bony changes were noted in 8 cases on CT while MRI showed it in 6 cases. MRI failed to depict the hyperostosis in a case of meningioma.

MRI showed contrast enhancement in 50 cases while it was observed in 48 cases on CT. CT failed to detect the tumor in two cases in which MRI showed mild enhancement.

### **Frequency Distribution of Intracranial Neoplasms**

Commonest intracranial neoplasms were gliomas (30%), followed by meningioma (16.6%), metastases (10%), medulloblastoma (6.6%) & others.

### **Age and Sex Distribution of Intracranial Neoplasms**

Incidence peaks of gliomas & meningiomas were seen predominantly in 3<sup>rd</sup> – 4<sup>th</sup> decade of life. 20% of all intracranial tumour occurred in paediatric age group under 20 years of age. Also we observed one patient presented in 1<sup>st</sup> decade of life. Men were found to be affected more than women in present study (17:13) except for meningioma with female predominance (1.5:1).

### **Location Distribution**

In present study supratentorial location (40 /60) was found to be more common than infratentorial locations with both CT and MRI. We observed that MRI was more accurate in lesion localisation than CT. In a case of dural based metastases, two out of three metastatic lesions were observed as located infratentorially on CT. Whereas MRI, clearly demonstrated the lesion in supratentorial location on sagittal images.

### **Gliomas**

There were eighteen cases of glioma. Most of these were hypodense on NCCT and were hypointense on T1- weighted and hyperintense on T2 – weighted images on MRI. We found that MRI was better in tumour detection, localization, demarcation from normal brain parenchyma, identification of sub

acute / chronic intratumoral haemorrhage and degree of enhancement than CT. However, calcification was better seen on CT. (**Figure IV & V**).

### **Posterior Fossa Neoplasms**

MRI found to be more sensitive than CT.

Meningioma was the most common extra-axial tumour in present study.

MRI provided more information than CT on pituitary morphology and neighbouring structures in sellar, suprasellar, parasellar and juxtacellular neoplasms. MR was superior to CT in assessment of extent of tumour, in demonstration of tumour relationship to vessels, optic chiasma and adjacent structures of brain. (**Figure VI**). However, CT was superior to MRI in detecting the presence of calcification which is diagnostic in case of craniopharyngioma.

In our two cases of colloid cyst, MR was more sensitive than CT to the presence of tumour and in demonstration of heterogeneity of tumour. (**Figure VIII**)

In cases of metastases, we made the observation that MR was superior to CT in localisation, assessment of extent of lesion and in degree of enhancement. While, CT demonstrated early intratumoral hemorrhage better than MRI. (**Figure VII**)

## **DISCUSSION**

### **Lesion detection:-**

**McConachie et al<sup>4</sup>** and **Atlas et al<sup>1</sup>** reported that MR imaging is more sensitive than CT for detection of brain tumors. However, in our study, CT and MRI detected all the cases but in one case of metastasis MRI detected one more lesion.

### **CSF Cleft / Pial vessels:-**

**Schubeus et al<sup>5</sup>** studied fifty cases of meningioma and concluded that MRI appears to be better than CT in demonstrating extraaxial location of the tumour, with the identification of tumour capsule, consisting of CSF margin and displaced vessels and relationship to the meninges.

Similar results were noted in present study as MRI demonstrated the CSF cleft and Pial vessels in eight

out of ten cases of meningioma & in two cases of dural based metastases and acoustic schwannoma, however these findings were not demonstrated on CT. (Figure I, II & III).

#### **Extent of tumour**

**Gusnor and Atlas *et al*<sup>1</sup>** reported that MR has the advantage of being able to better define tumour extent than CT because of its greater contrast resolution and multiplanar capability.

Similar results have been found in present study with better demonstration of extent of posterior fossa, base of skull, sellar, parasellar and juxtaseella neoplasms on MR than CT.

#### **Peritumoral edema**

We observed that FLAIR images showed better demarcation between tumour and edema than conventional MR sequences and CT. In four cases, mild peritumoral edema was seen only on flair images.

**Tsuchiya *et al*** also reported the same in their study of 34 patients that FLAIR images showed peritumoral edema more clearly than T2- weighted images when the tumour itself was not hyperintense.

#### **Intratumoral hemorrhage:-**

**Kieffer and chang** described that MRI has greater sensitivity for detection of subacute and chronic haemorrhages whereas early intratumoral or peritumoral haemorrhages are more clearly defined with greater certainty on CT than on MRI.

Similar results were seen in present study, as in two cases where CT failed to detect the intratumoral haemorrhage were found to have subacute / chronic hemorrhage on MRI. In four other cases both CT & MRI showed the early intratumoral haemorrhage but it was more clearly defined with CT than MRI.

#### **Calcification**

**Lee and Tassel, McConachie *et al*<sup>4</sup>** in their studies concluded that CT is highly sensitive in detecting calcification whereas MR cannot reliably demonstrate or exclude its presence. Lovener also found the same that CT is more sensitive than MRI in detecting the presence of calcification. We also observed the same in our study as CT demonstrated

calcification in twelve cases whereas MRI was unable to demonstrate it.

#### **Bony changes**

**Kieffer and Chang, Master and Zimmerman, Yeakley *et al*** reported that CT is superior to MR in demonstration of bone changes like hyperostosis or bone destruction. We also found the same as MRI failed to demonstrate the bony change in a case of meningioma in which CT showed hyperostosis of underlying sphenoid bone. In all other cases, both CT & MRI were equally good in demonstration of bony changes.

#### **Contrast enhancement**

**Graif *et al*** in their study of seventeen cases of malignant brain tumour compared degree of enhancement with CT & MRI and noted that MRI showed greater degree of enhancement than CT in eight cases. Present study also showed the similar results as MRI showed more enhancement than CT in eight cases, six cases with moderate enhancement & two cases with mild enhancement on CT showed intense enhancement on MRI. In two cases CT was unable to show contrast enhancement while MRI showed mild enhancement.

#### **CONCLUSION**

Summarizing, MR has many advantages over CT all without the need of ionizing radiation and iodinated contrast media in imaging of intracranial neoplasms. The multiplanar capability and superior contrast resolution of MRI makes it a better technique than CT in imaging of intracranial neoplasms in terms of tumour detection, localization, assessment of extent of tumour, identification of subacute / chronic intratumoral hemorrhage, degree of enhancement and demonstration of tumour relationship to adjacent structures of brain. MR nevertheless, requires significantly longer image acquisition times than CT. MR is inferior to CT in identification of bony changes, intratumoral calcification and early intratumoral hemorrhage.

Hence, we conclude that MR is the preferable method for evaluation of intracranial neoplasms and CT is useful as a supplementary modality when

detailed information about bony anatomy and calcification is required. Also application of a diagnostic algorithm that integrates advanced imaging features with conventional imaging findings may help the practicing radiologist make a more specific diagnosis for an intracranial tumour.

### ACKNOWLEDGEMENT

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**Conflict of Interest:** None declared

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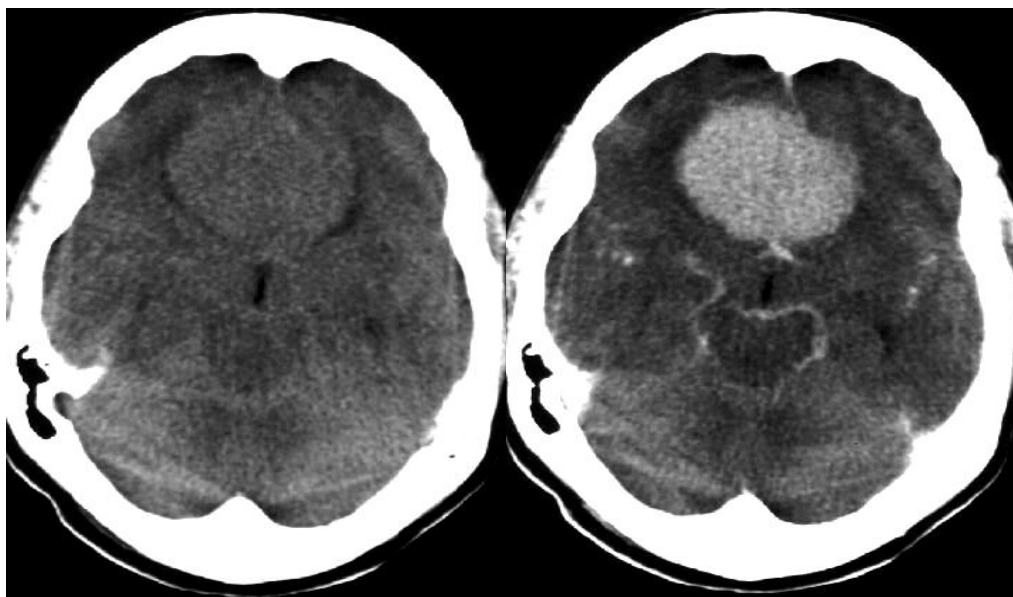
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**Table 1: Parameters Used For Analysis**

	TR	TE	FOV	FLIP ANGLE	SLICE THICKNESS
DW	2842	72	240	90	5mm
T1W Axial	596	15	240	69	5mm
T2W Axial	4479	100	240	90	5mm
T1W Sag	606	13	240	69	5mm
T1W Gd Axial	596	15	240	69	5mm
Axial					
FLAIR	11000	120	240	90	5mm

**Table II Comparison of various features of intracranial neoplasms**

Various features	On CT	On MRI
1. Lesion detected	58	60
2. CSF Cleft / pial vessels	Not seen	Seen (10)
3. Extension		
a. In sellar region	6	8
b. Inferior extent of posterior fossa neoplasms	8	18
c. Inferior extent of base of skull lesion	? 2	2
d. Extension into IAC	? 2	2
e. Extension into left orbit		
4. Peritumoral edema	26	30
5. Intratumoral haemorrhage	2	6
a. Acute	4	4
b. Chronic	0	4
6. Calcification	12	Not seen
7. Bony changes	8	6
8. Contrast Enhancement	48	50

**MENINGIOMA****Figure I ( Plain & Contrast CT image of meningioma)**

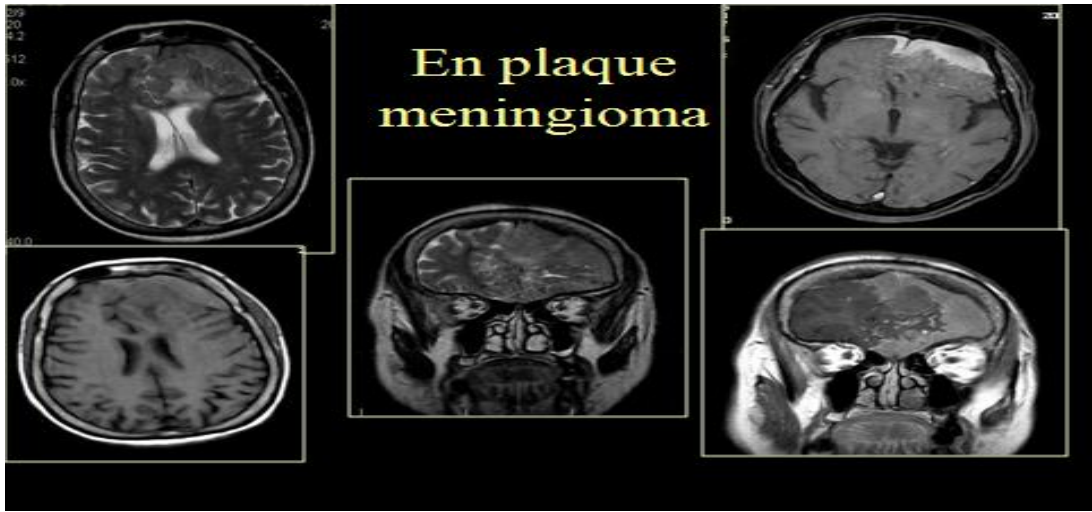


Figure II ( MR findings of meningioma )

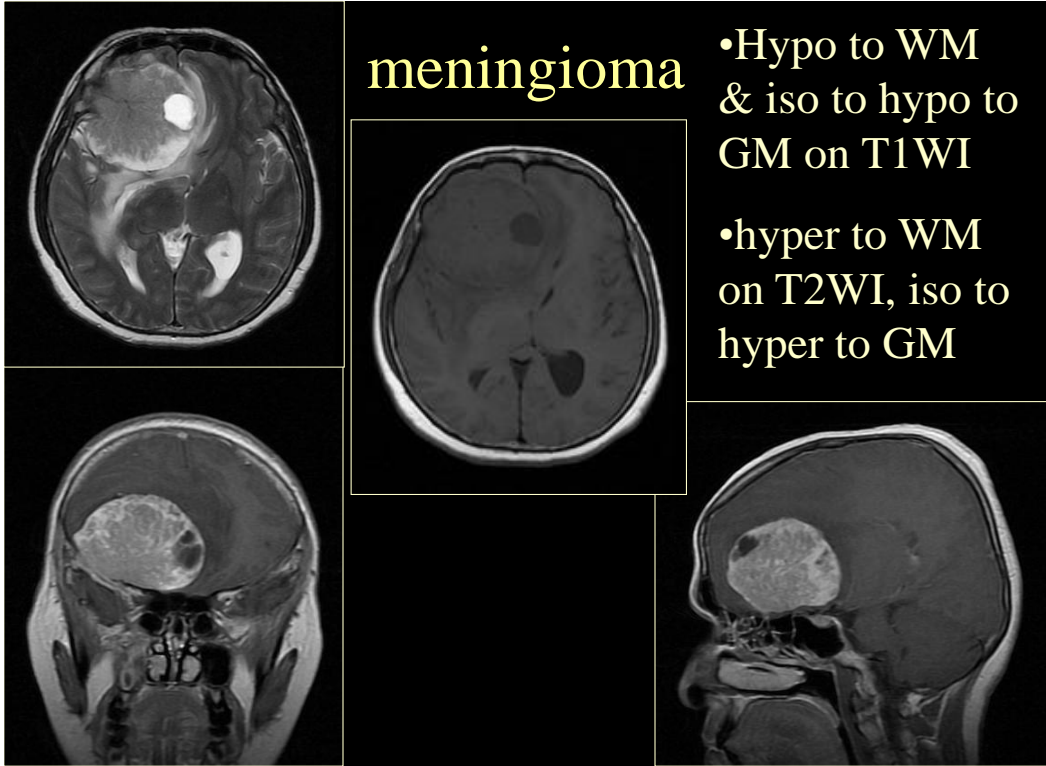
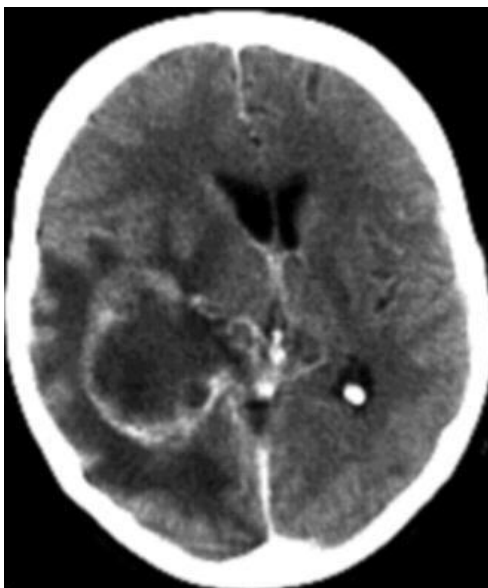


Figure III

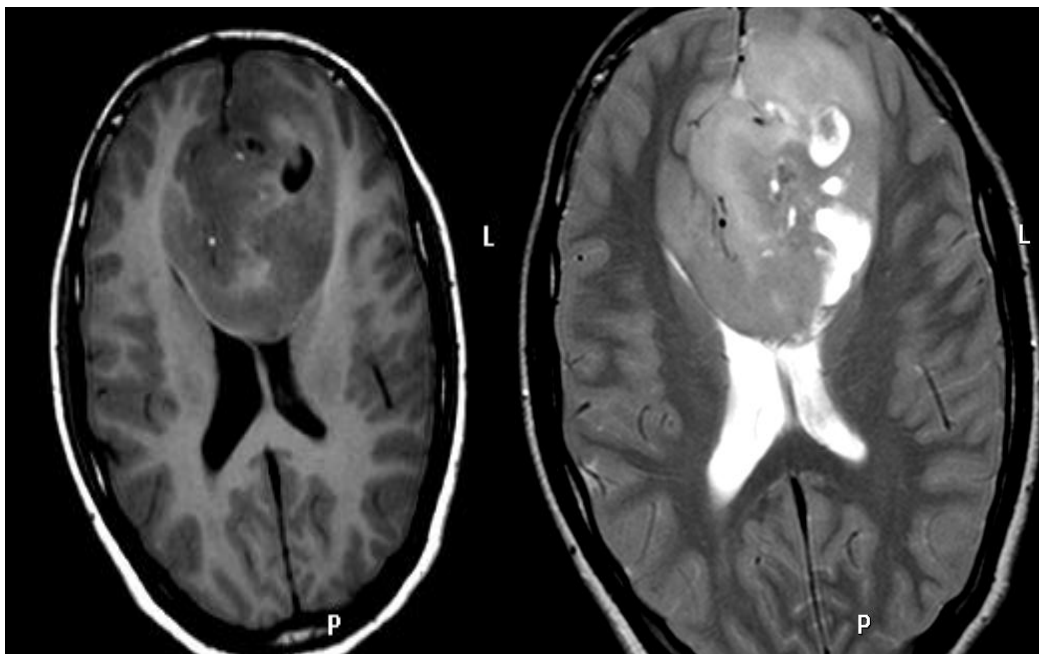


**ASTROCYTIC TUMOURS-GLIOMA**



**Figure IV : CT Features of Glioma**

**GLIOMA-MR APPEARANCES**



**Figure V**

### EPENDYMOMA

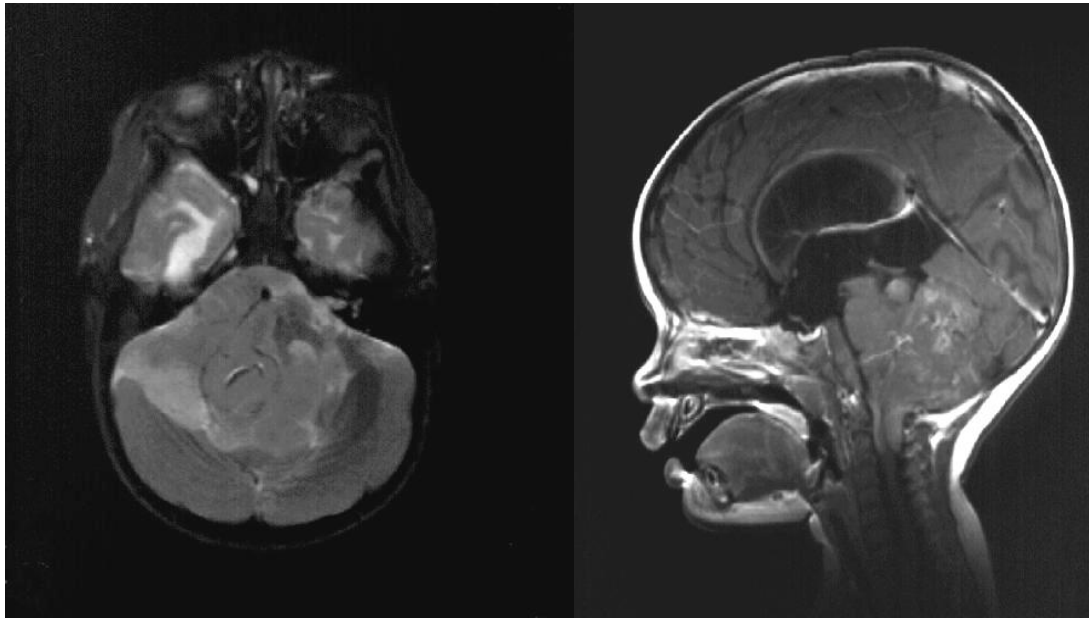


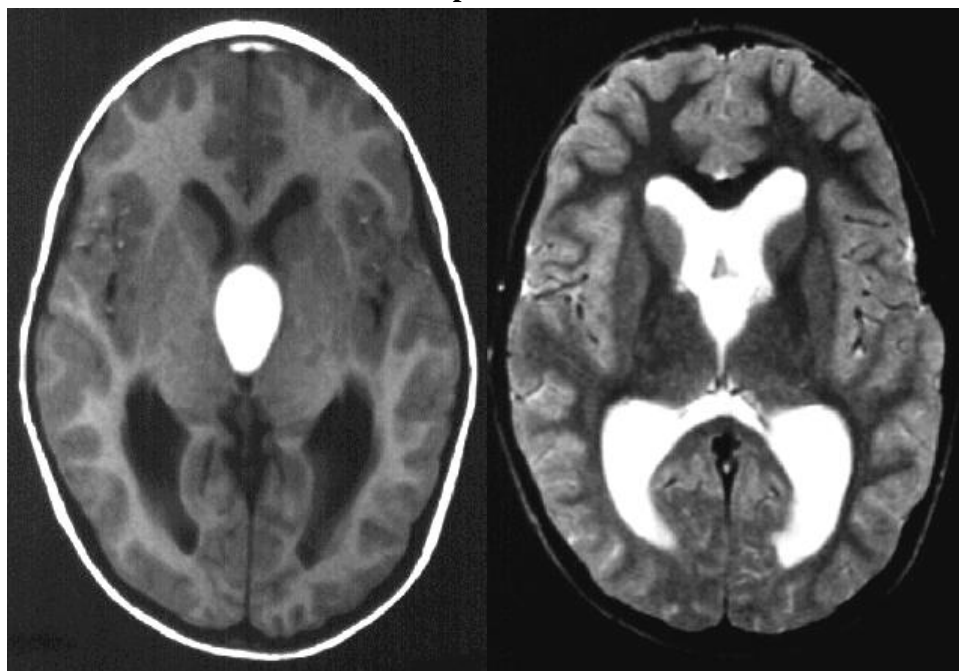
Figure VI

### INTRACRANIAL METASTASIS- CT Appearances



Figure VII

**COLLOID CYST- Comparative CT & MR Evaluation**



**Figure VIII**