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Role of MRI in Evaluation of Supratentorial Brain Neoplasms

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ABSTRACT
Aims &Objectives :-
To assess findings on MRI in cases of supratentorial brain neoplasms. 2. To study the distribution of various supratentorial neoplasms. 3. To study different radiographic patterns of supratentorial neoplasms evident on MRI. 4. To study various intracranial supratentorial neoplasms using contrast enhanced MRI scan. 5. To observe the usefulness of advanced MRI techniques like Diffusion Weighted Imaging (DWI) and Gradient Recalled Echo (GRE) in characterization of supratentorial neoplasms. 6. To determine anatomical site of origin and demarcate the extension of supratentorial brain neoplasms.
Material and Methods :-
This is a study of 50 patients referred to the department of radiodiagnosis with clinical history suspicious of intracranial pathology& underwent Magnetic resonance imaging. The study was performed on 1.5T SIEMENS MRI machine at GCS Hospital, AHMEDABAD over a period of 24 months from January 2021 to December 2022.
Results: *The present study included 50 cases of patients with supratentorial brain neoplasms.*
- *In our study most of patients were between 31- 60 years of age (53% of all patients) with largest group between 31-40 years (20% of all patients.*
- *The most common presenting symptom was Limb Weakness (28%) followed by headache (25%), Altered Consciousness (23%), seizures (20%) and vomiting (5%) respectively.*
- *Out of 50 cases of Supratentorial Neoplasms, 36(72%) were intra-axial lesions, 12 (23%) were extra-axial lesions and 2 (5%) were intra ventricular lesions.*
- *The Parietal lobe was most commonly involved part of brain in 26 patients. Many of these patients had simultaneous involvement of cerebral lobes and ventricles.*
- *In this study, 69% of the lesions were solitary and 31% were multiple.*
- *In present study on T1WI most of the tumors were predominantly hypointense (34 patients - 68%). Most of the lesions demonstrated predominantly hyperintense (38 patients –76%) signal on T2WI. Most of the lesions were non-suppressed on FLAIR images (28 patients - 57%). The lesions which showed suppression were chiefly lesions with cystic components.*
- *18 patients (37 %) of present study showed diffusion restriction on DWI and 23 patients (46%) showed blooming on Gradient images.*
- *In this study, 34 patients showed perilesionaledema and 32 patients showed mass effect. 37 % of the neoplasms (18 patients) showed necrotic components within the lesion probably due to high grade of tumor in many.*
- *Commonest type of supratentorial neoplasms were metastases comprising 29% of this study. Next most common type of neoplasms in this study was meningeal neoplasms having approximately 25% of cases.*

Conclusion: *All of the tumor lesions were demonstrated very well on MRI scans with magnificent sensitivity in detecting hemorrhage/calcification, necrosis, edema as well as extension of the tumors to other adjacent sites. Advanced MRI techniques like DWI and GRE have helped to diagnose all suspected malignant lesion non-invasively with fair accuracy which was not possible with CT scans. The salient advantages of MRI are its ability to tissue characterize the lesion, detect hemorrhage/calcification, necrosis and edema accurately, ability to differentiate malignant from benign lesions non-invasively and most importantly lack of ionizing radiation. Thus MRI assumes great diagnostic importance & it proves to be a valuable modality of imaging in evaluating the characteristics, distribution and assessing the extent of various intraaxial and extraaxial neoplasms in the supratentorial region.*
Keywords :*Supratentorial brain neoplasms, Magnetic resonance imaging (MRI),, neurological complaints*

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I. INTRODUCTION

MRI has earned recognition as the optimal screening technique for the detection of most intracranial pathologies including brain neoplasm. MRI scan is more accurate in diagnosing supratentorial brain tumors than CT as CT has the considerable disadvantage of beam hardening artifact and MRI has a unique ability of tissue characterization. Presence of various characteristics like hemorrhage, calcification, necrosis, edema, mass effect and neovascularization are all better evaluated with MRI than with CT scan. Introduction of various advanced MRI techniques like Diffusion weighted imaging (DWI) and Gradient recalled echo (GRE) has revolutionized the differentiation of malignant etiology from the benign ones. MRI sequences before and after intravenous administration of paramagnetic contrast agents provides inherently greater contrast resolution between structural abnormalities and adjacent brain parenchyma and has proved to be more sensitive in the detection of focal lesions of the brain.

II. MATERIAL AND METHODS

This is a study of 50 patients referred to the department of radiodiagnosis with clinical history suspicious of intracranial pathology& underwent Magnetic resonance imaging. The study was performed on 1.5T GE Signa Explorer MRI machine at GCS Hospital, AHMEDABAD over a period of 24 months from January 2021 to December 2022.

Relevant demographic data, history of illness and significant clinical findings of all patients were recorded. Previous investigations were reviewed.

The conventional protocol included T1W, T2W, and FLAIR sequences in axial, sagittal and coronal planes. Contrast medium was administered intravenously to all cases using Gd-DTPA, 0.1mmol/ Kg, given manually by a slow intravenous injection. Post contrast T1 weighted axial, coronal and sagittal sequences were performed. Echo-planar diffusion-weighted images (DWI) were obtained in all patients and were acquired with b values of 1000 seconds/mm² in 3 orthogonal gradient directions. Apparent diffusion coefficient (ADC) images were also generated to assess false-positive non diffusion-related effects on DWI.

Inclusion criteria:-Patients who are suspicious of any intracranial pathology.

Exclusion criteria :-

- Implanted electric and electronic devices are a strict contraindication to the magnetic resonance imaging, and in particular - heart pacemakers (especially older types), insulin pumps, implanted hearing aids, neurostimulators, intracranial metal clips, metallic bodies in the eye
- Metal hip replacements (old type), sutures or foreign bodies in other sites are relative contraindications to the MRI because they obscure the visualization of normal anatomy due to artifact effect.

II. RESULT

The present study included 50 cases of patients with supratentorial brain neoplasms. Following observations were made according to age, presenting symptoms and MR appearances of the various lesions and the study data was analyzed.

Table-1: AGE DISTRIBUTION

AGE (in years)	NO. OF PATIENTS	PERCENTAGE
1-10	1	1.53
11-20	1	1.53
21-30	4	10.76
31-40	10	20.00
41-50	8	15.38
51-60	9	18.46
61-70	7	13.84
71-80	5	9.23
81-90	5	9.23

In our study most of patients were between 31- 60 years of age (53% of all patients) with largest group between 31-40 years (20% of all patients). Youngest patient was 2 year old with Low Grade Glioma and the oldest patients were 5 in number, three of them having Metastasis and two having Meningioma.

Table No. 2 DISTRIBUTION ACCORDING TO THE PRESENTING SYMPTOMS

PRESENTING SYMPTOM	NO.OF PATIENTS	PERCENTAGE
Headache	12	24.61
Altered consciousness	11	23.08
Limb weakness	14	27.69
Seizures	10	20.00
Vomiting	3	4.61

The most common presenting symptom was Limb Weakness (28%) followed by headache (25%), Altered Consciousness (23%), seizures (20%) and vomiting (5%) respectively.

Table No. 3 DISTRIBUTION ACCORDING TO THE LOCATION OF THE LESION

LOCATION	NO. OF PATIENTS	PERCENTAGE
Intra-axial	36	72.30
Extra-axial	12	23.07
Intra-ventricular	2	4.61

Out of 50 cases of Supratentorial Neoplasms, 36(72%) were intra-axial lesions, 12 (23%) were extra-axial lesions and 2 (5%) were intra ventricular lesions.

Table-4: DISTRIBUTION ACCORDING TO THE PARTS INVOLVED

PART	NO. OF PATIENTS
Frontal lobe	21
Temporal lobe	22
Parietal lobe	26
Occipital lobe	5
Lateral ventricle	2
Others	8

The Parietal lobe was most commonly involved part of brain in 26 patients. Many of these patients had simultaneous involvement of cerebral lobes and ventricles. Next most common site of neoplasms was the Temporal lobe (in 22 patients). Decreasing order after it was Frontal – 21 patients, others (e.g. Basal Ganglia and Deep Peri-ventricular White Matter) – 8 patients and Occipital lobe – 5 patients and Lateral Ventricles – 2 patients.

Table-5: DISTRIBUTION ACCORDING TO THE NUMBER OF THE LESIONS

NO. OF LESIONS	NO. OF PATIENTS	PERCENTAGE
Multiple	15	30.76
Single	35	69.24

In this study, 69% of the lesions were solitary and 31% were multiple. Majority of multiple lesions were seen in cases of metastases and a few cases of meningioma.

Table-6: SIGNAL INTENSITY ON CONVENTIONAL MRI SEQUENCES

SEQUENCES	SIGNAL	NO. OF PATIENTS	PERCENTAGE
T1W	Hypointense	34	67.69
	Hyperintense	0	-
	Isointense	16	32.30
T2W	Hypointense	9	16.92
	Hyperintense	38	76.92
	Isointense	3	6.15
FLAIR	Non-supressed	28	56.92
	Supressed	22	43.07

In present study on T1WI most of the tumors were predominantly hypointense (34 patients - 68%). The heterogeneity of signal was attributed to presence of hemorrhage (mostly subacute) or calcification. Then followed isointense signal on T1WI which is seen mostly in cases of meningioma. Most of the lesions demonstrated predominantly hyperintense (38 patients –76%) signal on T2WI. The heterogeneity on T2WI was most probably due to necrotic or cystic components. Then followed hypointense and isointense lesions. Most of the lesions were non-suppressed on FLAIR images (28 patients - 57%). The lesions which showed suppression were chiefly lesions with cystic components.

Table-7: SIGNAL INTENSITY ON ADVANCED MRI SEQUENCES

SEQUENCES	SIGNAL	NO. OF PATIENTS	PERCENTAGE
DWI	RESTRICTION	18	36.92
	NO RESTRICTION	32	63.07
GRE	BLOOMING	23	46.15

18 patients (37 %) of present study showed diffusion restriction on DWI and 23 patients (46%) showed blooming on Gradient images.

Table –11: ENHANCEMENT

ENHANCEMENT	NO. OF PATIENTS	PERCENTAGE
Heterogenous	26	52.30
Homogenous	10	20.00
Rim	9	16.92
No enhancement	5	10.76

In my study most of patients (89%) showed some enhancement, most common being heterogeneous/inhomogeneous enhancement. 5 patients (11%) didn't show any enhancement which included mainly low grade neoplasms. Most common tumor to show intense homogenous enhancement was meningioma.

Table – 12: NECROSIS, EDEMA AND MASS EFFECT

	NO. OF PATIENTS	PERCENTAGE
EDEMA	34	67.69
MASS EFFECT	32	64.61
NECROSIS	18	36.92

In this study, 34 patients showed perilesionaledema and 32 patients showed mass effect. 37 % of the neoplasms (18 patients) showed necrotic components within the lesion probably due to high grade of tumor in many. They included metastasis, gliomas of higher grade.

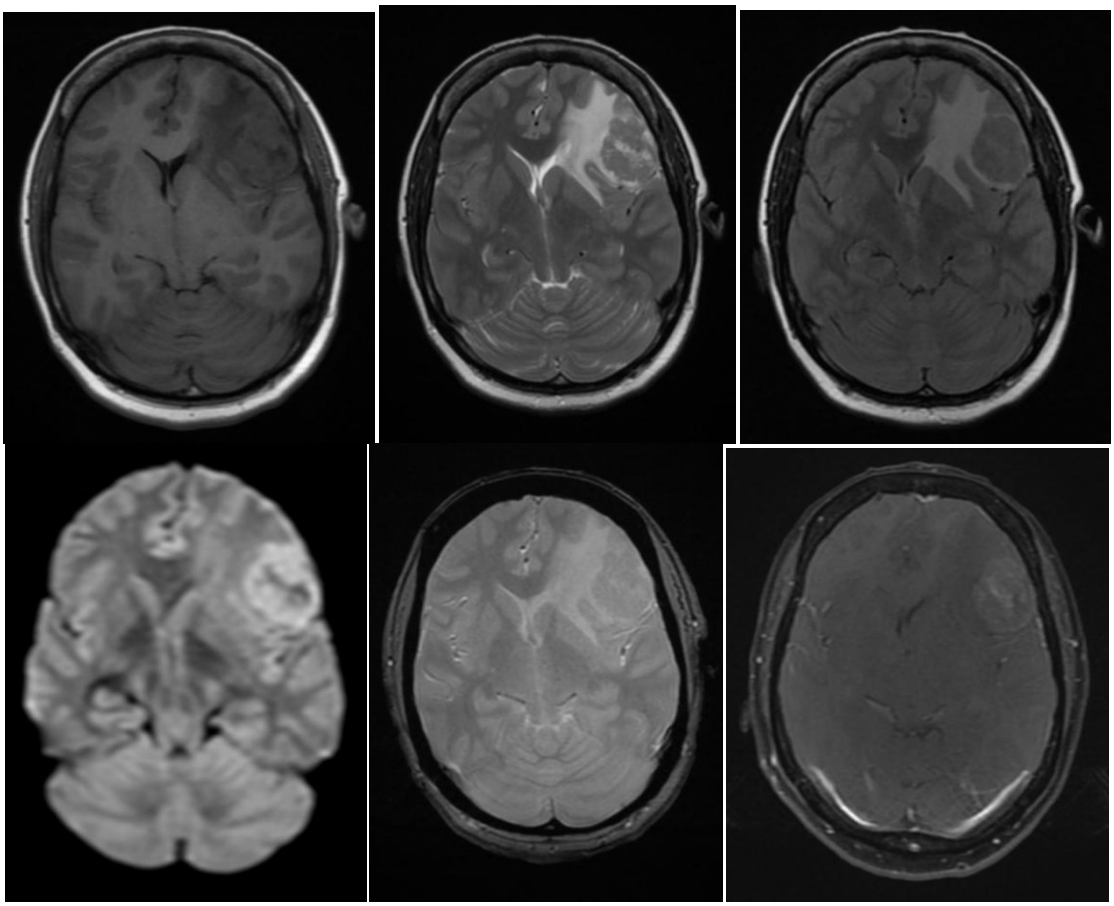
Table–13: DIAGNOSIS AND FREQUENCY OF DISTRIBUTION

	NO. OF PATIENTS	PERCENTAGE
Metastasis	15	29.23
Meningeal Neoplasm	12	24.62
High Grade Glial Neoplasm	11	21.53
Low Grade Glial Neoplasm	8	16.92
Neuronal & Mixed Glioneuronal Neoplasms	2	4.62
Hematopoietic	1	1.54
Mesenchymal Neoplasm	1	1.54

Commonest type of supratentorial neoplasms were metastases comprising 29% of this study. Next most common type of neoplasms in this study was meningeal neoplasms having approximately 25% of cases, which was comprised mostly by meningioma (9 cases) & other 3 cases showed atypical meningioma pattern. Next most common types were glial neoplasms having approximately 39% patients. Among 19 cases of glial neoplasms, on MRI approximately 11 cases were diagnosed with higher grade of neoplasms (majority of them were glioblastoma multiforme). Other 8 cases were diagnosed as low grade glial neoplasms. Other miscellaneous types were Neuronal & Mixed Glioneuronal Neoplasms (4.6%), Hematopoietic Neoplasm and Mesenchymal Neoplasm 1.5% each.

CASE 1 :METASTASIS

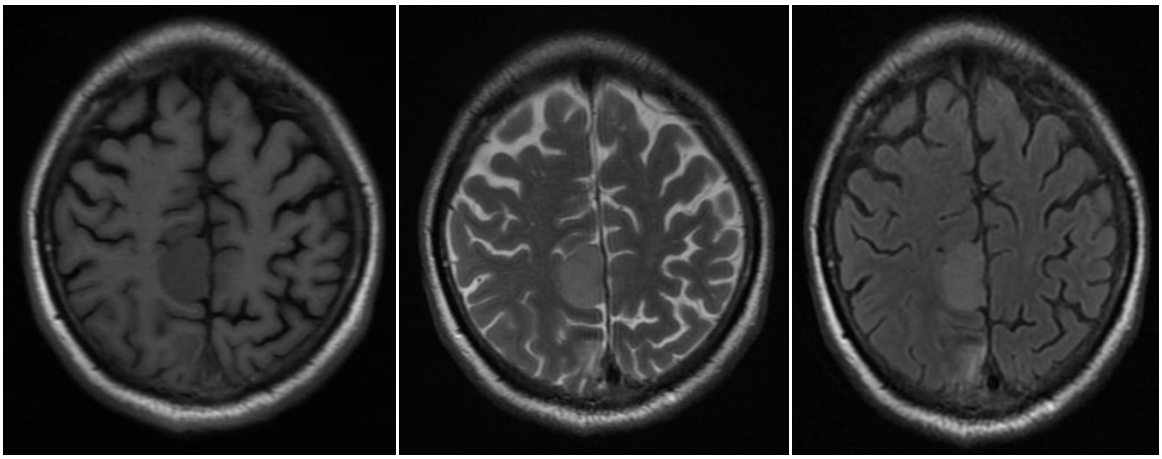
The images shown below are of a 45 year old female patient presenting with single episode of seizure before 3 weeks.(Clinical profile : Known case of Ca ovary, Post operative and chemotherapy status).

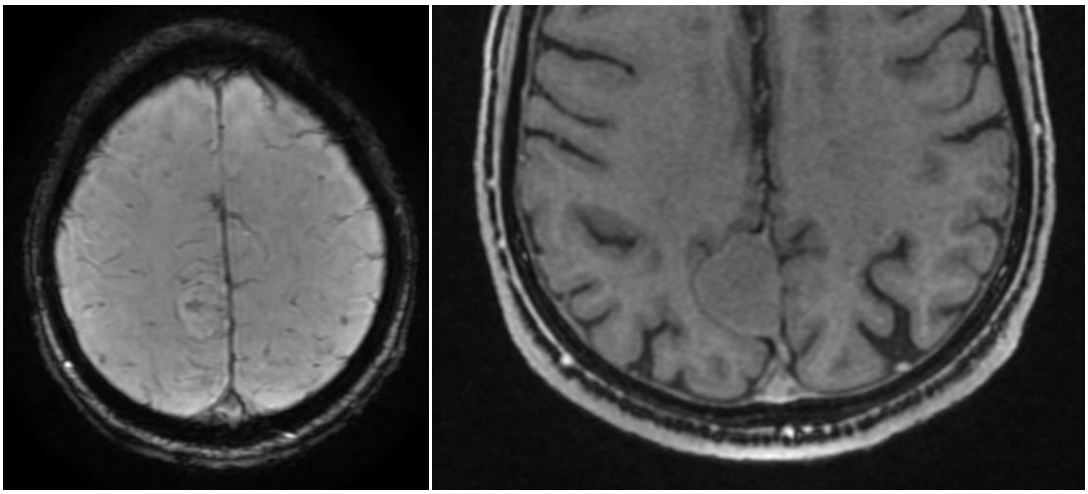


Altered signal intensity lesion involving left fontal region with moderate perilesional edema noted. It appears isointense on T1W, T2W and FLAIR images with few T2W central hyperintense components.
It shows diffusion restriction on DWI images.
On post contrast study, it shows heterogeneous enhancement.
There is compression effect noted over frontal horn of left lateral ventricle with mild contralateral midline shift.

CASE 2 :MENINGIOMA (FALCINE)

A 40 years old female patient came for MRI of brain with complaint of progressive increase in contralateral upper and lower limb hemiparesis since last 2 months.

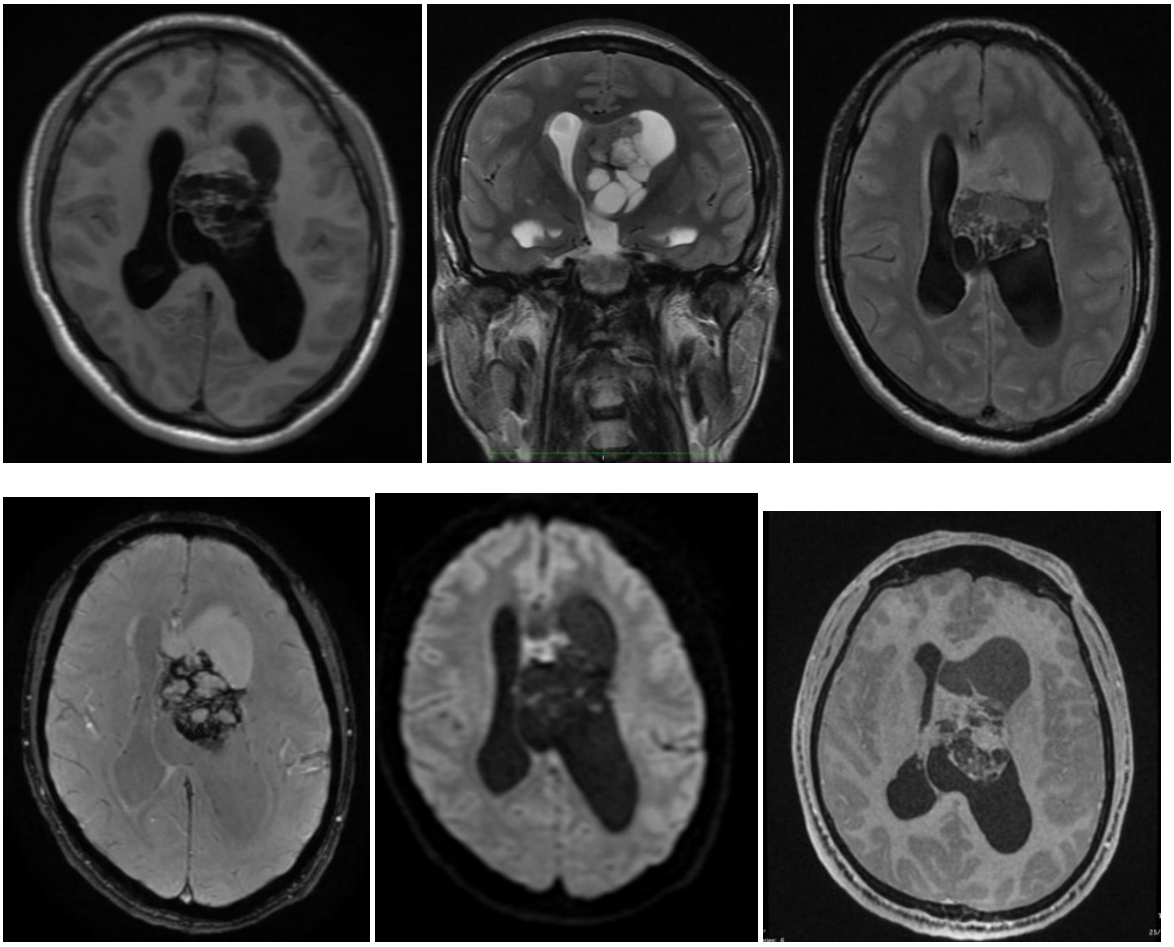




Extra-axial well defined dural based altered signal intensity lesion noted involving right parietal region along falx cerebri which appears isointense on T1W and iso to hyperintense on T2W and FLAIR images.
On DWI, the lesion does not show restriction.
On SWI, the lesion does not show blooming.
On post contrast study, the lesion shows homogenous enhancement with a dural tail.

CASE 3 :CENTRAL NEUROCYTOMA

A 28 year old male patient came with complaint of few episodes of vomiting since last week. A solitary solid-cystic lesion was seen involving foramen of monro on left side.



Presence of ill-defined multi cystic altered signal intensity with multiple septations , foci of calcifications and few hemorrhagic foci involving the body of left lateral ventricle in the region of foramen of monro abutting the septum pellucidum.

The lesion is heterogeneous on T2W with central hyperintensities , heterogenously hyperintense on T2W and FLAIR images.

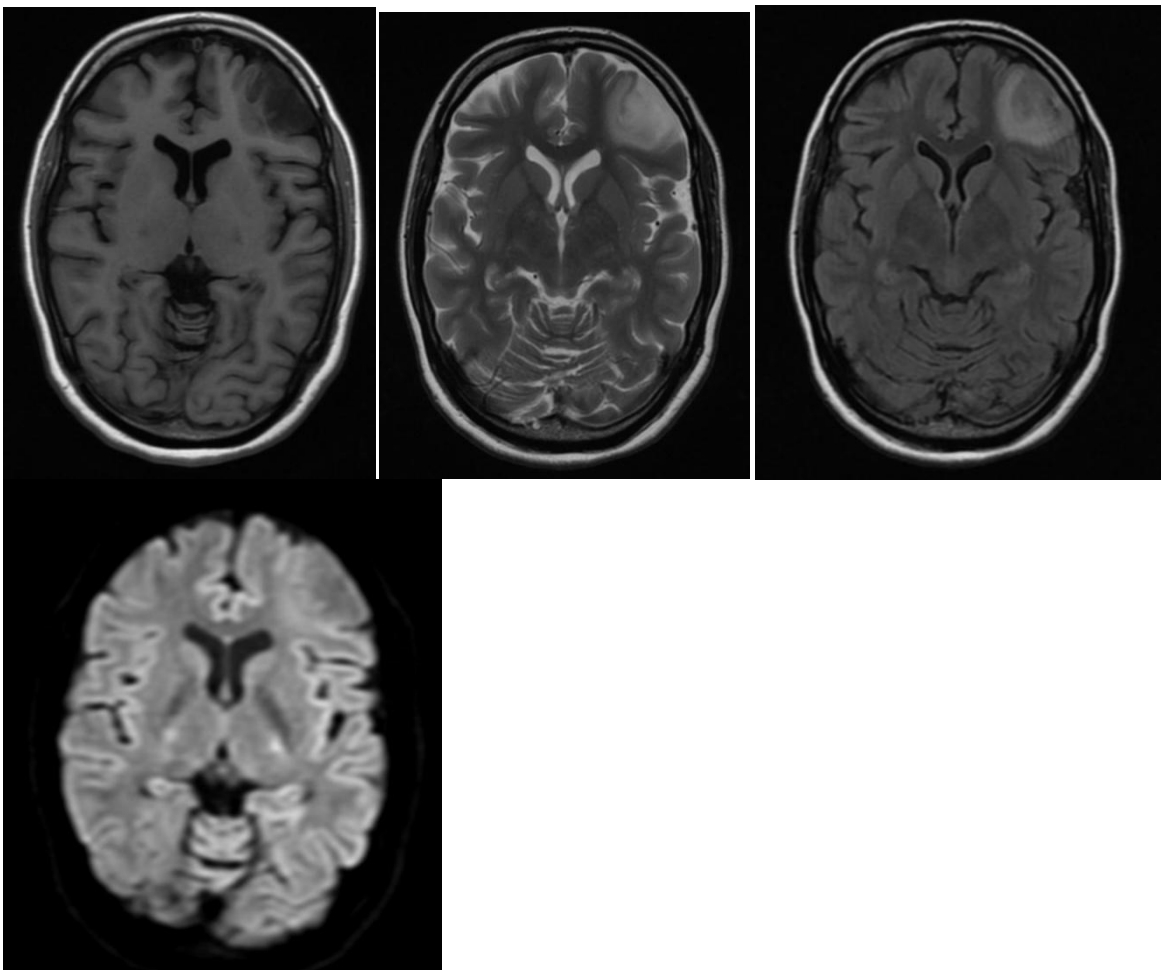
On SWAN, it shows internal septal blooming areas.

ON DWI, it is showing patchy areas of diffusion restriction.

The lesion causes dilatation of of left horn of lateral ventricle with mass effect on septum pellucidum causing displacement of septum and compression of right lateral ventricle. Interiorly it is extending into 3rd ventricle and causes effacement of aqueduct and proximal moderate hydrocephalus.
On post contrast study , it is showing minimal heterogenous enhancement of septa.

CASE 4: DNET

31-year-old female with seizures.



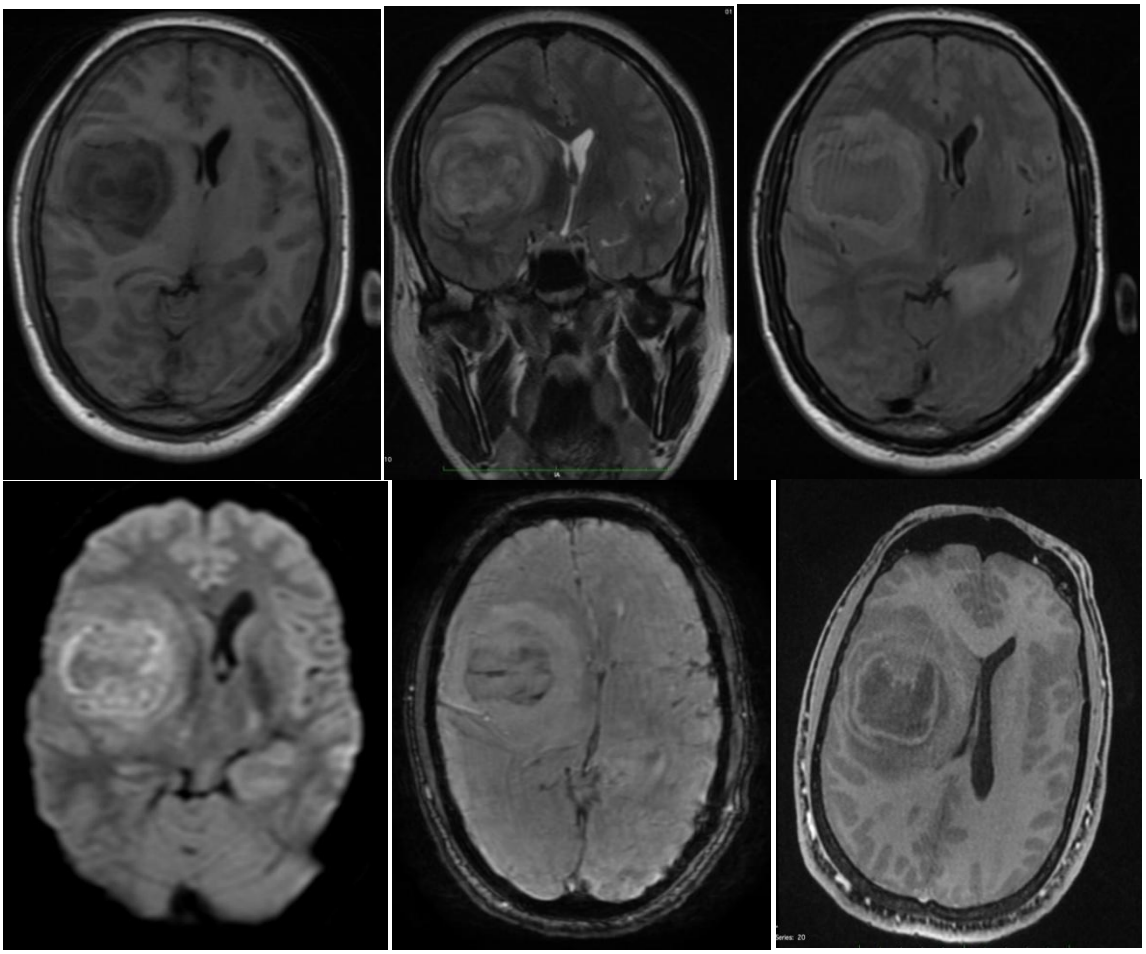
Altered signal intensity lesion involving cortical and subcortical region of left frontal lobe, which appears hypointense on T1W and hyperintense on T2W and FLAIR images showing minimal surrounding oedema.

On DWI the lesion does not show any restriction.
On SWAN images the lesion does not show any foci of blooming.

On post contrast study, the lesion shows minimal enhancement in its periphery.

CASE 5 : GLIOBLASTOMA MULTIFORME

An 34 years old male patient came for MRI brain with complaint of left sided hemiplegia since 2 weeks preceded by history of fall down before 15 days. Patient was a known case of Hypertension and is on regular medications since last 4 years.



Ill defined altered signal intensity lesion involving right parieto-fronto-temporal region, which appears heterogeneously hypointense on T1W and heterogenously hyperintense on T2W and FLAIR images.On DWI, it shows few patchy areas of diffusion restriction .On SWAN, few areas of blooming are noted.
Significant perilesional edema is noted as evident by T2W and FLAIR hyperintensity.
The lesion causes mass effect in form of effacement of sulci, compression over ipsilateral lateral ventricle and contralateral midline shift towards left by 10 mm.
On post contrast study, the lesion shows peripheral thick ring enhancement with few internal areas of heterogeneous enhancement.
Another similar ill defined altered signal intensity lesion involving left temporal lobe, left thalamus and hypothalamus which appears hypointense on T1W and hyperintense on T2W and FLAIR images.
On contrast study it shows subtle enhancement.
Findings raise p/o metastasis more likely.

IV. DISCUSSION

Metastases:

➢ In our study, metastases turned out to be the most common supratentorial neoplasm with age varying from 40 years to 85 years and a male: female ratio of 12:7. The overall mean age of presentation was 63.32 years whereas it was 64.83 years for male and 60.71 years for females.

➢ According to Potts et al (1980) study on 313 patients, metastatic lesions of brain showed most frequent sites involved were the frontal region, parietal region and posterior fossa. (1)

In our study, Metastatic lesions of brain showed most frequent sites involved were the parietal region followed by equal involvement of frontal and temporal region. Majority of the cases showed multiple lesions within the brain.

➢ The lesions were predominantly hypointense on T1WI and hyperintense on T2WI. On Post-contrast study, most lesions showed some enhancement with 7 patients each showing heterogeneous and peripheral rim like enhancement in respectively.

➢ On DWI, only 6 lesions demonstrated restriction of diffusion with low ADC values. However all lesions in the perilesional region showed normal or non- malignant spectra correlating with Tsougos I et al who also noticed similar findings. (2)

➢ Out of the 15 patients six patients had earlier underwent CT scans but they showed non-specific findings of benign or malignant etiology which were better imaged on MRI using contrast and advanced MRI techniques like Diffusion Weighted Imaging, correlating with Peter D. Schellinger et al. (3)

Meningeal Neoplasms:

➢ According to G Ramprakash, et al meningioma is overall most common intracranial tumor, representing 35% of all primary brain tumor. (4)

o In present study, meningioma is the second most common primary neoplasm representing approximately 35 % of all primary brain neoplasm with an age range of 37 years - 85 years and a mean age of 56.43 years. The male to female ratio was 3:5.

Most of the tumors were isointense on T1WI and hypointenseon T2WI. Majority of the tumors didn't show any suppression on FLAIR images and didn't show any restriction of diffusion on DWI.

➢ On Post Contrast study, 8 patients (66.6%) showed homogenous enhancement of the lesions with 4 patients (33.3 %) showing heterogenous enhancement due to necrosis& calcification. The degree of enhancement is dependent both on tumor vascularity and extracellular accumulation of contrast.

o Calcification in meningiomas occurs in the form of psammomatous calcification or patchy nodular calcification. Gradient images show blooming whenever the calcification is present. It is not always possible to differentiate between calcification and hemorrhage& between these two forms of calcification with confidence on MRI.

➢ Mahmood et al., reported that malignant and atypical meningiomas, although relatively uncommon and accounting for approximately 1.7% and 6.26% of all meningiomas, respectively.(5)

o In our study, 3 cases (25%) of atypical meningiomas were found and majority of them showed diffusion restriction with lower ADC values and patchy enhancement.

High Grade Glioma

➢ According to Van Dijken BRJ et al (2017), among 1174 cases of high grade gliomas, mean age was found to be 58 years with male predominance (61.3%). (6)

o In our study, among 19 cases of gliomas, 11 were high grade i.e. 56%. Majority of high grade gliomas were comprised of glioblastoma multiforme (GBM) with age varying from 14 years to 82 years and a male: female ratio of 1:1. The mean age of presentation was 49.71 years.

➢ The lesions were most commonly located in the temporal region followed by parietal, frontal and occipital region respectively. The lesions were invariably isointense to hypointense on T1WI and hyperintense on T2WI along with non-suppression on FLAIR images.

➢ According to Leeds NE in 1984 of the 100 patients, 71 were high grade glioma, all were found to have contrast enhancement.(7)

o As per our study of 11 cases of high grade glioma, all cases showed some contrast enhancement. Majority of them (9 patients) showed heterogeneous enhancement along with peripheral ring like enhancement in 2 patients. Contrast enhancement in the higher grade/malignant tumors is related to vascularity necrosis, pleomorphism and cellularity.

Neuronal and Mixed Neuronal Glial Tumors

➢ According to Al-Hajri et al (2017), mixed glioneuronaltumors having low grade behavior with temporal lobe predominance. Most common presenting symptoms were refractory seizures with age range between 4 - 34 years in DNET and 4 - 33 years in Ganglioglioma. They showed cases with "bubbly appearance" correlated with the specific glioneuronal element. Contrast enhancement was present in 25% of complex DNETs. (8)

o In present study, two patients of neuronal and mixed neuronal Glial tumors were seen of ages of 31 years and 23 years. 1 case was female (of DNET) and 1 case (of ganglioglioma) was male.

o All 3 patients came with complaints of seizures with invariably involving temporal lobe correlating well with Lee JW et al42 (9) and AlHajri et al. (8)

o The lesions showed hypointense on signal T1WI and hyperintense signal on T2WI without any areas of diffusion restriction on DWI. Ganglioglioma showed few areas of blooming within the lesion whereas DNET did not show any blooming on gradient images. Both lesions showed some contrast enhancement on Post Contrast study. DNET was seen having homogeneous contrast enhancement while Ganglioglioma showed heterogeneous contrast enhancement.

V. CONCLUSION

All of the tumor lesions were demonstrated very well on MRI scans with magnificent sensitivity in detecting hemorrhage/calcification, necrosis, edema as well as extension of the tumors to other adjacent sites. Advanced MRI techniques like DWI and GRE have helped to diagnose all suspected malignant lesion non-invasively with fair accuracy which was not possible with CT scans. The salient advantages of MRI are its ability to tissue characterize the lesion, detect hemorrhage/calcification, necrosis and edema accurately, ability to differentiate malignant from benign lesions non-invasively and most importantly lack of ionizing radiation. Thus MRI assumes great diagnostic importance & it proves to be a valuable modality of imaging in evaluating the characteristics, distribution and assessing the extent of various intraaxial and extraaxial neoplasms in the supratentorial region.

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