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Imaging of Intracranial Space Occupying Lesions: A Prospective Study in A Tertiary Care Centre in Northern India

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Abstract
Introduction: *The high morbidity & mortality associated with ICSOLs necessitates their early diagnosis so as to plan the required intervention. Intracranial Space occupying lesions (ICSOL) can be neoplastic, inflammatory or infective in aetiology. Widely available imaging techniques, computed tomography (CT) & magnetic resonance imaging (MRI) are used to detect these lesions. This study was done to evaluate the ICSOL on neuroimaging & correlate the clinical findings with the radiological assessment.*
Methods: *In this prospective cohort study, 80 patients with ICSOL were studied by CT & MRI. Imaging findings were evaluated & tabulated & correlated with the clinical findings & histopathological findings (wherever available). The findings were statistically analyzed.*
Results*: Most patients were in age range of 31 – 50 years (mean 42.2 y). Male : females ratio was 3:2. Most common presenting symptom was headache. Solitary lesions were present in 58 patients (72.5%) and multiple lesions in 22 patients (27.5%). 76.2% lesions were supratentorial & 23.7% infratentorial in location. 76.2% patients were having neoplastic lesions and 23.7% had non-neoplastic lesions. Metastases were the most common neoplastic lesion while among non neoplastic lesions, arachnoid cysts were the most common. Mass effect was the most common associated imaging finding. For neoplastic lesions the imaging sensitivity was 90%, specificity was 57%, accuracy was 84.2%, PPV was 90% and NPV was 57%. While for the non neoplastic lesions imaging sensitivity was 57%, specificity was 90%. accuracy was 84.2%, PPV was 57% and NPV was 90% (95% CI). There was weak positive correlation (phi coefficient 0.41) between clinical and imaging findings.*
Conclusion: *Neuroimaging in combination with clinical findings can be helpful in early diagnosis and localization of ICSOL. Imaging can be predictive of the aetiology of the ICSOL. Due to the small size and inherent bias in this study a larger epidemiological study is indicated.*
Keywords*: ICSOL ,Clinical presentation, CT, MRI,*

I. Introduction

The term "intracranial space occupying lesions" is defined as any neoplasm, benign or malignant, primary or secondary, as well as any inflammatory or parasitic mass lying within the cranial cavity. It also includes haematomas, different types of cysts, & vascular malformations.[1]

Different authors have reported that majority of patients of ICSOL had neoplasms followed by infective & traumatic etiology.[2,3] Gliomas are more common followed by meningiomas, abscesses, pituitary tumors & tuberculoma. [4]

Pediatric brain tumors are most commonly located in the infratentorial region as compared to supratentorial region.[5] Intracranial lesions can present with seizures, focal neurological deficits, raised ICP, or endocrine dysfunction, or can be incidental findings.[6] Neurological symptoms produced by brain tumors are general & focal. General symptoms results from increased intracranial pressure, which results directly from progressive enlargement of the tumor within the limited volume of cranial vault; local symptoms are due to the effects of the tumor on contiguous areas of the brain. Increased intracranial pressure produces headache, vomiting, impaired vision & changes in consciousness.[7]

The goals of diagnostic imaging in the patient with suspected intracranial masses include [8] :-*detection* of the presence of a mass, -*localization* of the extent of the mass (including definition of involvement of key structures & assessment of the presence & severity of secondary changes, e.g., edema, herniation, hemorrhage)-*characterization* of the nature of the process.

Due to large number of conditions contributing to intracranial space occupying lesions one has to assess the patient clinically as well as distinguish between neoplastic & non-neoplastic nature of the lesion as detected on neuroimaging (CT/MRI). Due to paucity of data in our geographical region present study was

undertaken to assess the clinical presentation and imaging findings in patients with ICSOL along with histopathological correlation where ever available.

II. Methods

This prospective cohort study was conducted from October 2013 to June 2015 & included 80 patients referred by various clinical departments with clinical suspicion of intracranial space occupying lesions, evaluated by computed tomography & magnetic resonance imaging. After taking informed consent, a detailed clinical history was recorded of each patient & relevant clinical examination was done.

2.1 Inclusion criteria

- Presence of ICSOL on neuroimaging (CT/MRI).

2.2 Exclusion criteria

- Traumatic & non traumatic intracranial hematoma,
- Infarct & demyelinating lesions,
- Lesion size less than 2 cms
- Bony lesions of skull

2.3 Technique

Requested neuroimaging was done with prior explanation of the radiological investigation & informed written consent of the patient/relatives. CT was performed on Philips ingenuity core 128 multislice unit with axial, coronal and sagittal reconstructions of desired thickness of acquired data. CECT scans were performed after bolus injection of low osmolalaity non ionic iodinated contrast material. MRI scans were performed on 1.5T GE signa HDe 8 channel unit with acquisition of spin echo T1, T2, T2 Flair, SWI in desired planes and axial EPI- DWI & ADC maps. CEMRI was done post IV gadolinium (dose 0.1mmol/kg) injection with acquisition of TIW scans in three orthogonal planes. Imaging findings were evaluated & tabulated & correlated with the clinical findings & histopathological findings (wherever available) subsequently.

2.4 Statistical analysis:

Data were initially summarized into means, standard deviations (SD); mean±SD and percentages in a form of

comparison tables and graphs. Statistical analysis was performed using Microsoft Excel software and Standard Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 15 for windows. Sensitivity, Specificity, Positive predictive value, Negative predictive value were calculated. All probability values were two-tailed. Statistical significance was considered as $p<0.05$.

III. Results

Out of total 80 patients enrolled for study most patients were in age range of 31 – 50 years & the mean age was 42.2 years. 48 (60%) patients were male & 32 (40%) patients were females.

3.1 Symptoms & Signs

The main presenting symptoms were headache in 42 patients (57.5%), loss of consciousness in 23 patients (28.7%), 18 patients (22.5%) each were having seizure & vomiting. The most common clinical signs were altered sensorium in 26 patients (32.5%), behavioural changes in 18 patients (22.5%) & visual field defects in 14 patients (17.5%).

3.2 Multiplicity and location

Solitary lesions were present in 58 patients (72.5%) & multiple lesions in 22 patients (27.5%). 76.2% lesions were supratentorial & 23.7% infratentorial in location. Most common supratentorial location in adults was frontal lobe in 19.6% followed by parietal lobe 15.6%. Most common supratentorial locations in children were frontal lobe & sella in 20% each. Infratentorially, cerebellum (35%) & posterior fossa (40%) were found to be most common location in adults & children respectively. Supratentorial lesions were most common both in adults & children. 58.7% lesions were intraaxial & 41.2% extra axial in location. In adults, intraaxial lesions were more common than in children.

3.3 Incidence of lesion

76.2% patients were having neoplastic lesions & 23.7% patients had non-neoplastic lesions. Neoplastic lesions included metastases 20%, Astrocytomas 15%, Meningiomas 10%, Pituitary adenoma 8.7%, Glial tumors 7.5%, Schwannomas 5%, Hemangioblastomas 2.5%, Oligodendrogliomas 2.5% & Craniopharyngioma 1.2%

whereas Non-Neoplastic lesion included Arachnoid cysts 10%, Abscesses 8.7%, Hydatid cysts 2.5%, Tuberculoma 1.2% & Cavernoma 1.2%.

3.4 Imaging

CECT was done in 36 patients, out of which majority (55.5%) were having hypodense lesions & most common associated finding was mass effect (83.3%). CECT was done in 10 patients out of which 8 patients (80%) were having ring like pattern of enhancement. Unenhanced MRI, was done in 63 patients and majority of the lesions appeared hypointense on T1WI (73%), hyperintense on T2WI (74.6%) & hyperintense on FLAIR (38%) sequences with mass effect (79.3%) as most common associated findings. CEMRI was done in 50 patients & showed homogeneous enhancement in16 cases (32%).

3.5 Clinico-Radiological Concordance

It was done in 38 patients having histopathological reports and other investigations (e.g., pus culture examination/ Casoni test). Of this subgroup of 38 patients, provisional clinical diagnosis of neoplastic lesion was given in 26 cases and non-neoplastic lesions in 12 cases. (Table 1) While on neuroimaging, neoplastic lesions were diagnosed in 31 cases and non-neoplastic lesions in 7 cases.(Table 2)

Table 1 : Distribution of ICSOL on the basis of clinical diagnosis (N=38)

NEOPLASTIC	26
NON-NEOPLASTIC	12

Table 2 : Distribution of ICSOL on the basis of radiological diagnosis (N=38)

NEOPLASTIC	31
NON-NEOPLASTIC	7

Out of 31 suspected neoplastic lesions on imaging, 28 were confirmed on histopathological or laboratory findings. Calculated p value was 0.003 and result was statistically significant at $p<0.05$. Sensitivity was 90% and Specificity was 57%. Accuracy was 84.2%. Positive predictive value was 90% and Negative predictive value was 57%. (Table 3)

Table 3 : Statistical analysis of radio-pathological concordance in neoplastic lesions (using 2×2 table and calculating chi square test)

	HISTOPATHOLOGICAL		
IMAGING		NEOPLASTIC	NON-NEOPLASTIC
	NEOPLASTIC	28	3
	NON-NEOPLASTIC	3	4

Out of 7 suspected non neoplastic lesions on imaging, 4 were confirmed on histopathological or laboratory findings. Calculated p value was 0.003 & result was statistically significant at $p<0.05$. Sensitivity was 57% and Specificity was 90%. Accuracy was 84.2%. Positive predictive value was 57% and Negative predictive value was 90%. (Table 4)

Table 4: Statistical analysis of radio-pathological concordance in non-neoplastic lesions (using 2×2 table and calculating chi square test)

	HISTOPATHOLOGICAL		
IMAGING		NON-NEOPLASTIC	NEOPLASTIC
	NON-NEOPLASTIC	4	3
	NEOPLASTIC	3	28

Out of 26 clinically suspected cases of neoplastic lesions, 23 were confirmed on histopathological or laboratory findings. Calculated p value was 0.1 & result was not statistically significant at $p<0.05$. Sensitivity was 74.1% and Specificity was 90%. Accuracy was 71%. Positive predictive value was 88.4% and Negative predictive value was 33.3%. (Table 5)

Table 5 : Statistical analysis of clinico-pathological concordance in neoplastic lesions (using 2×2 table and calculating chi square test)

	HISTOPATHOLOGICAL		
CLINICAL		NEOPLASTIC	NON-NEOPLASTIC
	NEOPLASTIC	23	3
	NON-NEOPLASTIC	8	4

Out of 12 clinically suspected cases of non neoplastic lesions, 4 were confirmed on histopathological or laboratory findings. Calculated p value was 0.0004 & result was statistically significant at $p<0.05$. Sensitivity was 90% and Specificity was 74.1%. Accuracy was 71%. Positive predictive value was 33.3% and Negative predictive value was 88.4%. (Table 6)

Table 6: Statistical analysis of clinico-pathological concordance in non-neoplastic lesions (using 2×2 table and calculating chi square test)

	HISTOPATHOLOGICAL		
		NON-NEOPLASTIC	NEOPLASTIC
CLINICAL	NON-NEOPLASTIC	4	8
	NEOPLASTIC	3	23

Using Phi coefficient (+0.41); weak positive correlation between clinical & radiological findings of neoplastic & non-neoplastic lesions was noted. Calculated p value was 0.02 & result was statistically significant at $p < 0.05$. (Table 7)

Table 7 : Clinico-radiological correlation for both neoplastic & non-neoplastic lesion (using Phi coefficient)

	RADIOLOGICAL		
		-ve CONCORDANCE	+ve CONCORDANCE
CLINICAL	+ve CONCORDANCE	2	24
	-ve CONCORDANCE	5	7

IV. Discussion

The term ICSOL is generally used to identify any lesion whether neoplastic or inflammatory in origin which increases the volume of intracranial contents & leads to a rise in intracranial tension (ICT). The presentation of ICSOL has changed radically with increased availability of modern imaging techniques like CT & MRI.The age ranges from 1-90 yrs in present study. The peak incidence was in 5th decade (23.7%) followed by 3rd decade (17.5%) with male predominance & male to female ratio was 3:2 which was correlated with Madan AH et al study[9], majority of lesions were detected in the 4th & 5th decade with male to female ratio of 1.85:1.

In most of the cases in our study, more than one symptoms & signs were present. The commonest symptom was headache in 57.5%. The similar observation was seen in study by Benjarge PV & Kulkarni A [10] in which 55 patients had headache out of 80 patients and by Mahmoud MZ [3] in which 43% patients presented with headache. The second most common presenting complaint in our study was loss of consciousness in 28.7% whereas 16.2% & 14% patients in Benjarge PV & Kulkarni A [10] & Mollah N et al study[11] respectively had similar complaints. In our study, 22.5% patients were having seizure & vomiting. Seizures & vomiting were the third commonest symptom observed in 46.25% out of 80 patients in Benjarge PV & Kulkarni A study [10] whereas Mollah N et al found vomiting in 52% & seizures in 36%.[11]

The most common clinical signs was altered sensorium in 32.5% which was high as compared to Mollah N et al study[11], only 6% had altered sensorium. The second most common presenting sign in our study was behavioural changes in 22.5%, which was high as compared to Benjarge PV & Kulkarni A study [10] abnormal behaviour was observed in 8.75% cases.

In our study, 76.2% lesions were supratentorial & 23.7% infratentorial in location, which were corresponding to study by Chander R et al [12], having 79% supratentorial & 21% infratentorial lesions. Supratentorial was most common location both for adults & children. Most common supratentorial location in adults were frontal lobe in 19.6% followed by parietal lobe in 15.6%. Most common supratentorial location in children were frontal lobe & sella in 20% each. Infratentorially, cerebellum (35%) & posterior fossa (40%) were found to be most common location in adults & children respectively. Benjarge PV & Kulkarni A [10] found, parietal lobe (27.5%) as most common location which was not corresponding with our observation. Another study conducted by Jamjoom ZAB [13] found that the ratio of supratentorial to infratentorial lesions was lowest (1.1: 1) in children & young adults below the age of 20 years which was corresponding with our observation. Unlike other series of brain neoplasms which showed a higher incidence of infratentorial than supratentorial tumors in children [14,15] this study shows continuous predominance of the supratentorial location throughout all age groups. Because of the small number of pediatric brain tumors in this series, this finding may not be definite. [13]In our study, 58.7% lesions were intraxial & 41.2% extraxial. In adults. intraaxial lesions were more common than in children. Chander R et al [12] study concluded that 64% lesions were intra-axial & 15% extra-axial, which was corresponding to our study.

4.1 Incidence Of Lesion

In present study the incidence of different lesions were as follows.

4.1.1Neoplastic (76.2%): metastases 20%, Astrocytomas 15%, Meningiomas 10%, Pituitary adenoma 8.7%, Glial tumors 7.5%, Schwannomas 5%, Hemangioblastomas 2.5% & Oligodendrogliomas 2.5% & Craniopharyngioma 1.2%

4.1.2Non-Neoplastic (23.7%): Arachnoid cysts 10%, Abscesses 8.7%, Hydatid cysts 2.5%, Tuberculoma 1.2% & Cavernoma 1.2%.

The above findings of incidence were corresponding to study of Goyani BR et al [16], that metastases were the most common single group of ICSOL (27%). In another study conducted by Jamjoom ZAB [13] on 192 cases in which Neuroepithelial tumors comprised 39.7% of all intracranial neoplasms, followed by meningiomas (22.8%), pituitary adenomas (16.8%), metastatic tumors (8.2%), malformative tumors (4.3%), & neurinomas (3.8%). In the study conducted by Mustafa ZM [3], he found 77.2% tuberculoma & 22.7% abscesses out of 22 non-neoplastic cases which was not corresponding with our study in which arachnoid cysts & abscess were most common non-neoplastic lesions.

4.2 Radio-Pathological Corrrelation

For neoplastic lesions neuroimaging had sensitivity of 90%, Specificity was 57%, PPV was 90% and NPV was 57%. While for the non neoplastic lesions imaging sensitivity was 57%, specificity was 90%, PPV was 57% and NPV was 90%. (95% CI). Accuracy was 84.2% in both types of lesions. Calculated p value was 0.003 & result was statistically significant at $p < 0.05$. These findings are in partial agreement with Zacharaki EI et al study [17] which concluded that imaging accuracy, sensitivity, & specificity for brain masses were 85%, 87%, & 79% respectively.

4.3Clinico-Pathological Correlation

For neoplastic lesions, Sensitivity was 74.1%, Specificity was 90%, Accuracy was 71%, Positive predictive value was 88.4% & Negative predictive value was 33.3%. Calculated p value was 0.1 & result was not statistically significant at $p < 0.05$. For non-neoplastic lesions, Sensitivity was 90%, Specificity was 74.1%, Accuracy was 71%, Positive predictive value was 33.3% & Negative predictive value was 88.4%. Calculated p value was 0.0004 & result was statistically significant at $p < 0.05$. Our study was closely correlated with Rathod V et al [2] study of 52 cases, the clinico-radiological & clinico-pathological correlation of ICSOL was founded in 61.5%.

4.4Clinico-Radiological Correlation

Phi coefficient for both neoplastic & non-neoplastic lesions was +0.41 (p value was 0.01 which was statistically significant at $p < 0.05$). This indicates the weak positive agreement between the clinical & radiological findings. The findings could not be substantiated with literature due to paucity of data.

V. Conclusion

Intracranial space occupying lesions comprise of a diverse group of lesions. With the introduction of CT & MRI scanning, imaging of lesions has acquired a new dimension whereby excellent anatomical detail in axial, sagittal & coronal planes as well as lesion characterization has become possible. These modalities have helped in the early diagnosis & localization of the SOL and in complement with advanced neurosurgical techniques, have brightened the prognosis of mass lesions. Since this study was hospital based with interval-bias with a small sample size; a larger population based study & histopathological correlation are warranted for confirmation of our findings

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FIGURES

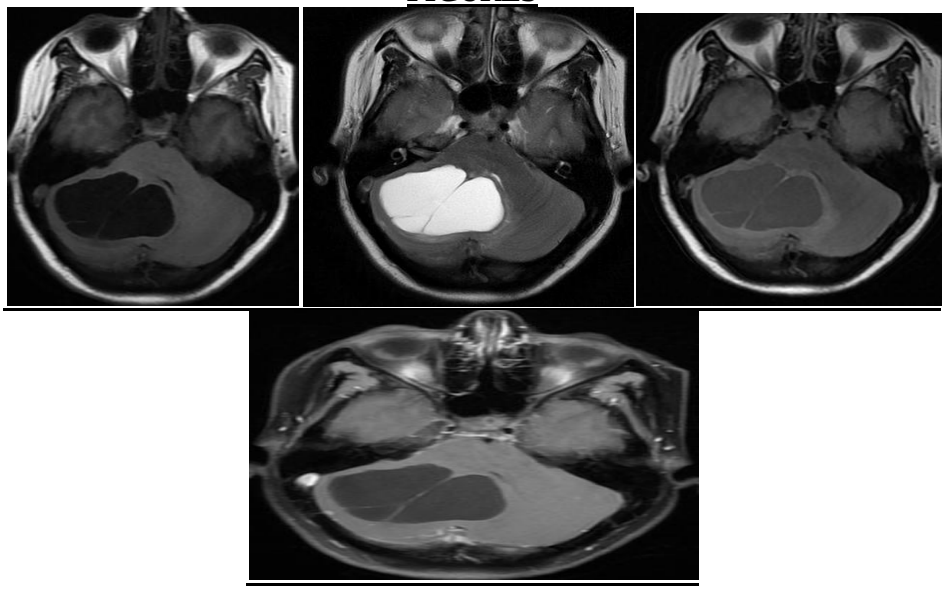

Figure 1: Ax TI/T2/FLAIR/C+ : showing multiseptated cystic lesion appearing TI hyperintense & T2 hypointense in right cerebellum extending into left cerebellar hemisphere & compressing 4th ventricle with mild perilesional oedema. On PCI, lesion shows faint septation enhancement suggestive of pilocytic astrocytoma

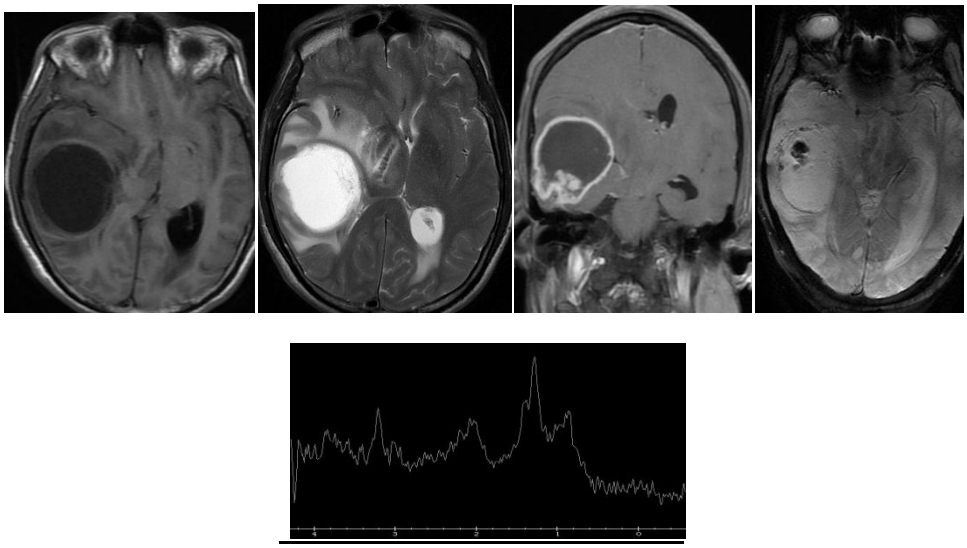

Figure 2: AX T1/T2, COR C+ GRE images: showing large SOL in right temporal region with predominately cystic component with thick irregular enhancing rim & an enhancing solid nodular component which is also showing blooming on GRE with significant perilesional oedema. MRS showing increased choline & lactate peak suggestive of glioblastoma multiforme.

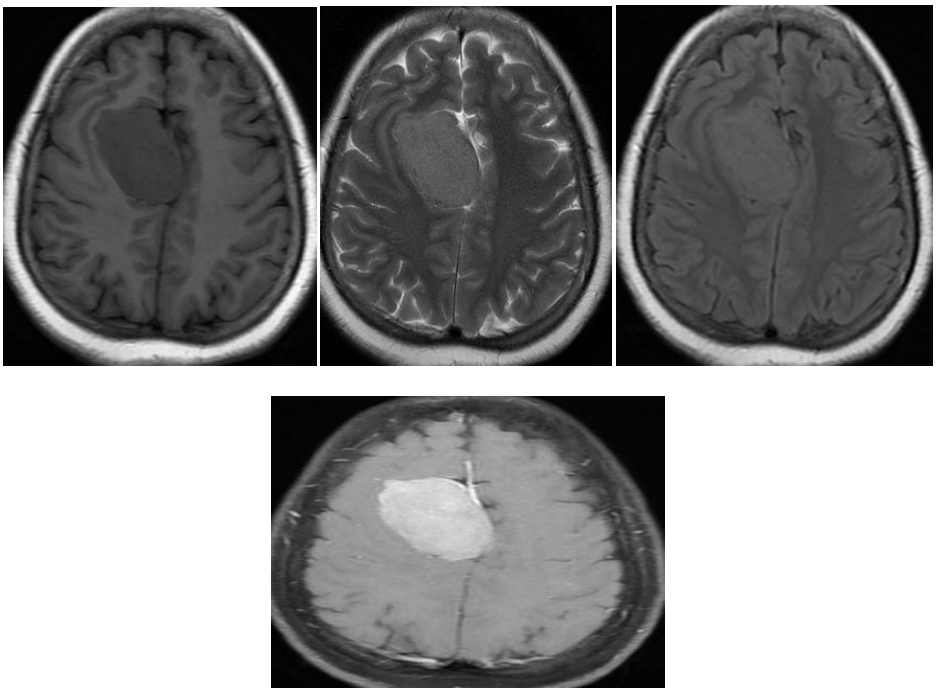

Figure 3: AX T1/T2/FLAIR/C+ Images: shows extraaxial mass lesion appearing isointense on T1/T2/FLAIR images in right frontal parasagittal in location with midline shift. CSF cleft is noted along the interface SOL & brain. On PCI, intense homogeneos enhancement is seen with adjacent enhancing dura (Dural Tail sign)

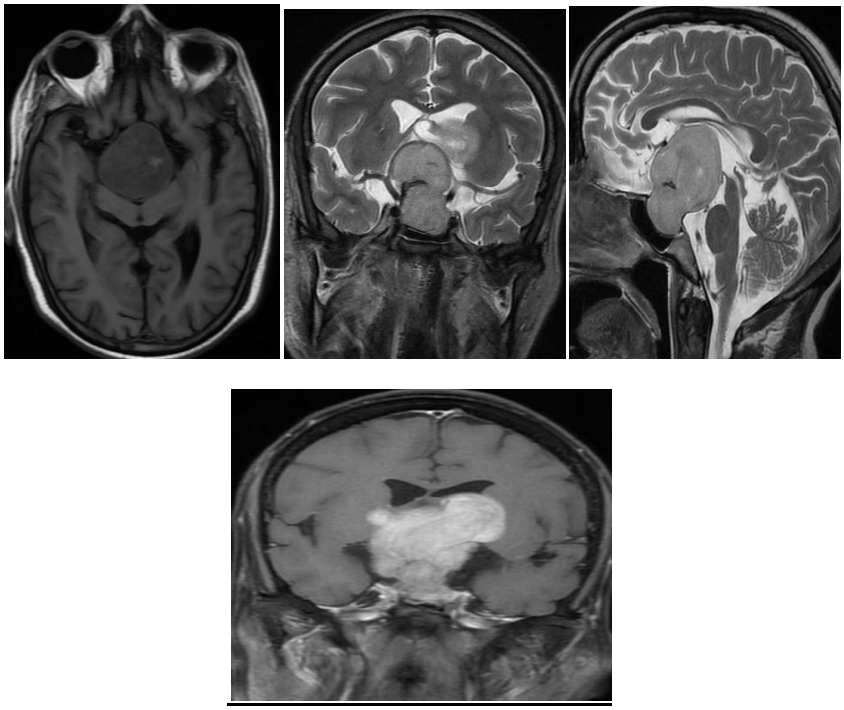

Figure 4: AX T1, COR T2 & SAG T2 Shows Sella & Suprasellar mass lesion causing mass effect in the form of effacement & compression of optic chiasma, encasing ICA, compressing midbrain & splaying of midbrain. SAG C+ & AX C+ shows diffuse homogeneous enhancement suggestive of pituitary macroadenoma.

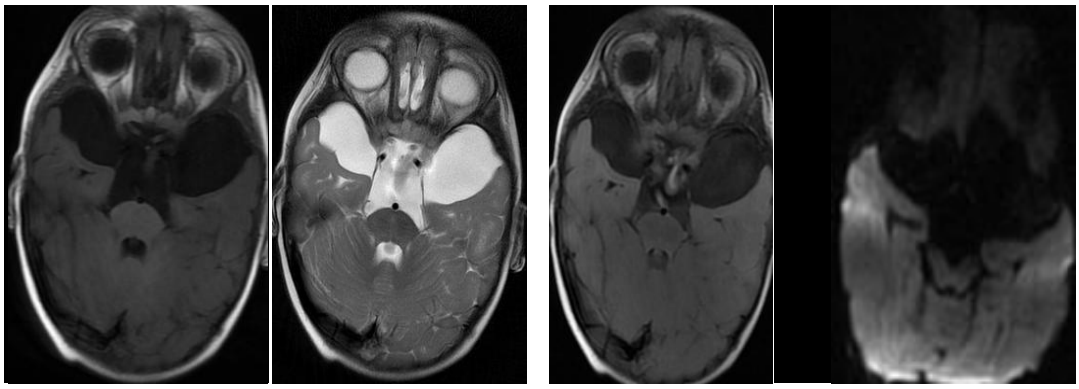

Figure 5: AX T1/T2/FLAIR/DWI image: showing ill defined CSF intensity SOL involving suprasellar, parasellar space & extension into bilateral MCF, sylvian cistern & interpeduncular cistern with possible encasement of ICA, MCA, bilateral PCOM, PCA, circle of willis, pituitary stalk, optic chiasma & causing elevation & posterior displacement of 3rd ventricle. No evidence of restricted diffusion on DWI suggestive of large arachnoid cyst.

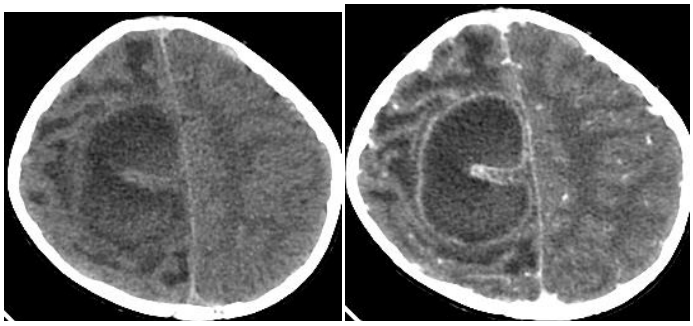

Figure 6: NCCT & CECT image showing well defined conglomerated hypodense lesion with hyperdense rim in right fronto-parietal region with perilesional oedema & midline shift. & post contrast image showing rim enhancement with leptomeningeal enhancement suggestive of cerebral abscess