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MR imaging spectrum in intracranial meningiomas-a retrospective study

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Abstract: *Meningiomas are one of the most common benign intracranial tumors seen in females after 3rd decade. They are well defined extra axial masses with characteristic CT and MR imaging features. In the present study we retrospectively evaluated the MR imaging in 67 operated cases of intracranial meningiomas in our institute.*

Key Words : *Meningioma-MRI-dural masses*

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I. Introduction

Meningiomas are slow growing benign tumors that arise from the meningothelial cells of the arachnoid membrane. Majority of the tumors present in middle age or above. The clinical signs are varied and are due to compression of brain structures or obstruction of ventricular system. About 90 % of meningiomas belong to benign WHO Grade1 lesions. However a small percentage represent WHO Grade 2 (atypical 5-7 %) and WHO Grade 3 (anaplastic 1-3 %) types[1].These extra axial tumors are located mostly along the parasagittal planes and along the lateral cerebral convexity, sphenoid wing, posterior fossa. They also seen in the middle cranial fossa, along the olfactory groove, sella turcica, tentorium , CP angle, lateral ventricle and optic nerve sheath. Meningiomas are mostly solitary and multiple meningiomas are seen in neurofibromatosis type 2[2]. On MRI, meningioma typically show the following features. Iso to hypointensity on T1 weighted and iso to slightly hyperintensity on T2 weighted, FLAIR sequences, varying degrees of restriction on diffusion weighted imaging with homogenous enhancement on contrast administration. Rarely they show calcification which is better appreciated on CT scan and appear as low intensity signal on T2 weighted sequences. Although most of the meningiomas show homogenous enhancement with contrast ,heterogenous and peripheral enhancement is seen in rare microcystic type of meningioma. One of the characteristic feature of meningioma is the presence of dural tail (due to enhancement of dura infiltrating away from the lesion) which is seen in 72 % of cases[3] . The presence of CSF cleft between the tumor and the underlying brain cortex is also one of the characteristic features of meningioma due to its extra axial location[4] . Encasement of arteries and veins are usually seen in meningiomas that are located along the skull base or parasagittal planes. Meningiomas , especially enplaque type invades the underlying bone causing hyperostosis or lytic destruction. This finding is seen in 20% of cases of meningiomas and better evaluated on CT scan than MRI. MR Spectroscopy findings are mostly non specific. Meningioma may show increased choline (3.2ppm) , decreased creatine (3.0ppm), presence of lactate. Presence of alanine which was thought as specific is not detectable always [2].

II. Case Results :

Magnetic resonance imaging findings of 67 operated cases of intracranial meningiomas were analysed . The study was done mainly to look into the following points. Age incidence , sex of the patients, location of the tumor, T1 weighted sequence, T2 weighted sequence , contrast enhancement pattern, for any evidence of calcification, cysts, peritumoral edema, hemorrhage, MR spectroscopy findings.

Findings : The age varied between 17 years and 82 years with peak incidence between 40-60 years for females and above 60 years for males. The tumors are more common in female patients 49 out of 67 and the rest are males. Almost all locations described in the literature are affected with parasagittal tumors are the most common

site in our study 23 out of 67 (22.9%) followed by lateral hemisphere convexity closely.(Fig 1-9) . Meningiomas more common on left side 39 , and remaining 28 were right side(table 1)

Table 1.) Location of meningiomas in the present study

Parasagittal	23
Lateral hemisphere convexity	20
Sphenoid wing	5
Middle cranial fossa	4
Posterior fossa	4
Sellaturcica	3
CP angle	2
Olfactory groove	2
Others (I case of enplaque meningioma, tentoroium , two cases of recurrent meningiomas)	
Total cases =	67

Majority of the tumors followed the classical pattern of signal intensities on MR imaging. They are either homogenously hypo or isointense on T1 weighted sequences and slightly hyper intense on T2 weighted sequences, Fluid attenuated sequences and restricted on DW imaging. The contrast enhancement pattern was homogenous in many cases. 11 cases showed heterogenous signal intensities , focal or diffuse calcification and heterogenous enhancement after contrast administration, cysts, necrotic areas suggesting atypical type of meningiomas. Dural tail sign and peritumoral edema were noted in more than one third cases .Hyperostosis of underlying was more common than osteolysis in our study seen in 19 cases. Increased peaks of choline and creatine , presence of alanine on MR spectroscopy was observed in 10 cases only and the rest are nonspecific. Four cases showed intratumoral and peritumoral hemorrhage and in one case there was associated spontaneous intracerebral hemorrhage indicating anaplastic subtype of meningioma which was confirmed on histopathology (Fig 10). Encasement of adjacent carotid arteries and dural venous sinuses was seen in four cases. Two patients presented with recurrent meningiomas after surgery with typical findings (Fig 11). One case of enplaque meningioma and another case of meningioma arising from falx and tentorium also seen in our study (Fig 12 and fig 13). (Table 2)

Table 2.) list of salient features of meningioma on MRI

Findings	number of cases
Peritumoral edema	32
Dural tail sign	24
Bone hyperostosis /erosion	19
Cystic changes	8
Abnormal MR spectroscopy	10
Intra/peritumoral haemorrhage	4
Vascular encasement	4
Calcification	4

III. Discussion:

Meningothelial, fibrous, transitional subtypes constitute more than 80 % of meningiomas , considered as WHO Grade 1, which have typical imaging features of meningiomas described above. There are other small group of histological subtypes of meningiomas labeled as WHO grade 2 and WHO grade 3 which have different and atypical imaging findings extensively described[5]. Meningothelial meningioma, the commonest subtype of meningioma shows typical MR imaging findings- hyperintensity on T2 weighted sequence, homogenous contrast enhancement with dural tail sign and bone hyperostosis. Fibrous meningioma shows relative T2 hypointensity due to the presence of collagen. Transitional meningioma shows mixed iso- and hyperintensity on T2 weighted sequences. Psammomatous meningioma is characterized by the presence of calcifications besides the typical imaging features of WHO grade1 meningioma. Angiomatous meningioma shows the presence of multiple flow voids due to hypervascularity along with prominent peritumoral edema. Reticular type contrast enhancement with peritumoral edema characterize microcystic meningioma. Secretory meningioma commonly arise at skull base, shows high signal intensity on T2weighted sequence with high ADC values unlike typical meningioma along with significant peritumoral edema. Lymphoplasmacyte-rich meningioma seen in young patients shows typical irregular tumor margin with invasion to adjacent brain. The mass shows heterogenous contrast enhancement with significant peritumoral edema. Clear cell meningioma typically seen in young patients and located at cerebello pontine angles . Recurrence are common with this type. Heterogenous contrast enhancement , presence of cysts, peritumoral edema and lytic bone destruction are also common . MR imaging

of atypical and anaplastic meningioma : common in males. These tumors show irregular tumor margin, indistinct tumor brain interface, heterogenous signal intensities [6], restriction on diffusion weighted sequence. Underlying bone destruction, peritumoral edema, necrosis and calcification also seen. Metaplastic meningioma contain cartilaginous, osseous or lipomatous tissue and the imaging findings depend on the composition of the tumor. Though extra axial about 60 % of meningiomas are associated with vasogenic cerebral edema. In our study 32 cases showed brain edema. Meningiomas are rarely associated with cystic changes which can be extratumoral or intratumoral7. Spontaneous or intratumoral hemorrhage are occasionally seen in meningiomas. We had 4 cases of intratumoral hemorrhage of which one was associated with spontaneous intracerebral hemorrhage. Though avid and homogenous contrast enhancement is typical of meningioma , but sometimes it can be heterogenous or ring enhancement also. Many studies were reported in the literature correlating the MR imaging pattern with histopathological subtypes of meningioma [5,8] .

NORIAKI TOMURA et al[9] evaluated the neuroradiological findings in 8 cases of atypical meningiomas and found certain signs like absent dural tail sign, large perilesional edema ,heterogenous contrast enhancement with heterogenous signal intensities of the tumor , early venous filling on angiography (not seen in typical benign meningiomas) .

EMERSON L GASPARETTO et al [10] retrospectively analysed the MR imaging in 78 operated cases of meningiomas and found that most of the tumors showed heterogenous low signals on T1 weighted sequences with vasogenic edema in 90 % of cases. Based on MR imaging characteristics JASON M. HOVER [11] was able to differentiate soft and suckable or firm and fibrous meningiomas which guides the surgeon during the operation . He concluded that soft meningiomas are hypointense on T1W and hyperintense on T2weighted sequences where as firm or fibrous tumors are isointense on T1W and hypointense on T2Weighted imaging. Based on clinical and MR imaging parameters JOHN VARLOTTO [12] found that it was possible to distinguish grade 1 meningioma from high grade meningioma without biopsy in 85 patients.

ANDREW T.HALE and others [13] retrospectively evaluated MR imaging findings in 128 patients to differentiate meningioma grading. Presence of tumor necrosis, increased peritumoral edema, location along the falx, convexity, presence of draining vein, tumor volume are predictors of high grade meningioma. Meningiomas have to be differentiated from similar extra axial dural based conditions like dural metastases(hyperintensity on T2Weighted images), hemangiopericytoma (no bone hyperostosis, presence of prominent internal flow voids), neurosarcoid (besides dura, also involve leptomeninges, perivascular subarachnoid spaces), CNS lymphoma (hypointense on T2weighted sequence, multiple lesions , involve leptomeninges). From the present study we were able to correlate the MR imaging findings with the diagnosis of meningiomas in all cases .

IV. Conclusions :

MR imaging is the most important preoperative investigation in the diagnosis and grading of meningioma and it also helps to differentiate it from other conditions that mimic meningioma .

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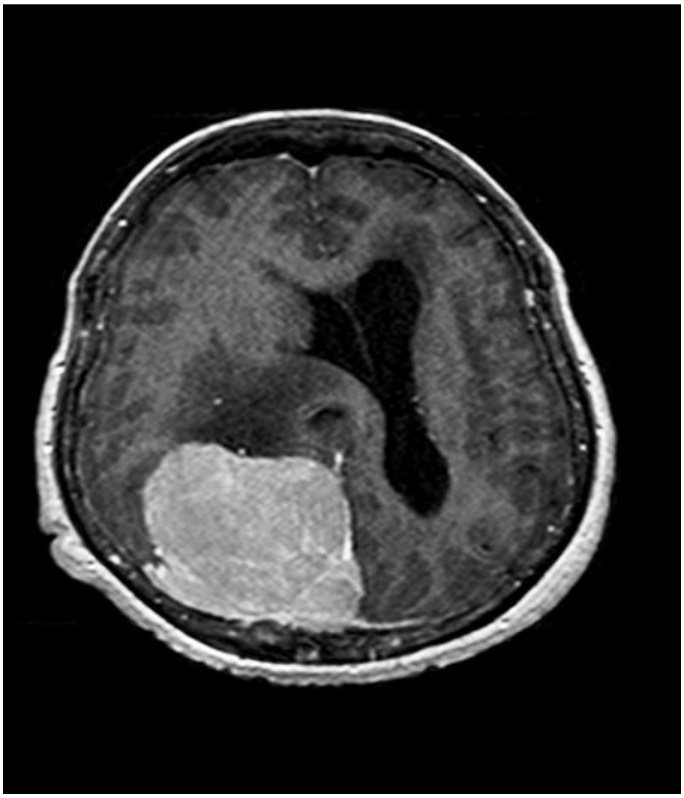

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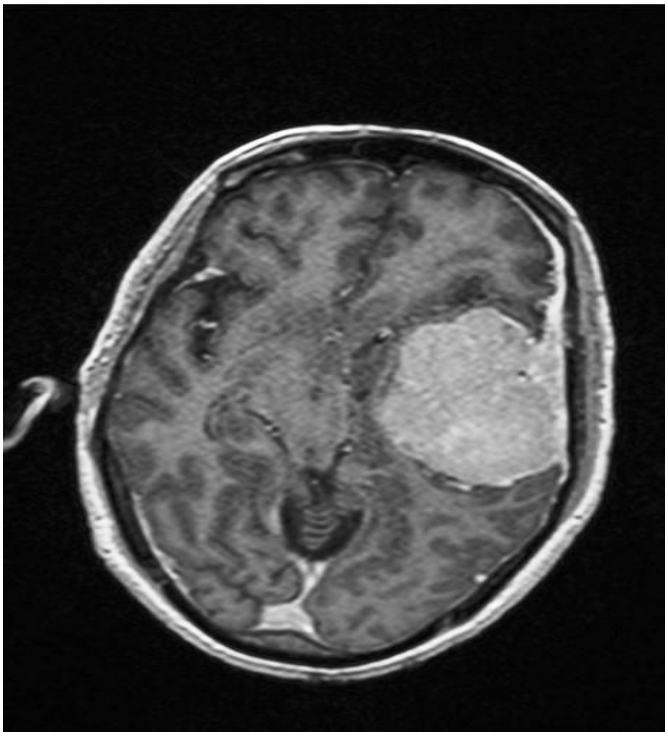
Fig 1.B)



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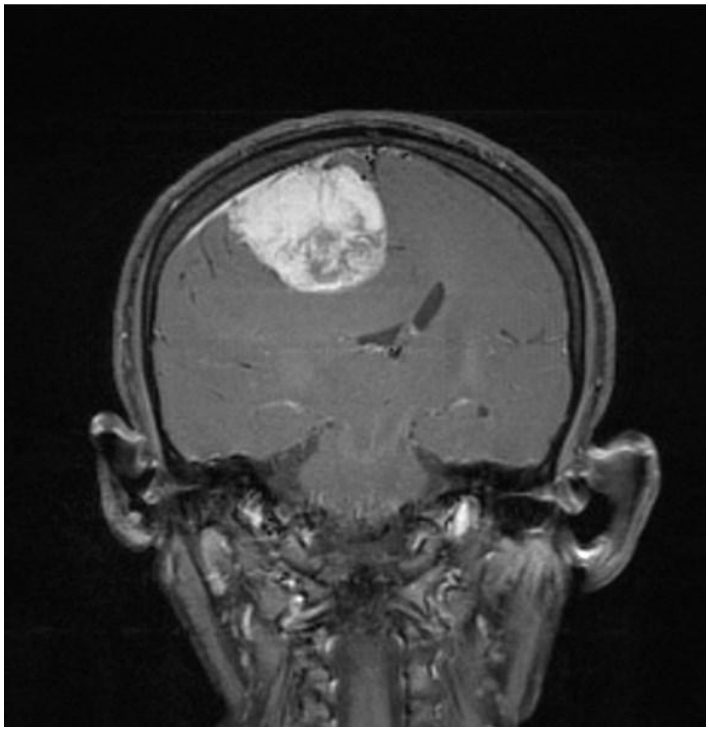

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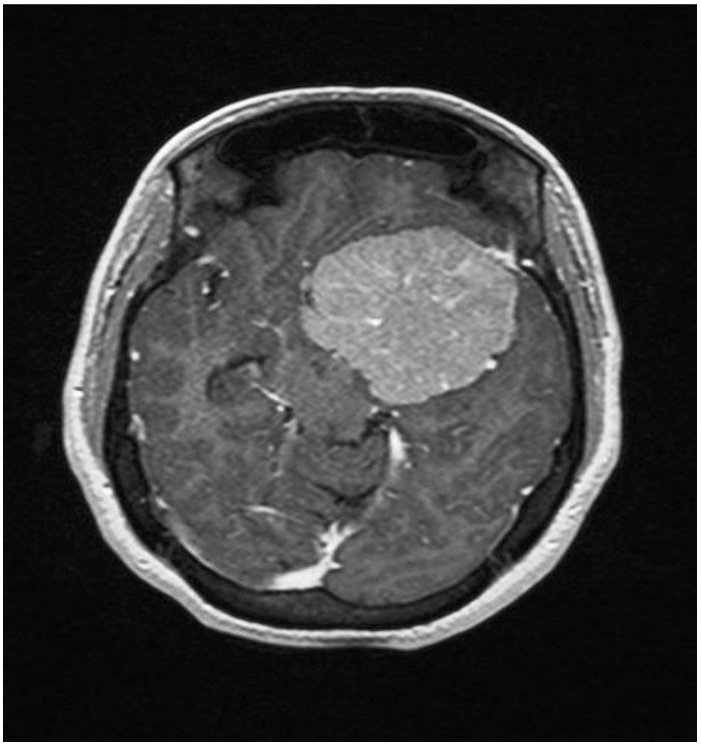

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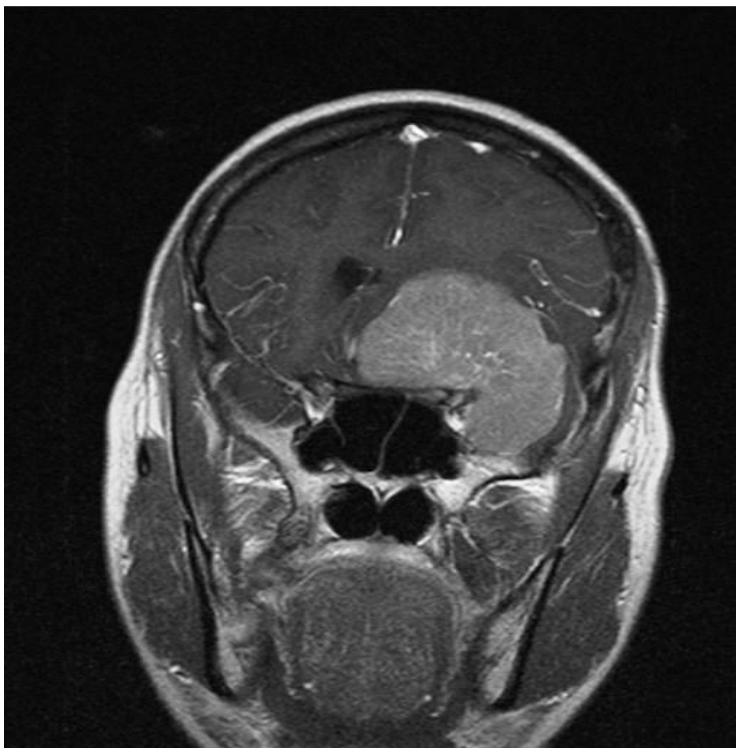

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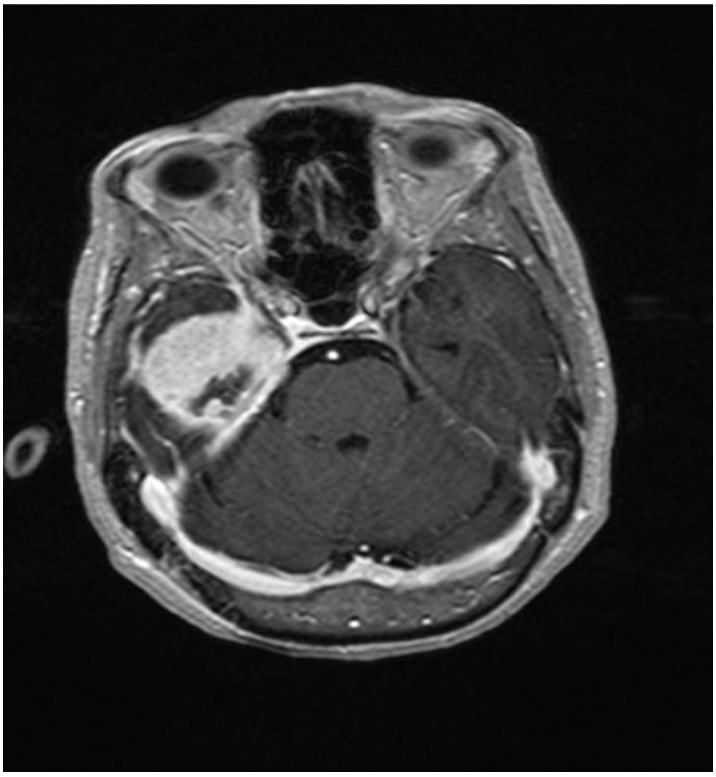

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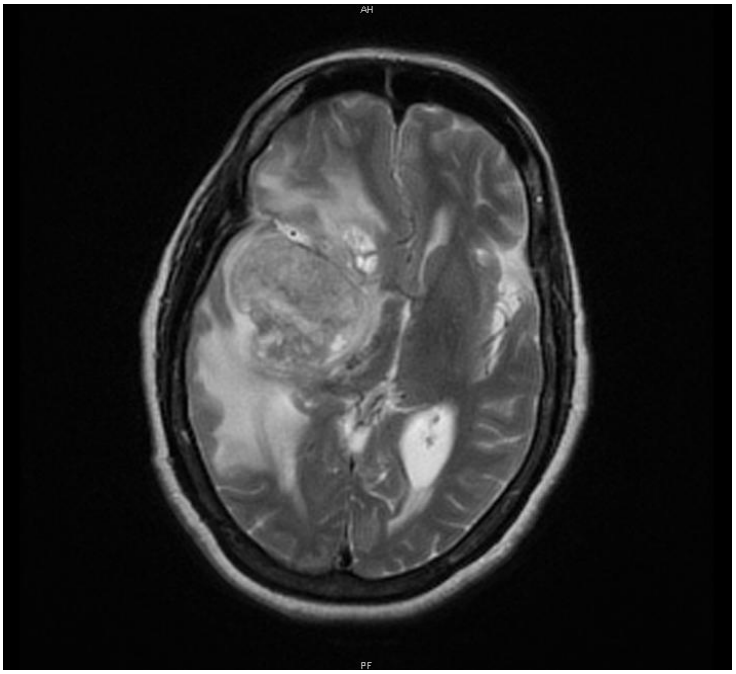

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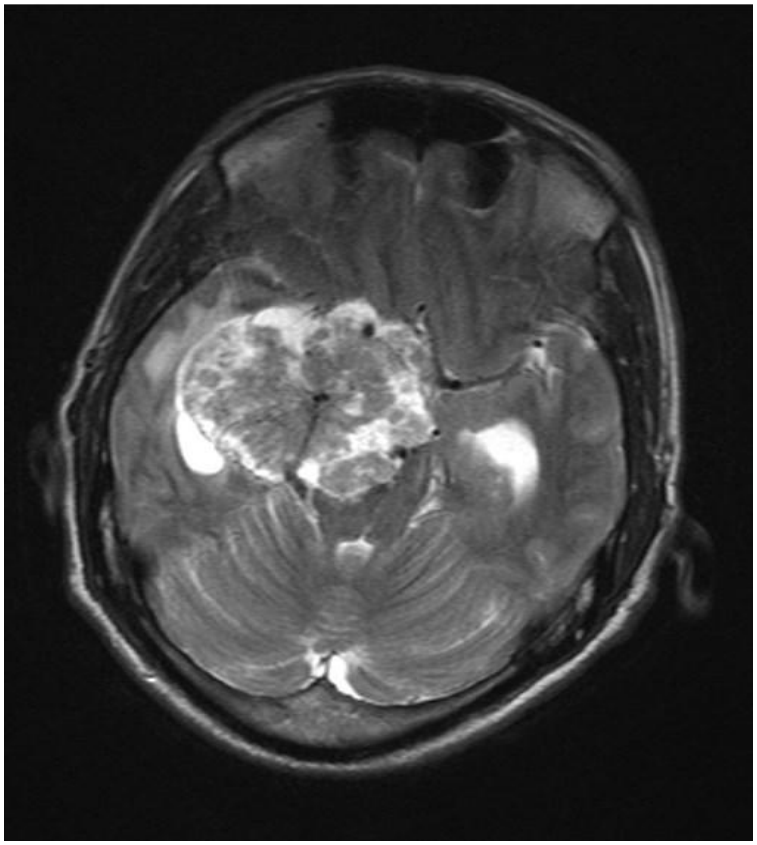

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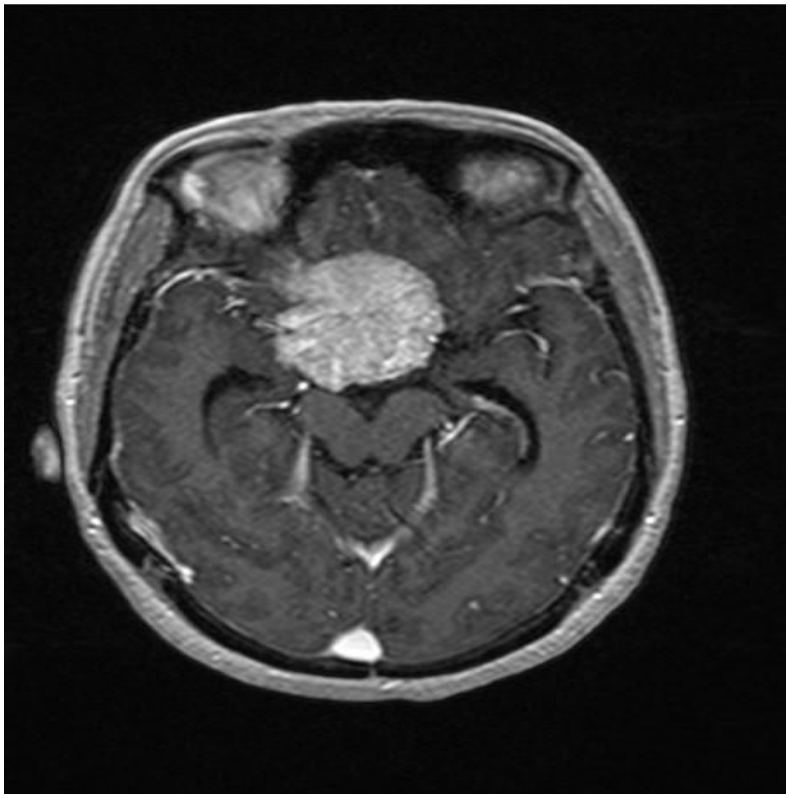

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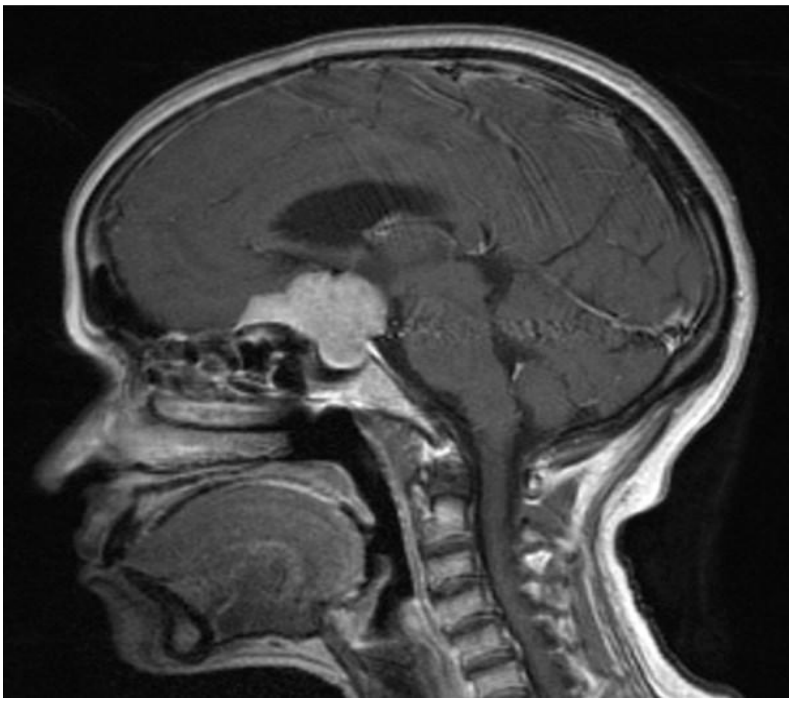

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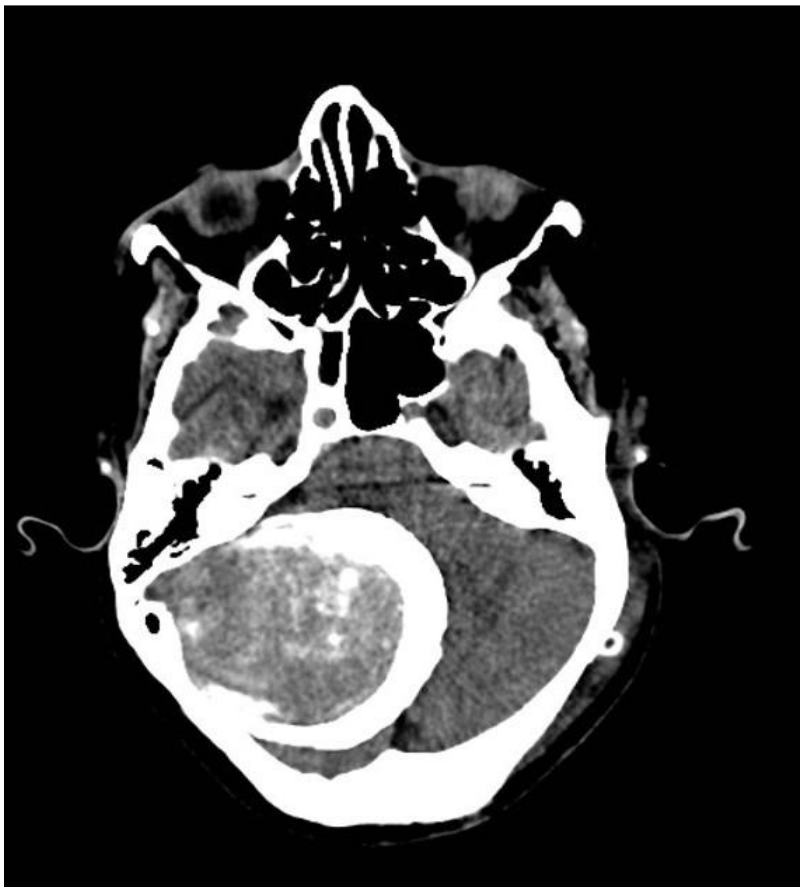

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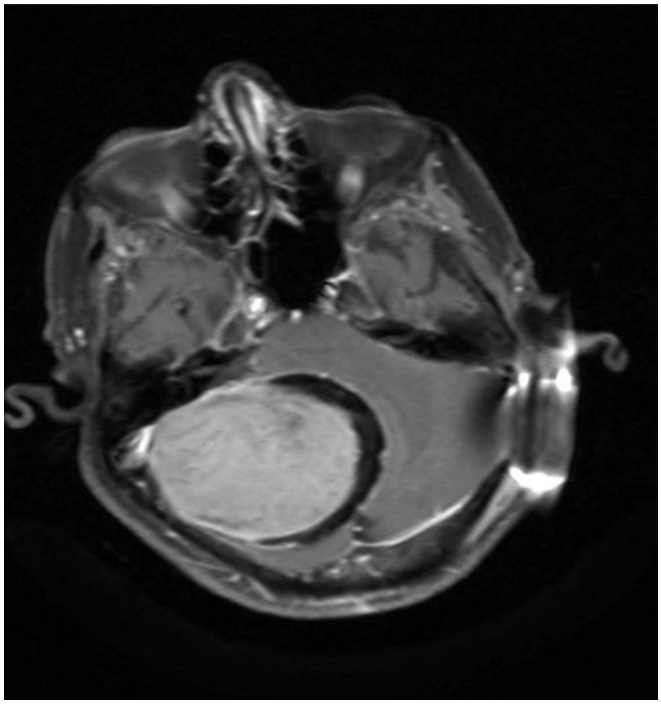
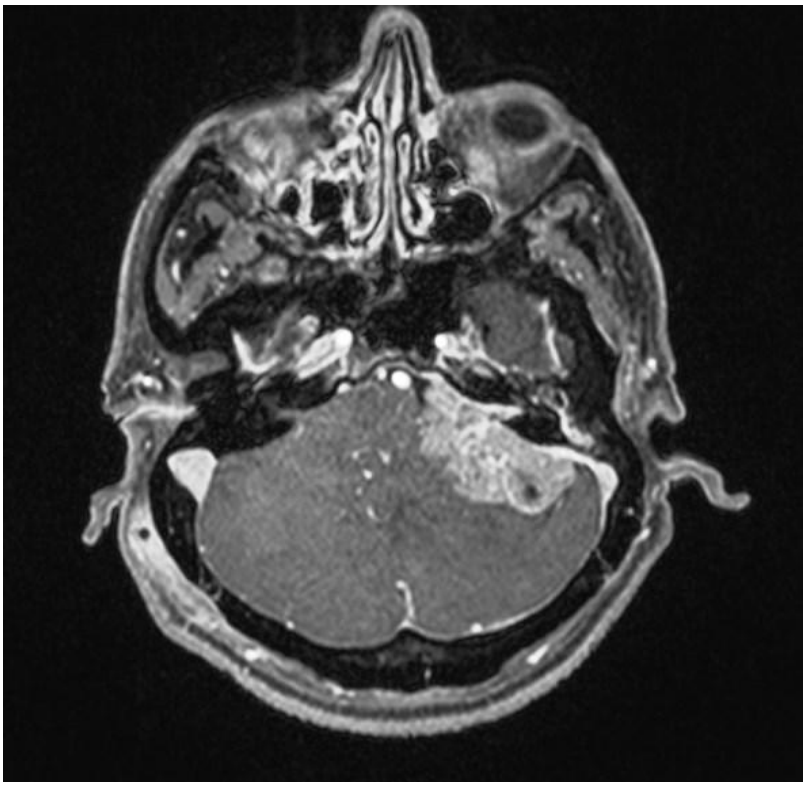


Fig 6.B)

Fig 6.C)



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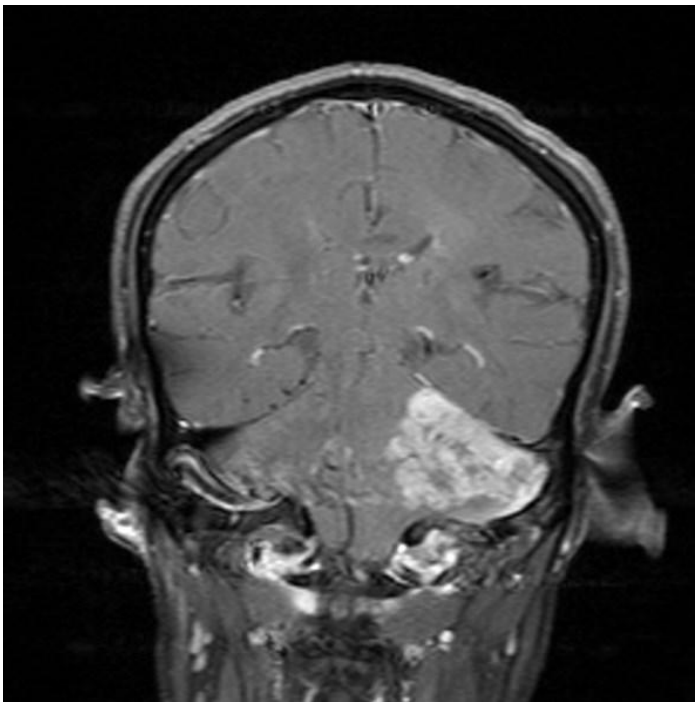

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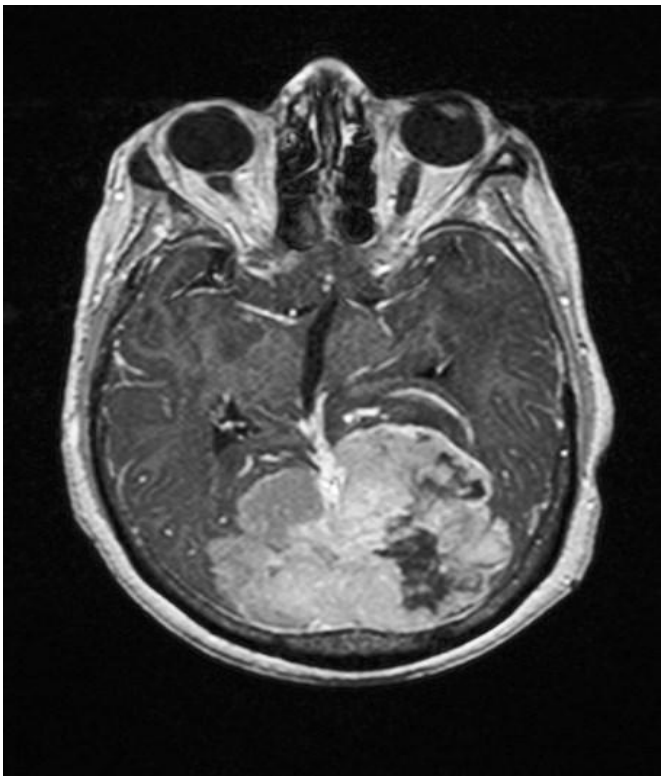

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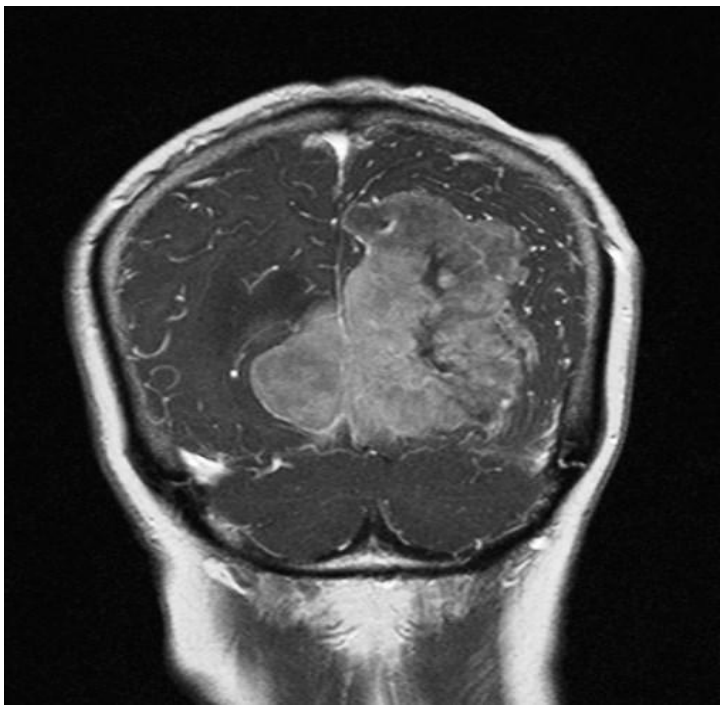

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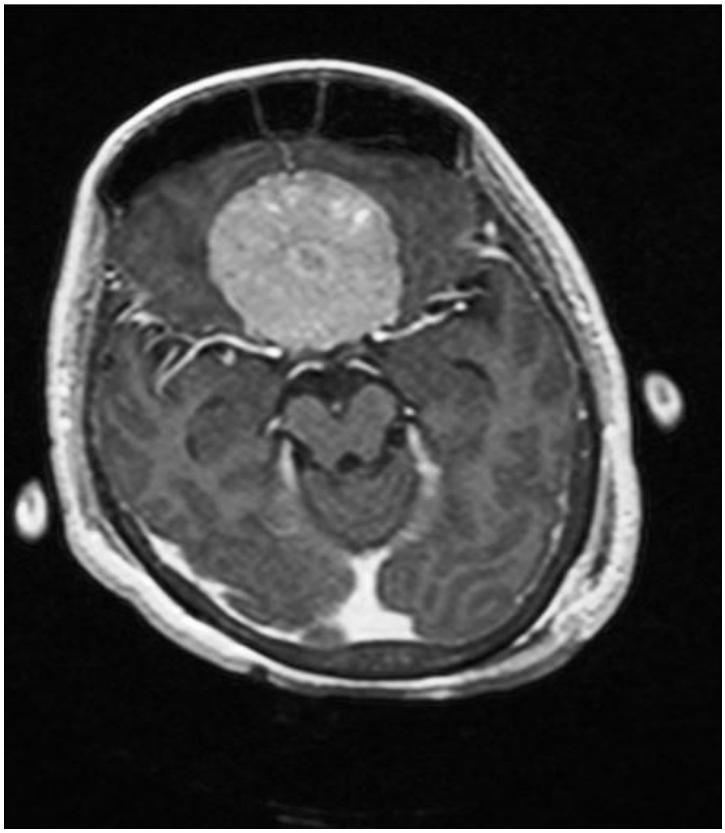

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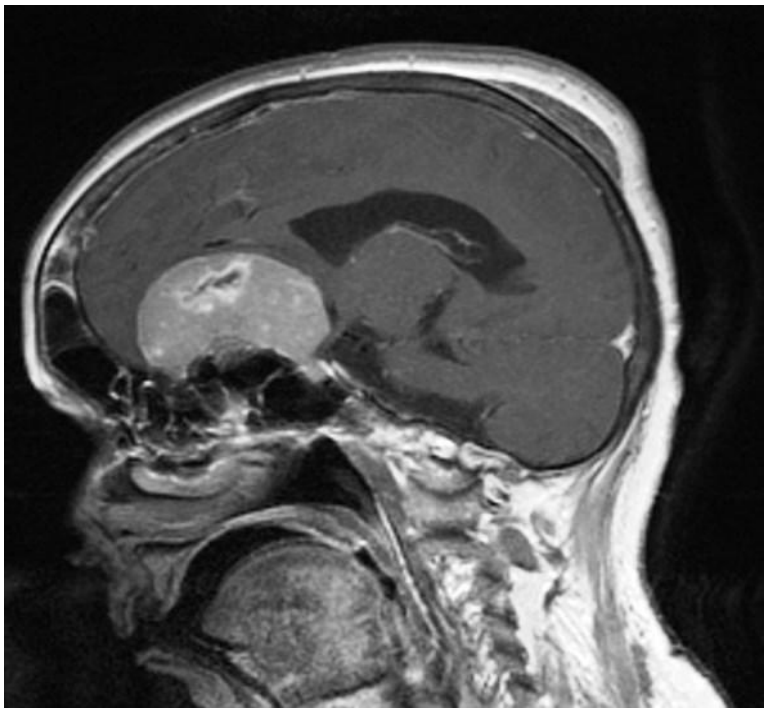

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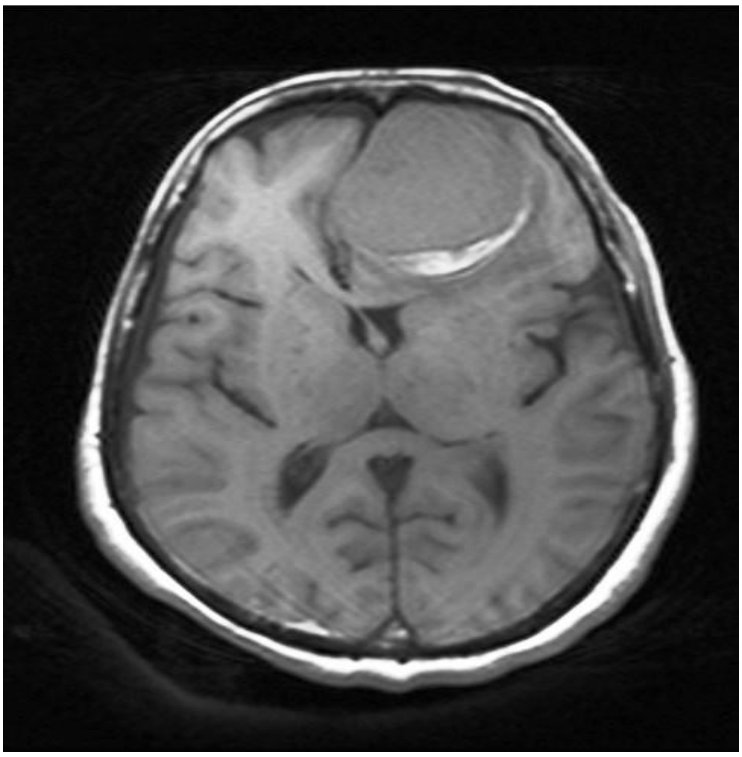

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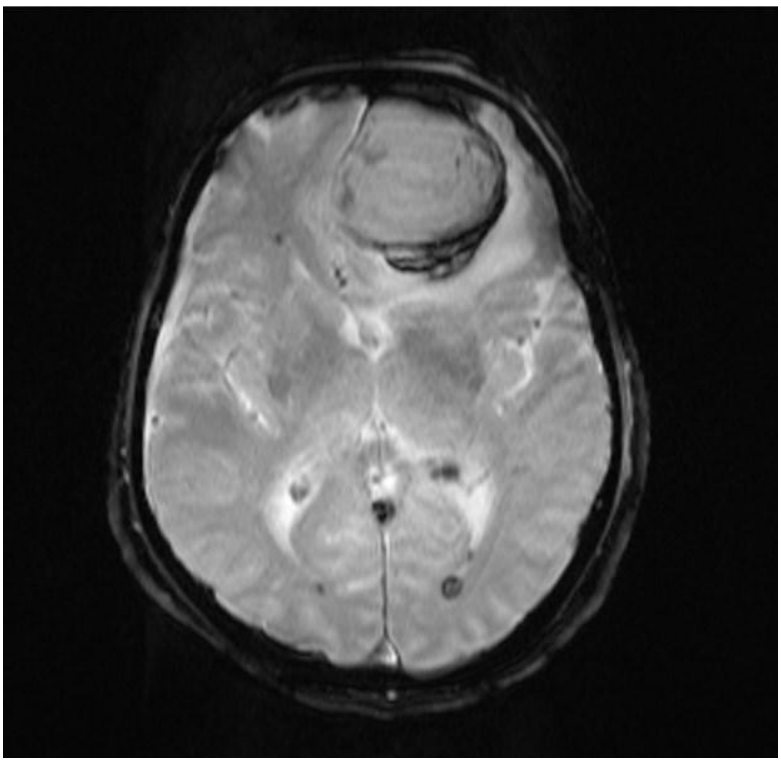

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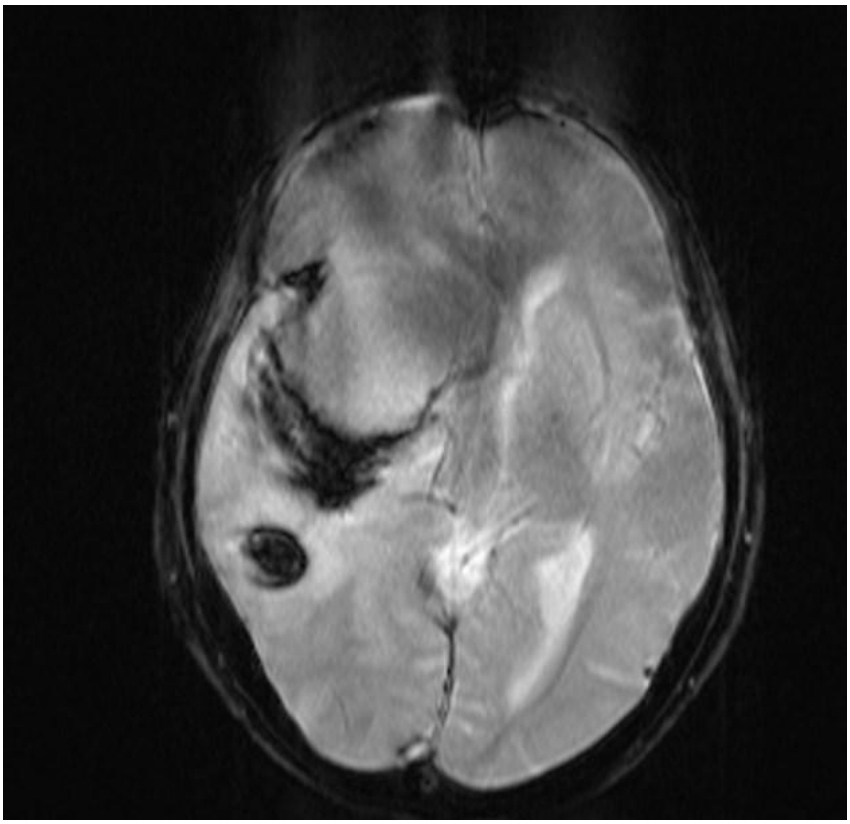

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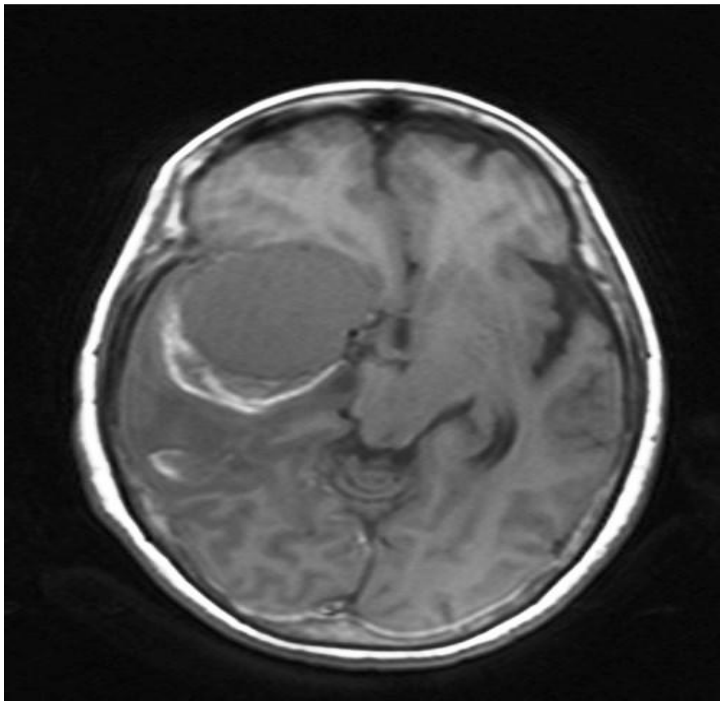

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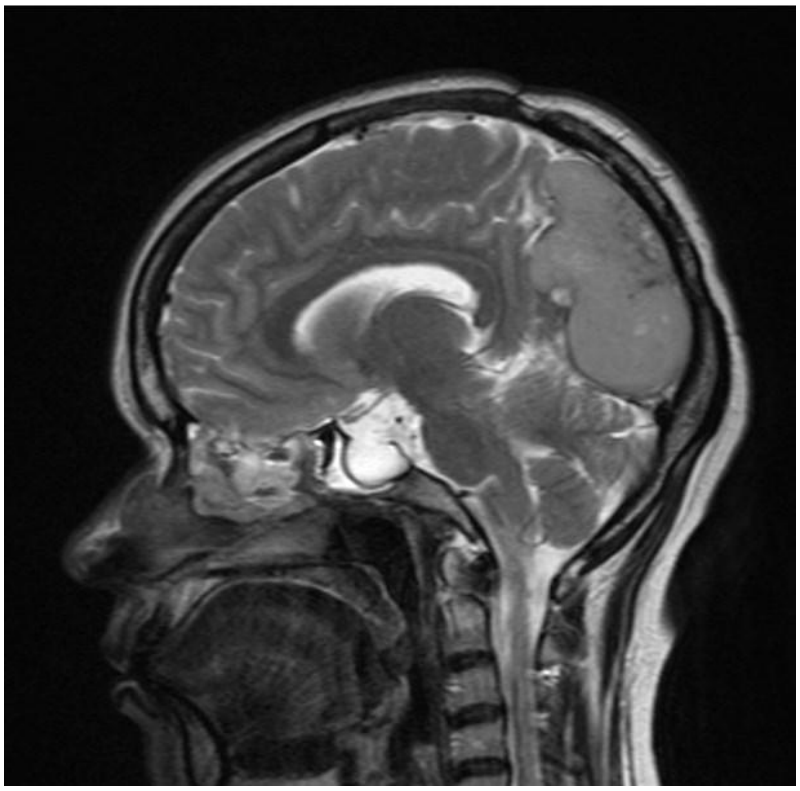

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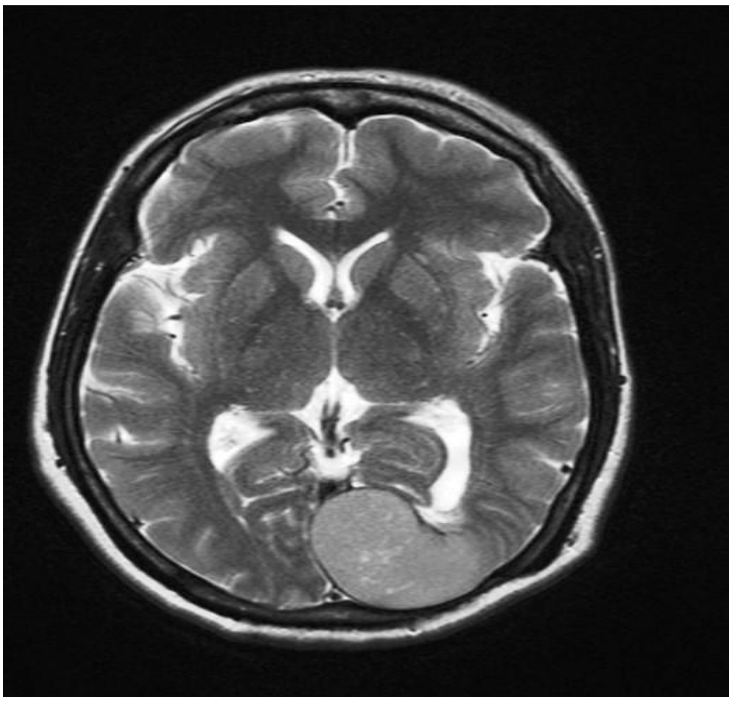

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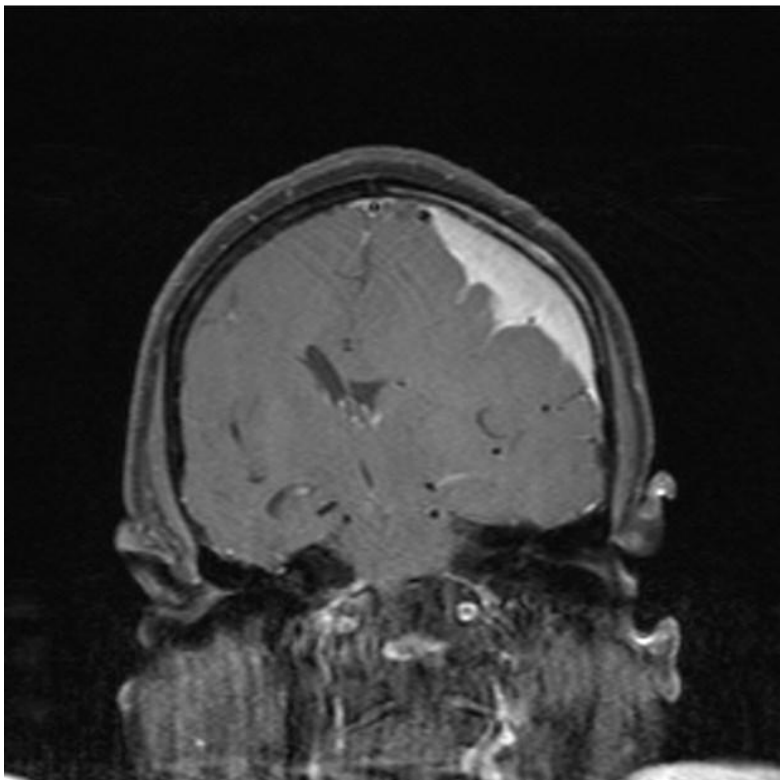

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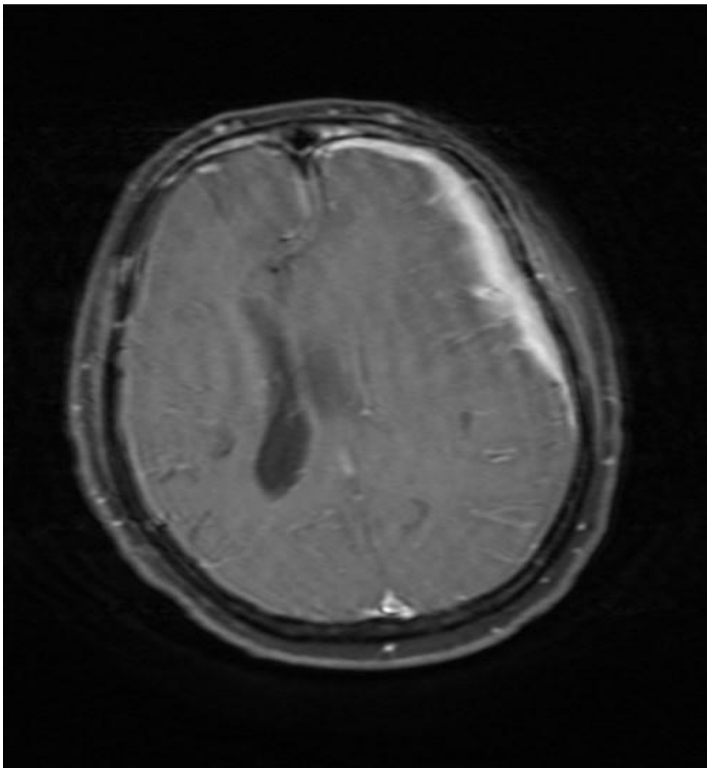

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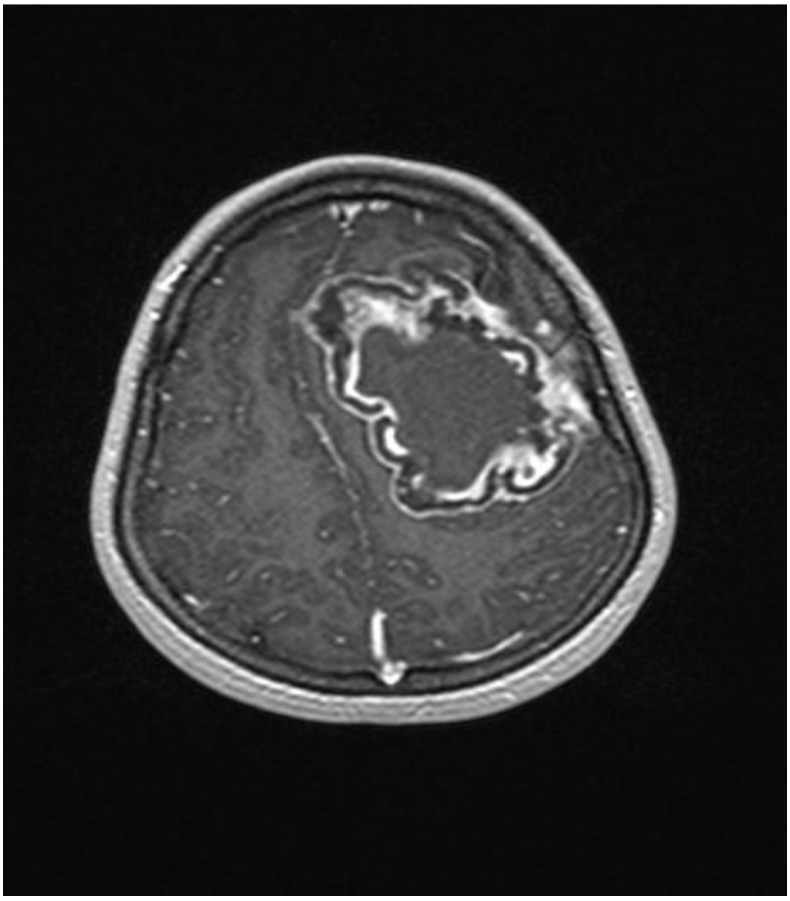

Fig 13.)

LEGENDS:
Fig 1 A & B: Contrast MR in axial & coronal planes show parasagittal meningiomas in two different cases.
Fig 2 A & B: Contrast MR show lateral convexity meningiomas in two different cases
Fig 3 A & B: contrast MR shows sphenoid wing meningioma
Fig 4 A,B.C: Axial MR show meningioma in middle cranial fossa in different cases
Fig 5 A & B: Meningioma at Sella turcica
Fig 6 A & B: Peripherally calcified posterior fossa meningioma
Fig 6 C: Left posterior fossa meningioma
Fig 7 A & B: Left CP angle meningioma
Fig 8 A & B: Meningioma from falx& tentorium
Fig 9 A & B: Bifrontal Meningioma
Fig 10. A& B: Parasagittal meningioma with peripheral hemorrhage
Fig 10).C & D: Right middle cranial fossa Meningioma with intra tumoral hemorrhage & intracerebral hemorrhage
Fig 11.) A &B : left parasagittal Recurrent Meningioma
Fig 12) A & B: Left frontoparietal enplaque meningioma
Fig 13) :Meningioma with cystic changes & hyperostosis

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