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Original Research Article.

To Assess the Diagnostic Accuracy of MRI in Intracranial Space Occupying Lesions

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ABSTRACT

Background: Intracranial space occupying lesions are a major cause of morbidity and mortality in the productive age-group of human beings. Non-specific and late-onset symptoms are often responsible for delay in diagnosis in majority of the cases. Imaging plays a pivotal role not only in the detection but also in accurate diagnosis of these lesions affecting management and further progress of the disease.

Advent of newer techniques in MRI like diffusion weighted imaging (DWI) and magnetic resonance spectroscopy (MRS) have prompted us to conduct this study comparing the role of imaging in reaching the final diagnosis in the present scenario.

Materials & Methods: Thirty patients of variable age and sex showing intracranial space occupying lesion on imaging were included in our study. Final MRI diagnosis was made using conventional & newer MRI techniques and the results were compared with the final histopathology / clinical diagnosis with follow-up. Additionally, the impact of newer MRI techniques on final diagnosis was also studied.

Results & Conclusion: Out of a total of thirty patients, histopathology could be achieved in 29 patients and the remaining one patient of tuberculoma was treated medically & followed up till near-complete resolution of the lesion. Peripheral ADC values on DWI and higher Cho:NAA & Cho:Cr ratios on MRS were found to be specific markers of malignancy and high-grade tumors. Though our study has a small sample size yet when conventional MRI technique was coupled with DWI & MRS, more than 90% sensitivity & specificity could be achieved.

Keywords: Accuracy, MRI, Intracranial Space Occupying Lesions, Diagnosis.

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INTRODUCTION

Intracranial tumors though uncommon yet are one of the most malignant tumors affecting humans and are often resistant to multiple treatment modalities.[1] Malignant brain tumors are major cause of mortality from solid tumors in children and 3rd most common cause of death due to cancer among 15 to 34 years old patients.[2,3]

The current neuroimaging standard for evaluating tumors of brain is anatomy-based magnetic resonance imaging (MRI) with intravenous contrast.[4,5] Since contrast-enhanced MRI (CE-MRI) does not completely depict the complicated biology of infiltrative brain tumors and has limited ability in differentiating a high-grade tumor from a single brain metastasis, hence anatomic MRI is non-specific. Grading tumors is relevant for determining the right treatment strategies[6,7] and assessing prognosis.[8]

High grade glioma is conventionally treated with resection followed by radiotherapy and chemotherapy while most low-grade glioma (LGG) requires only surgery.[9] WHO grading of glial tumors in brain includes low grade glioma, intermediate grade glioma and high grade glioma.

Astrocytoma is a histologically-heterogeneous group of tumor with variable amount of cellular and nuclear pleomorphism, mitotic activity, vascular proliferation, and necrosis.[4] They are generally divided in to 3 grades: low-grade, anaplastic astrocytoma and glioblastoma multiforme (GBM).[10] Though nowadays histopathology is considered as gold-standard in grading tumors using presence of one or more criterion, like "nuclear atypia, mitosis, vascular endothelial proliferation and necrosis"[7] yet it has some limitations which can be summarised as:

1. Since only a few small samples of tissue are assessed, particularly from stereotactic biopsy, the most malignant portion of a tumor may not be sampled.
2. Insufficient sampling if the tumor is not at all accessible for resection.
3. Numerous classifications / grading systems for brain tumors exist.
4. Dynamic nature of CNS tumors, with around half of them dedifferentiating into higher malignant grades.[10] WHO classification scheme is standard reference for guidance of treatment and prognosis among brain tumor patients.[10]

Development and use of different advanced MRI techniques, during last decade, has increased such as diffusion-weighted images (DWI), diffusion-tensor images (DTI) and fibre tractography, perfusion & permeability images, and proton-MR spectroscopy (MRS). Diffusion is defined "as the process of random molecular thermal motion occurring at a microscopic scale.[11] Diffusion imaging depends on diffusibility of protons which is inversely proportional to cellular density. Tumor grade increases with increase in cellular proliferation and angiogenesis. MRS assesses the biochemical environment of lesion which depends on cell turnover. MRS is a noninvasive technique of assessing the amount of various metabolites in brain.[4] Hence, in this study we focus on assessing the role of these newer MRI techniques in characterizing and grading intracranial space occupying lesions.

AIM& OBJECTIVES

- To evaluate the role of conventional MRI sequences (T1W, T2W, T2FLAIR & post-contrast T1W) in diagnosing intracranial space occupying lesions.
- To evaluate role of MR-Diffusion and MR Spectroscopy in diagnosing intracranial space occupying lesions.
- To compare the role of MR-Diffusion & MR Spectroscopy with conventional MRI sequences in intracranial space occupying lesions.
- To assess accuracy of Magnetic Resonance Imaging in the diagnosis of intracranial space occupying lesions.

MATERIALS & METHODS

The current study was conducted in the Department of Radiodiagnosis, Teerthanker Mahaveer Medical College & Research Centre after approval by the ethical research committee. Written informed consent was obtained from all the patients after explaining them about the nature of imaging modality used for their diagnosis.

The study was carried out over a period of 16-months, from January 2016 to June 2017. The study included 30 patients, who were referred to the department of Radiodiagnosis with suspicion of intracranial SOL, patients detected with intracranial SOL on CT and patients detected with intracranial SOL on MRI without advanced MR imaging.

The MR imaging protocol consisted of

Sequence	TE* (msec)	TR** (msec)	Field of view (cm)	Image Matrix	Slice thickness (mm)	Interslice Gap (mm)
T1 Axial	44	2500	230	256x256	5.0	1.5
T2 Axial	99	5000	230	320x320	5.0	1.5
T2 Coronal	99	5000	240	320x320	5.0	2.5
T2 Sagittal	99	5000	240	320x320	5.0	1.5
T2FLAIR Axial	99	9000	230	256x256	5.0	1.5
Post Contrast MPRAGE	5.06	1890	230	256x256	1.0	0.5
DWI	89	1400	230	192X192	5.0	1.5
SWI	40	49	230	164x256	3.0	1.0

*Time to Echo; **Time of Repetition; FLAIR: Fluid-Attenuated Inversion Recovery; MPRAGE: Multiplanar Gradient Echo.

MRI was done with 1.5-Tesla MRI, Magnetom Siemens, Avanto, Erlagen Germany using dedicated head coil.

Noncontrast MR images were taken first followed by postcontrast images. Size, shape, location, solid / cystic or complex nature of lesion was noted besides any associated invasion.

In diffusion-weighted MRI study, apparent diffusion coefficient (ADC) maps were also obtained. Image acquisition was done at b-value of 0, 400 & 1000. Changes in diffusion patterns in the lesion were noted. Mean ADC value was used in our study for evaluation.

Magnetic resonance spectroscopy (MRS) was done using multiple voxel technique at TE values of 30 and 135. Water suppression was done using CHESS (Chemical Shift Selective) Technique, prior to inner volume suppression (IVS). The results of MRS were analysed for levels of important chemicals / metabolites like NAA, choline, creatine, Cr2, lactate, lipids, succinate & amino acids.

Susceptibility weighted images (SWI) were taken to detect presence of any calcification or hemorrhage within the SOL.

Interpretation and analysis of findings was done to make the radiological diagnosis confidently. The radiological diagnosis was then compared with the histopathological diagnosis in operated cases and clinical diagnosis in patient where resolution of lesion was achieved by medical treatment.

Inclusion Criterion

- All patients with CT or Noncontrast MRI diagnosis of intracranial SOL

Exclusion Criteria

- Patients with absolute contraindication for MRI like patients with implants, pacemakers or history of metallic foreign bodies inside their body.
- Patients having history of allergy to MRI contrast agents.
- Patients with severely deranged renal function.
- Patients in whom histopathological diagnosis could not be obtained or when the patient could not be followed up for response to medical treatment in non-operated cases.

Risk from the study includes the following contrast-related hypersensitivity reactions:

- Major acute reactions - laryngospasm and anaphylaxis.
- Minor reactions - nausea, emesis, urticaria & headache.
- Local reactions: skin irritation, itching.

OBSERVATIONS AND RESULTS

In our study, age of patients ranged from 5 to 67 years. Maximum number of patients were aged 21-30 years (26.7%) while minimum (3.3%) in 11-20 years. Mean age of patients was 39.40±17.43 years. Table 1 shows the distribution of cases in our study according to age.

Our study had predominance of male patients (n=21; 70%) with male to female ratio of of 2.33. Table 2 shows the distribution of cases according to sex.

Headache was the most common clinical complaint reported by 90% of patients in our study (27 out of 30 cases) while vomiting, generalized weakness & weakness in limbs were reported the least i.e. 3.3% each. Table 3 shows the distribution of cases according the presenting clinical complaints.

In our study, histopathological diagnosis could be established in 29 out of 30 cases. Of these 20 (69%) were malignant while 9 (31%) were benign lesions. Among benign lesions, most common were Schwannoma & Meningioma (n=3 each) while least common was central neurocytoma (n=1). Among malignant lesions, most common was glioblastoma multiforme (n=9) followed by astrocytoma (n=4) and rest being represented by one case each. Table 4 shows the histopathological distribution of the cases.

Of the 29 cases with histopathological diagnosis, 8 (27.6%) cases had Grade I & Grade II lesions, 4 cases (13.3%) had Grade III and remaining 9 (31%) cases had Grade IV lesion. Table-5 shows distribution of cases as per histological grade.

Table 1: Age Distribution of cases

SN	Age Group	No. of cases	Percentage
1.	**≤10 Years**	2	6.7
2.	**11-20 Years**	1	3.3
3.	**21-30 Years**	8	26.7
4.	**31-40 Years**	6	20.0
5.	**41-50 Years**	4	13.3
6.	**51-60 Years**	6	20.0
7.	**61-70 Years**	3	10.0
Mean Age±SD (Range) in years		**39.40±17.43 (5-67)**	

Table 2: Gender Distribution of cases

SN	Gender	No. of cases	Percentage
1.	**Male**	21	70.0
2.	**Female**	9	30.0

Table 3: Distribution according to Presenting Complaints

SN	Complaint	No. of cases	Percentage
1.	**Headache**	27	90.0
2.	**Vomiting**	1	3.3
3.	**Generalized weakness**	1	3.3
4.	**Weakness in limbs**	1	3.3
5.	**Seizures**	5	16.7

Table 4: Distribution of cases according to Histopathological Findings (n=29)

SN	Diagnosis	No. of cases	Percentage
I.	**Benign**	9	31.0
	Central neurocytoma	1	
	Schwannoma	3	
	Meningioma	3	
	Low grade glioma	2	
II.	**Malignant**	20	69.0
	Anaplastic oligodendroglioma	1	
	Astrocytoma	4	
	Atypical meningioma	1	
	Ependymoma	1	
	Ganglioglioma	1	
	Glial neoplasm of Gemistocytic origin	1	
	Glioblastoma multiforme	9	
	Intermediate/High grade glioma	1	
	Supratentorial PNET	1	

Table 5: Distribution of cases according to Histopathological Grade (n=29)

SN	Grade	No. of cases	Percentage
I.	**Grade I**	8	27.6
2.	**Grade II**	8	27.6
3.	**Grade III**	4	13.3
4.	**Grade IV**	9	31.0

Table 6: Comparison of different metabolite ratios between benign and malignant tumors (n=29)

SN	Metabolite ratio	Benign (n=9)		Malignant (n=20)		Statistical significance (Mann Whitney U test)	
		Mean	SD	Mean	SD	'z'	'p'
1.	Cho:NAA	3.82	1.85	8.14	3.96	2.734	0.005
2.	NAA:Cr	1.24	0.74	1.20	0.65	0.849	0.417
3.	Cho:Cr	3.73	2.65	9.35	7.50	2.310	0.020
4.	NAA:Cr2	1.51	2.72	1.19	1.74	0.431	0.672

Table 7: Comparison of different metabolite ratios between Low Grade (Grades I/II) and High Grade (Grades III/IV) tumors (n=29)

SN	Metabolite ratio	Low grade (n=16)		High Grade (n=13)		Statistical significance (Mann Whitney U test)	
		Mean	SD	Mean	SD	'z'	'p'
1.	Cho:NAA	3.91	1.68	10.35	2.90	4.298	<0.001
2.	NAA:Cr	1.33	0.71	1.18	0.61	0.417	0.682
3.	Cho:Cr	3.99	2.53	12.05	7.95	3.333	<0.001
4.	NAA:Cr2	1.46	2.54	1.08	1.31	0.441	0.683

Table 8: Comparison of different MR Diffusion Weighted Apparent Diffusion coefficients between benign and malignant tumors (n=29)

SN	Region	Benign (n=9)		Malignant (n=20)		Statistical significance (Mann Whitney U test)	
		Mean	SD	Mean	SD	'z'	'p'
1.	Intratumoral	1146.70	752.96	1235.04	538.08	0.330	0.764
2.	Peripheral	1203.12	344.11	1803.53	432.78	3.111	0.001

Table 9: Comparison of different MR Diffusion Weighted Apparent Diffusion coefficients between Low Grade and High Grade tumors (n=29)

SN	Region	Low Grade (n=16)		High Grade (n=13)		Statistical significance (Mann Whitney U test)	
		Mean	SD	Mean	SD	'z'	'p'
1.	Intratumoral	1123.17	570.27	1311.58	642.42	1.096	0.288
2.	Peripheral	1482.87	517.51	1782.52	416.54	1.491	0.144

Table 10: Comparison of Diffusion Properties between benign and malignant and low and high grade tumors

SN	Variable	Total	R-		R+		Statistical significance (Fisher exact test) 'p' value
			No.	%	No.	%	
1.	Malignancy status						
	Benign	9	7	77.8	2	22.2	0.109
	Malignant	20	8	40.0	12	60.0	
2.	Grade						
	Low Grade	16	10	62.5	6	37.5	0.272
	High Grade	13	5	38.5	8	61.5	

Table 11: Area Under Curve values and Projected Cut-off values of NAA:Cho and Cho:Cr for differentiation of high grade lesions from low grade lesions under different considerations

Metabolite	AUC	Consideration	Projected cut-off	Projected sensitivity	Projected Specificity
Cho:NAA	0.971	High sensitivity	≥4.46	100%	68.7%
		High specificity	≥7.31	84.6%	100%
		Balanced	≥6.81	92.3%	93.7%
Cho:Cr	0.865	High sensitivity	≥3.01	100%	50%
		High specificity	≥7.57	61.5%	93.7%
		Balanced	≥5.36	84.6%	69.7%

Table 12: Area Under Curve values and Projected Cut-off values of Cho:NAA and Cho:Cr for differentiation of benign lesions from malignant lesions under different considerations

Metabolite	AUC	Consideration	Projected cut-off	Projected sensitivity	Projected Specificity
Cho:NAA	0.822	High sensitivity	≥2.14	100%	33.3%
		High specificity	≥6.82	65%	100%
		Balanced	≥3.80	85.0%	65.6%
Cho:Cr	0.772	High sensitivity	≥2.27	90.0%	44.4%
		High specificity	≥7.57	45.0%	100%
		Balanced	≥3.01	85.0%	55.6%

Table 13: Area under Curve values and Projected Cut-off values of Peripheral ADC for differentiation of high grade lesions from low grade lesions under different considerations

AUC	Consideration	Projected cut-off	Projected sensitivity	Projected Specificity
0.663	High sensitivity	≥1365.5	92.3%	50%
	High specificity	≥2269.2	15.4%	93.7%
	Balanced	≥1607.4	69.2%	62.5%

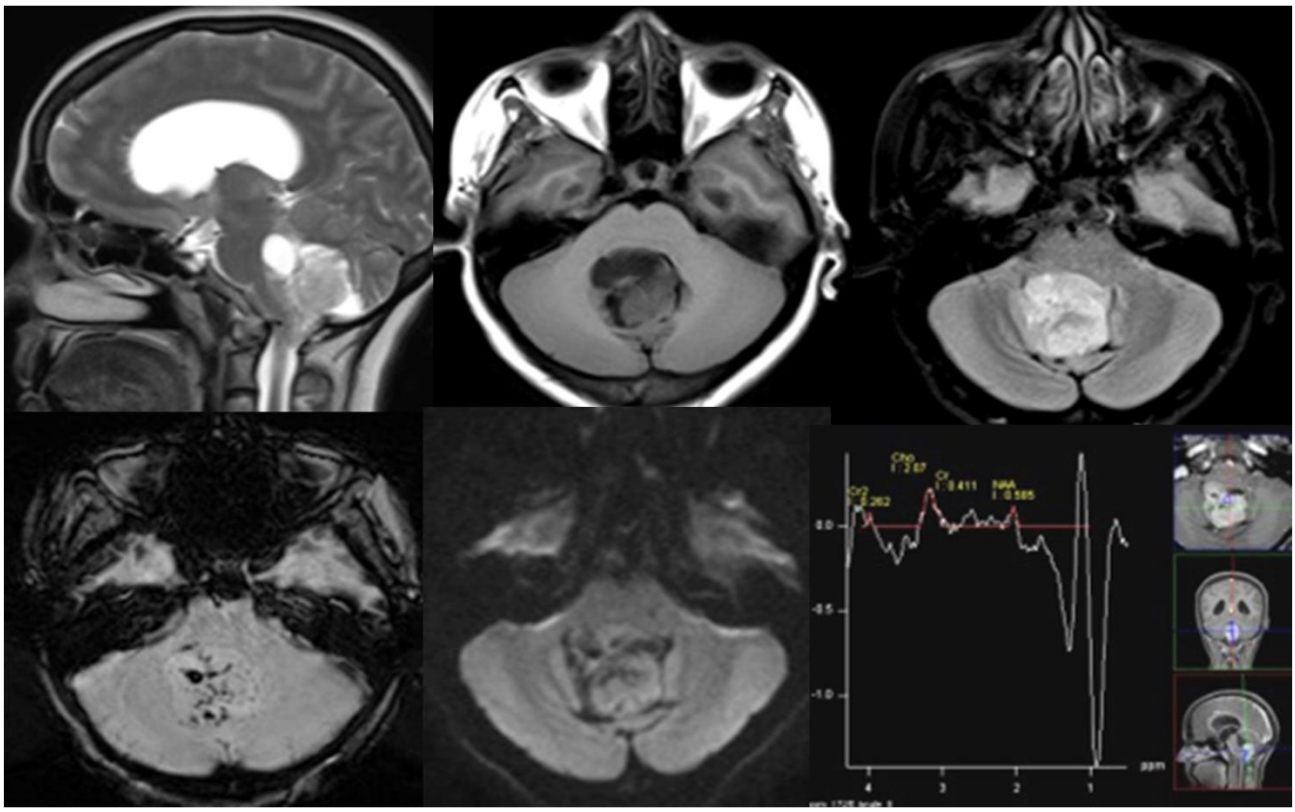

Figure 1: Case of Ependymoma in a 36yrs old female. An intra-axial lesion appearing heterogeneously hyperintense on T2W & T2FLAIR images & hyointense on T1W images showing internal cystic component is seen epicentered in vermian region of posterior fossa. It is causing partial effacement of 4th ventricle leading to proximal hydrocephalus. Extension of lesion into upper part of cervical canal via foramen magnum is also seen. Few foci of T2blooming are also seen within the mass representing calcifications. Postcontrast images show marked heterogeneous enhancement within the solid componenent of the lesion. No significant diffusion restriction is noted on DW images. MRS revealed severely reduced NAA with lipid-lactate peak.

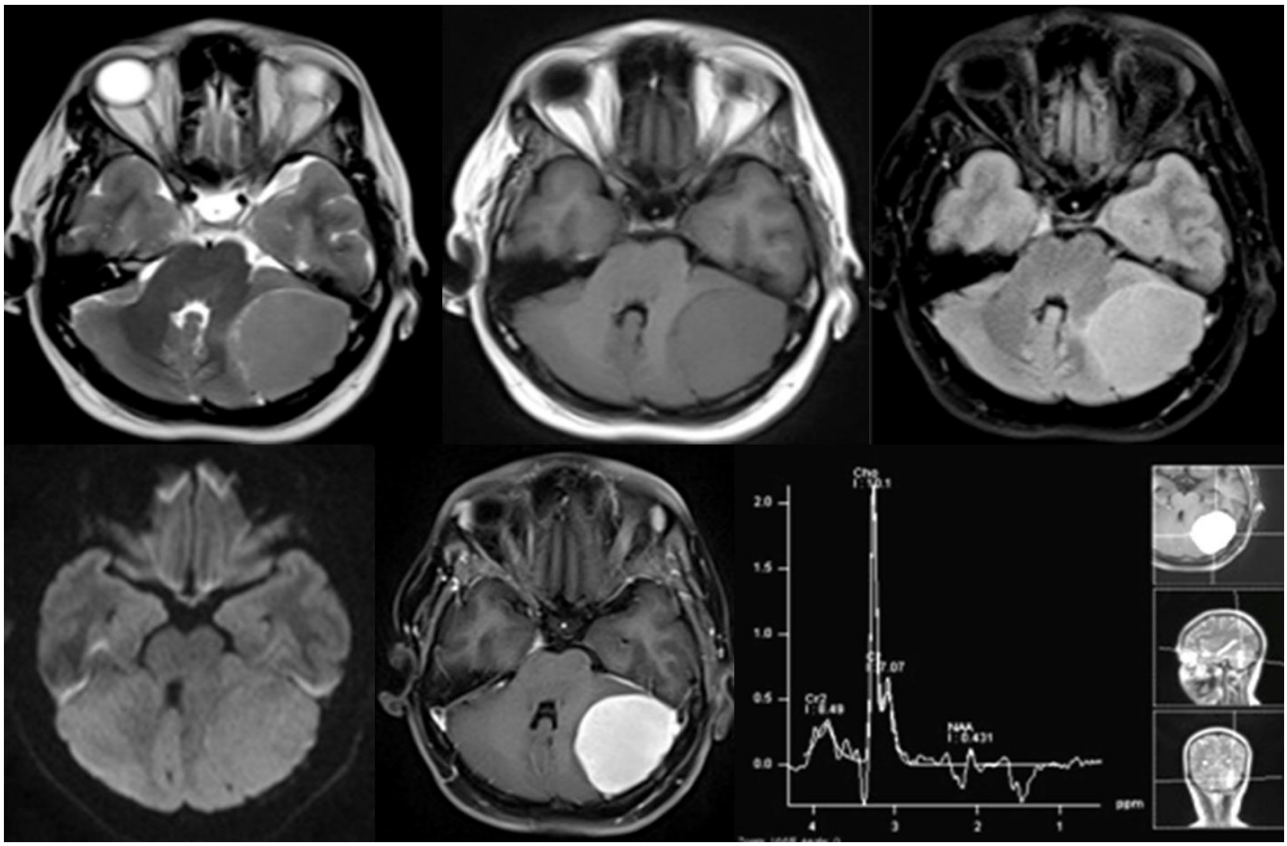

Figure 2: A case of posterior fossa meningioma in a 35yrs old female patient. There is an extra-axial, well defined lesion in posterior fossa appearing isointense to grey matter on T1W & T2W images with slight hyperintensity T2FLAIR images. The lesion does not show any significant restriction on DW images. Intense, homogeneous, postcontrast enhancement is noted within the lesion. MRS shows significantly raised Choline & reduced NAA levels.

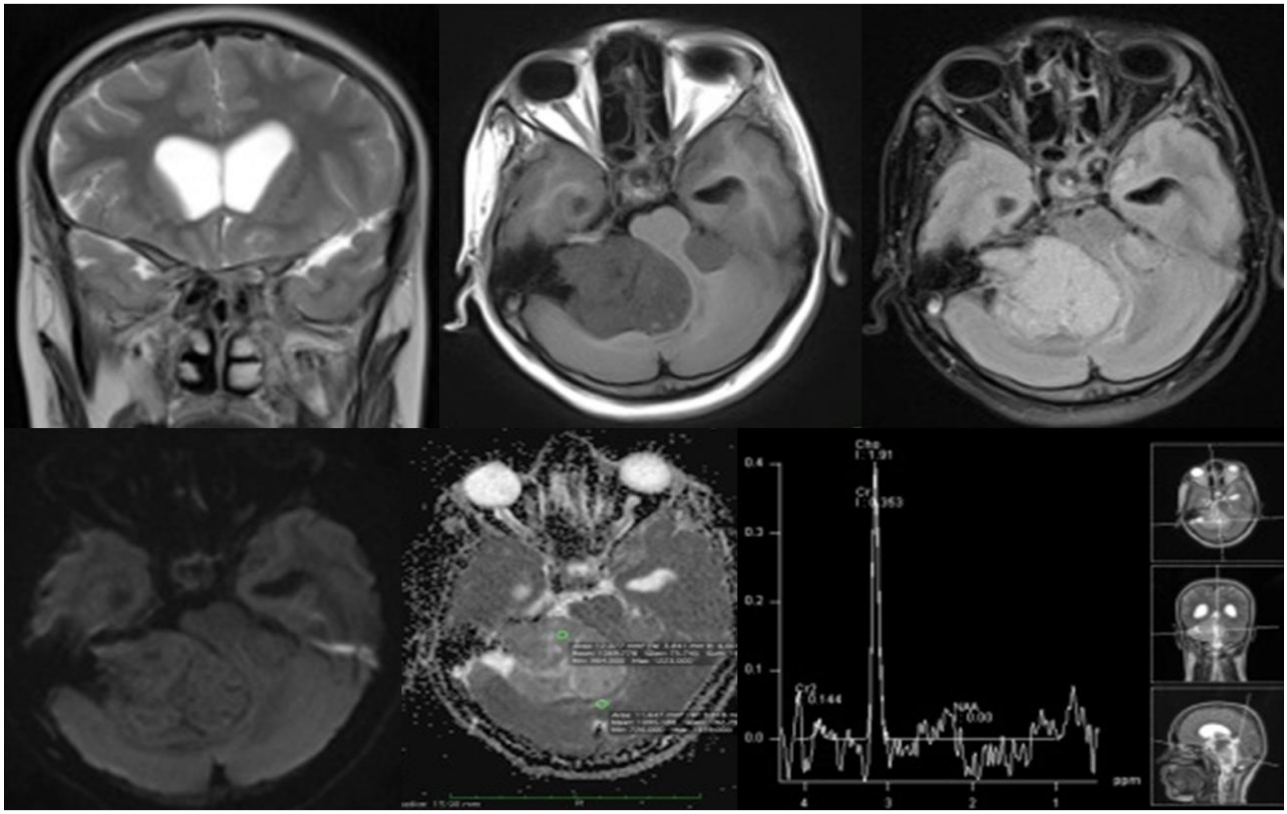

Figure 3: A case of bilateral CP angle schwannoma in a 25yrs old female patient. Well-defined, extra-axial lesions are noted in bilateral CP angle regions; larger on right side. The lesions are hypointense on T1W and hyperintense on T2FLAIR images compressing & rotating the brainstem with near-complete effacement of 4th ventricle leading to proximal hydrocephalus. Intense heterogeneous postcontrast enhancement is noted with enhancement along intracanalicular extension. No significant diffusion restriction is noted. MRS shows high Choline & Creatine with no detectable NAA. Lipid & lactate peaks is also noted.

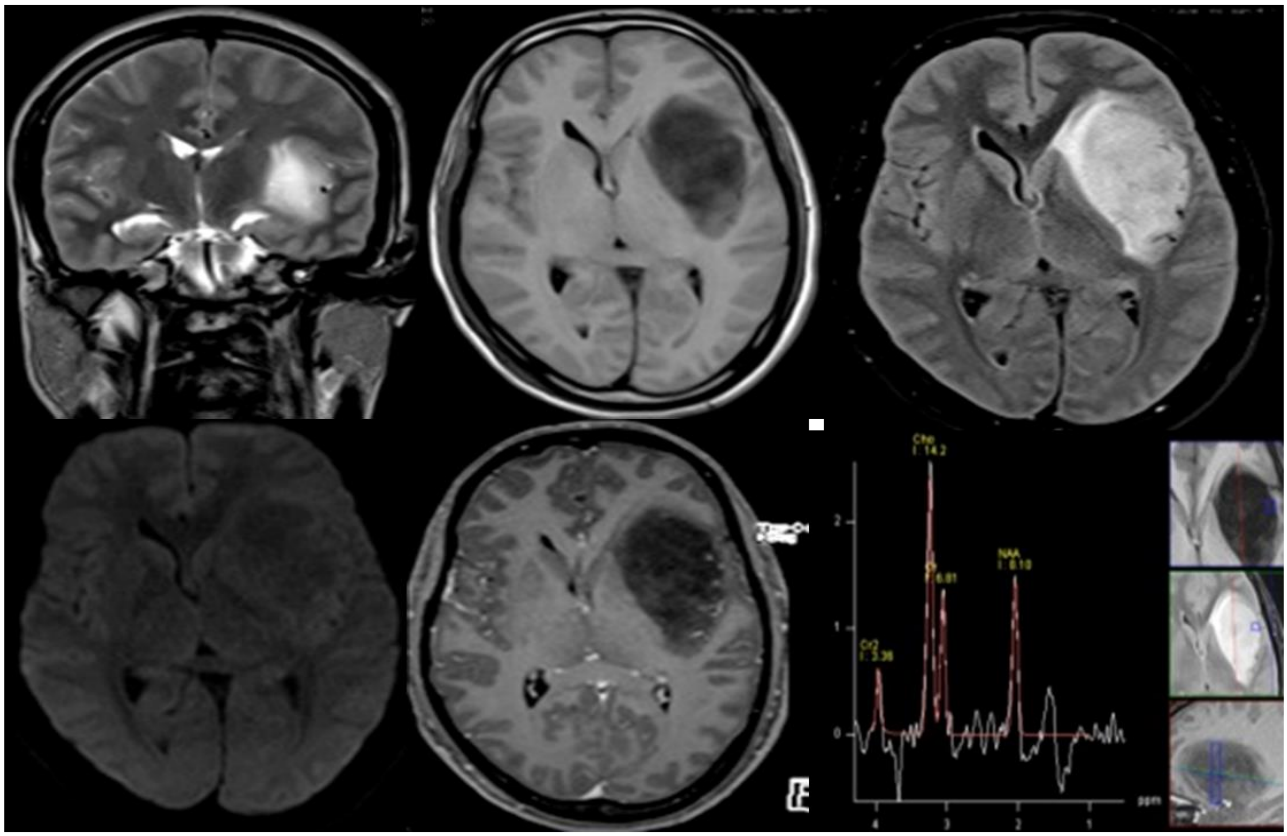

Figure 4: A case of low grade glioma in a 28yrs old male patient. A relatively well-defined lesion is noted epicentered in left lentiform nucleus & external capsule encircling left middle cerebral artery and producing a midline shift. The lesion is near-homogeneously hypointense on T1W & variable hyperintense on T2W & T2FLAIR images. The lesion does not show diffusion restriction or any significant postcontrast enhancement. MRS reveals high Choline, high Cho:Cr ratio and reduced NAA along with lipid-lactate & Cr2 peak.

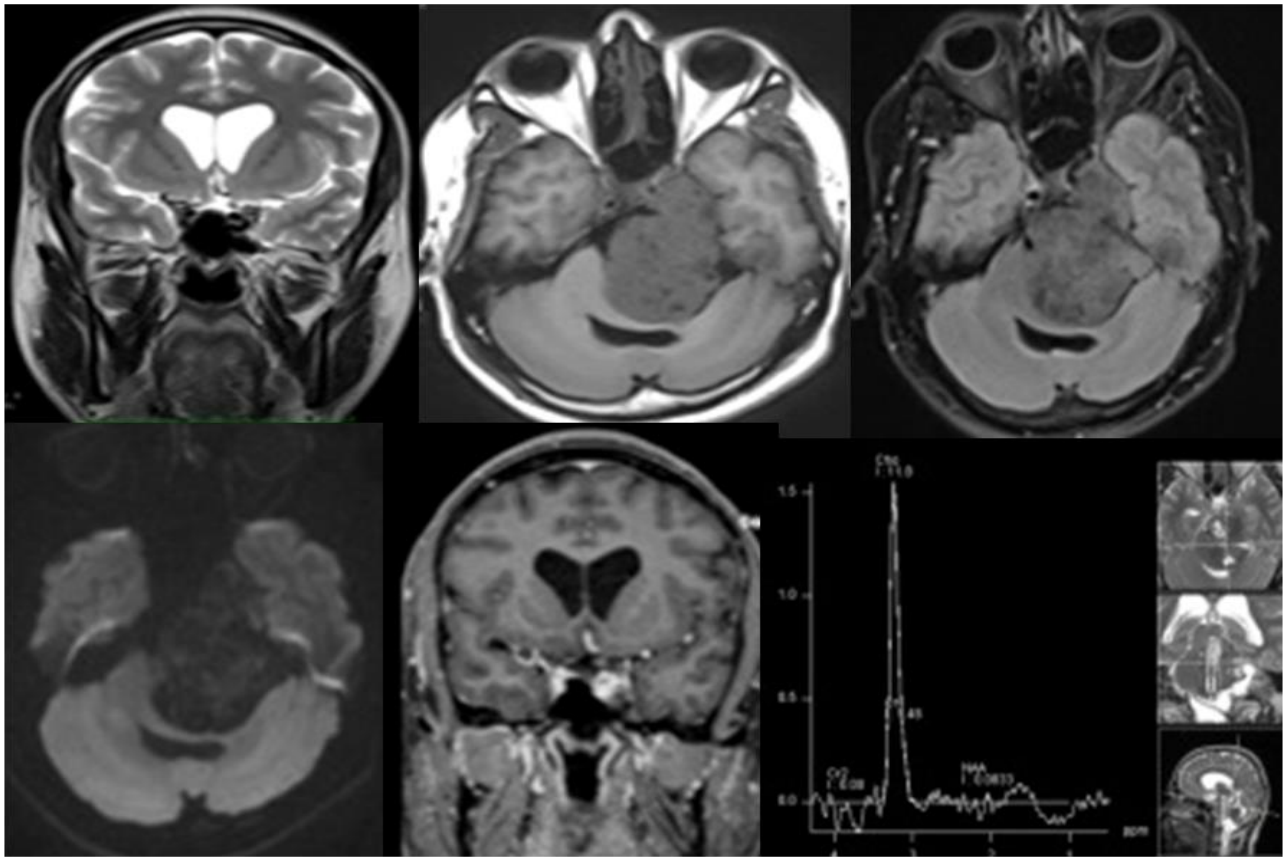

Figure 5: A case of trigeminal nerve schwannoma in a 28yrs male patient. A well-defined, extra-axial, lobulated, heterogeneous mass is noted in the region left CP angle appearing near-homogeneously hypointense on T1W & heterogeneously hyperintense on T2FLAIR images showing few small internal cystic areas. The lesion does not diffusion restriction. There is heterogeneous, mild to moderate, postcontrast enhancement of the lesion. MRS shows highly raised choline & slightly raised creatine with no detectable NAA.

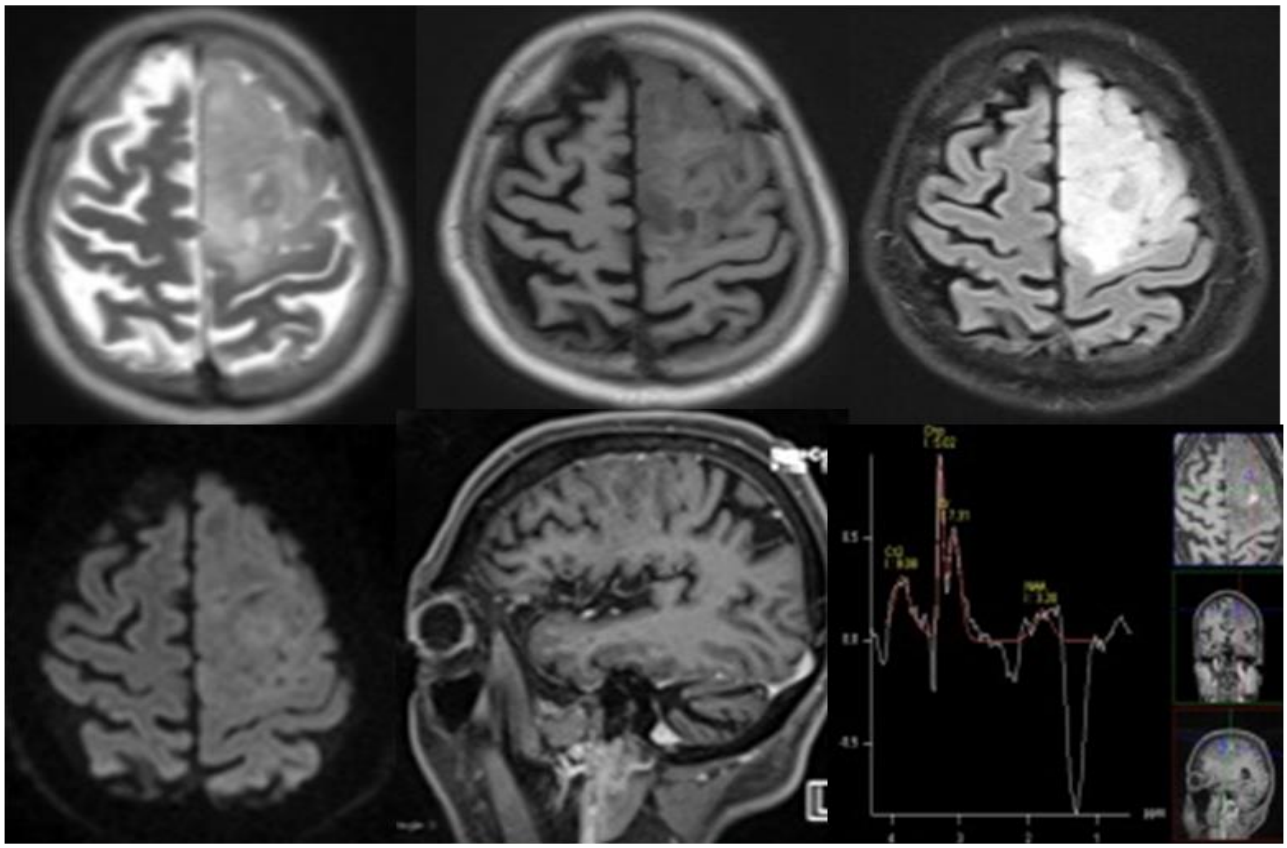

Figure 6: A case of intermediate-grade glioma in a 34yrs male patient. A lesion appearing heterogeneously hyperintense on T2W & T2FLAIR images and heterogeneous hypointense on T1W images is noted in the left frontal lobe near the vertex without obvious diffusion restriction. Few ill- defined subcentimetric patchy areas of postcontrast enhancement are noted within the lesion. MRS shows reduced NAA and raised choline with a lipid peak.

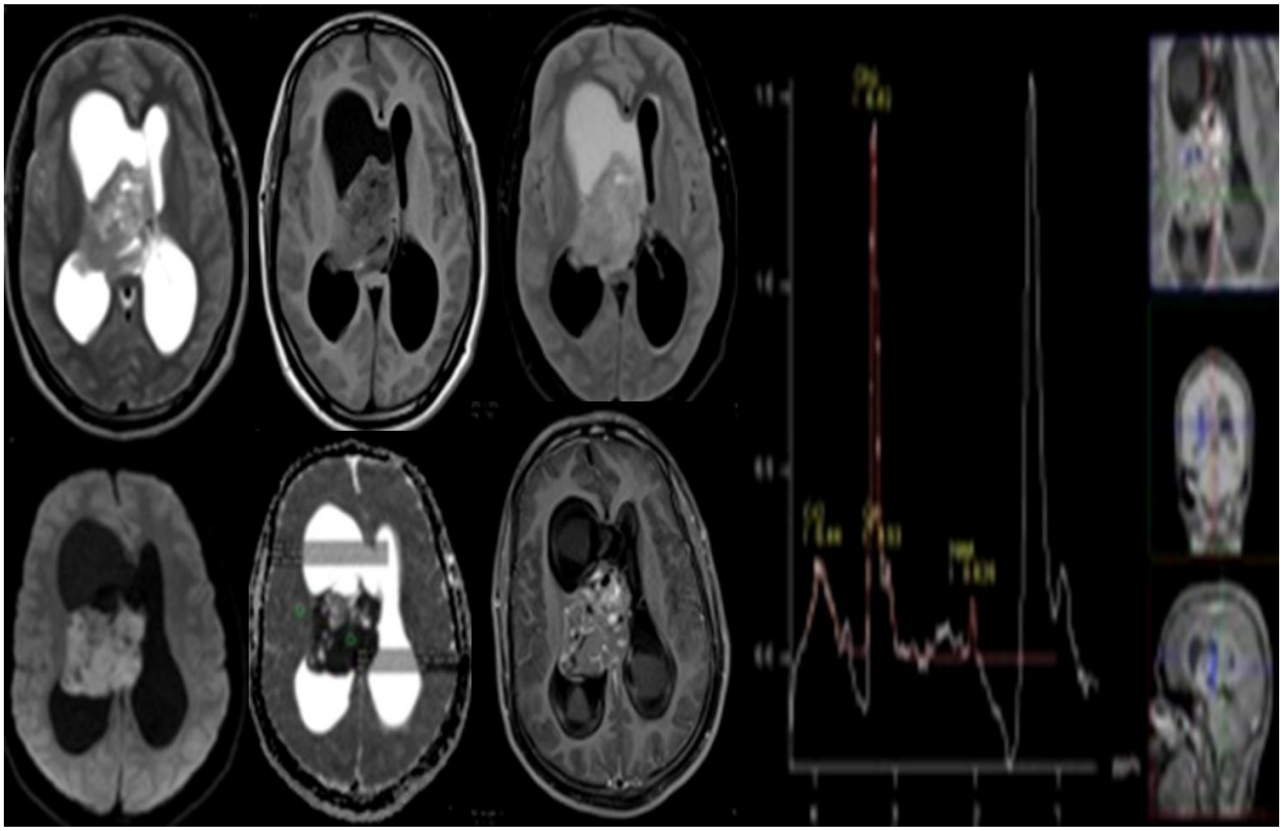

Figure 7: A case of central neurocytoma in a 23yrs old patient. There is a relatively well-defined lesion epicentered at foramen of Monro (right side) with central solid component with intralesional cyst-like areas simulating bubbly appearance. The mass is entrapping right frontal horn & is infiltrating in to right lateral ventricle & third ventricle. The lesion shows hypointense cystic part & near-homogeneously isointense solid part on T1W. Both cystic & solid parts appear variably hyperintense on T2W & T2FLAIR images. Significant restriction is noted on DWI & ADC images. Multiple areas of blooming are noted on SWI. There is heterogeneous postcontrast enhancement with few internal & peripheral vascular channels. MRS shows very high Choline peak with low NAA and lipid-lactate peak.

CORRELATION OF HISTOPATHOLOGICAL FINDINGS WITH MR-SPECTROSCOPY FINDINGS (Table 6, 7) (Figures 1-7)

Mean Cho:NAA and Cho:Cr ratios were lower in benign as compared to malignant and mean NAA:Cr and NAA:Cr2 ratios were higher in benign as compared to malignant lesions. On evaluating the difference between two groups, the difference was significant statistically for Cho:NAA and Cho:Cr ($p<0.05$).

Mean value of Cho:NAA and Cho:Cr were significantly lower in low grades as compared to high grade ($p<0.001$). However, mean value of NAA:Cr and NAA:Cr2 was higher in low grade as compared to high grade but difference was not significant statistically ($p>0.05$).

CORRELATION OF HISTOPATHOLOGICAL FINDINGS WITH DIFFUSION-WEIGHTED IMAGING FINDINGS (Table 8, 9, 10) (Figures 1-7)

Though both intratumoral as well as peripheral mean ADC values were higher in malignant as compared to benign cases yet the difference was significant statistically only for peripheral ADC values ($p=0.001$). Similarly, both intratumoral as well as peripheral mean ADC values were higher in high grade as compared to low grade lesions but the difference between two grades was not significant statistically either for intratumoral or for peripheral ADC values ($p>0.05$).

Though proportion of cases showing diffusion restriction was higher in malignant (60%) as compared to benign (22.2%) and in high grade (61.5%) as compared to low grade (37.5%) yet the difference was not significant statistically ($p>0.05$).

Analysis of above findings suggested that metabolite ratios Cho:NAA and Cho:Cr were helpful in differentiating benign vs malignant and low grade vs high grade of brain SOL. On DWI, peripheral ADC values showed a differentiating potential between high and low grade lesions.

Table 11 shows Receiver-Operator Characteristic (ROC) analysis findings for finding out cut-off values of Cho:NAA and Cho:Cr for differentiation between high and low grade lesions. For Cho:NAA & Cho:Cr ratios, the area under curve value was 0.971 & 0.865 respectively, both being above the generally acceptable value of AUC >0.7. Thus among different MRS metabolite parameters, Cho:NAA had high sensitivity as well as specificity in differentiating low grade and high grade lesions. Table 12 shows Receiver-Operator Characteristic (ROC) analysis findings for finding out cut-off values of Cho:NAA and Cho:Cr for differentiation between benign and malignant lesions. For both metabolite ratios, area under curve values was above 0.7. Under balanced considerations though both metabolite ratios had an equal sensitivity (85%) yet the specificity of Cho:NAA was higher (65.6%). Table 13 shows Receiver-Operator Characteristic (ROC) analysis findings for finding out cut-off value of peripheral ADC values for differentiation between high and low grade lesions. The area under curve value was 0.663 which is below the acceptable value of AUC >0.7, indicating that the criteria was neither adequately sensitive nor specific. Under balanced considerations, the projected cut-off value was $\geq$1607.4 had a projected sensitivity of 69.2% and a projected specificity of 62.5%.

The findings of present study thus emphasize the potential role of MR-Spectroscopy and Diffusion Weighted Imaging in grading of intracranial space occupying lesions.

CORRELATION OF MR IMAGING FINDINGS AND HISTOPATHOLOGICAL FINDINGS

MRI diagnosis could be established in all the 30 cases. A total of 11 (36.7%) were diagnosed as benign/non-malignant and 19 (63.3%) were diagnosed as malignant.

Out of 11 MRI-diagnosed benign/non-malignant lesions, three cases each of Schwannoma, Meningioma & low grade glioma while one case each of central neurocytoma & tuberculoma were included.

Among 19 MRI-diagnosed malignant cases, glioblastoma multiforme were maximum (n=7) followed by 3 each of astrocytoma & intermediate/high grade glioma, 2 of ependymoma and 1 each atypical meningioma, ganglioglioma, supratentorial PNET and tuberculoma/Metastasis respectively. Table 14 shows the distribution of cases as per MRI diagnosis.

For the histopathological diagnosis of malignancy, MRI had 19 true positive, no false positive, 1 false negative and 9 true negative cases, thereby showing it to be having a sensitivity of about 95% and specificity of about 100%. MRI had a positive predictive value of 100% and negative predictive value of 90% for diagnosis of malignancy. It had an accuracy of 96.6%. Table 15 shows correlation of MRI and histopathological findings of our study based on benign & malignant lesions. Out of 29 cases, disagreement between HPE and MRI diagnosis was seen in 5 (17.2%) cases. Two cases of glioblastoma multiforme were not correctly diagnosed by MRI and were diagnosed as ependymoma and intermediate/high grade glioma respectively. MRI also inaccurately diagnosed one case of anaplastic oligodendroglioma as low grade glioma. One case of anaplastic astrocytoma was diagnosed as tuberculoma/metastasis by MRI while one case of glial neoplasm of gemiostocytic origin which was diagnosed as intermediate/high grade glioma on MRI. One case was diagnosed as tuberculoma on MRI and was later confirmed on the basis of clinical response to ATT. Thus, the overall accuracy of MRI was 83.3%. Table 16 shows distribution of cases on the basis of MRI & histopathological diagnosis.

Table 14: MR Imaging Diagnosis (n=30)

SN	Diagnosis	No. of cases	Percentage
I.	**Benign/Non-malignant**	11	36.7
	Central neurocytoma	1	
	Schwannoma	3	
	Meningioma	3	
	Low grade glioma	3	
	Tuberculoma	1	
II.	**Malignant**	19	63.3
	Astrocytoma	3	
	Atypical meningioma	1	
	Ependymoma	2	
	Ganglioglioma	1	
	Glioblastoma multiforme	7	
	Intermediate/High grade glioma	3	
	Supratentorial PNET	1	
	Tuberculoma/Metastasis	1	

Table 15: Correlation between MRI and Histopathological Diagnosis for Benign and Malignant Lesions (n=29)

MRI Diagnosis	Histopathological Diagnosis		Total
	Malignant	Benign	
Malignant	19	0	19
Benign	1	9	10
Total	20	9	29

Sensitivity: 95%, Specificity: 100%, PPV: 100%, NPV: 90%, Accuracy: 96.6%

Table 16: Validation of different MRI Diagnosis by Histopathology

SN	Diagnosis	No. of cases	No. (%) Agreement with HPE	HPE diagnosis in misdiagnosed case
1	**Central neurocytoma**	1	1 (100%)	-
2	**Schwannoma**	3	3 (100%)	-
3	**Meningioma**	3	3 (100%)	-
4	**Low grade glioma**	3	2 (66.7%)	1 – Anaplastic oligodendroglioma
5	**Tuberculoma**	1	-	Confirmed by clinical response to ATT
6	**Astrocytoma**	3	3 (100%)	-
7	**Atypical meningioma**	1	1 (100%)	-
8	**Ependymoma**	2	1 (50%)	1 – Glioblastoma multiforme
9	**Ganglioglioma**	1	1 (100%)	-
10	**Glioblastoma multiforme**	7	7 (100%)	-
11	**Intermediate/High grade glioma**	3	1 (33.3%)	1- Glioblastoma multiforme, 1- Glial neoplasm of Gemiostocytic origin
12	**Supratentorial PNET**	1	1 (100%)	-
13	**Tuberculoma/Metastasis**	1	0(0%)	1- Anaplastic astrocytoma

DISCUSSION

The present study was done for assessing the accuracy of MRI, using MR-Diffusion and MR Spectroscopy in addition to conventional MRI sequences in cellular identification of intracranial space occupying lesions especially benign versus malignant tumors.

Space occupying lesion (SOL) of brain has a wide spectrum ranging from infective, vascular to neoplastic, both benign and malignant neoplasm. Infected lesions are predominated by granulomatous and pyogenic lesions while in the tumoral lesions, extra-axial tumors as meningioma, pituitary adenoma, schwannoma & less commonly epidermoid, hemangioma & chordoma predominate. Glioma and metastases are the common malignant neoplasm of the brain.[12]

Neoplasms contribute more than half of the brain SOL. Higher incidence of glioma has been reported from developed / industrialized countries while Caucasians are more susceptible than African & Asian population.[13] The occurrence of CNS tumors is reported to be on the rise.[14] CNS tumors are also the second most common solid tumors among children.[15]

Conventional MR sequences primarily help in differentiating brain SOL from other CNS pathologies based on the anatomical and structural information.[12] Contrast-enhanced MRI is not so helpful for evaluation of type of tumor or tumor grade detection.[16] MRS helps in reducing aggressive methods of brain SOL evaluation such as brain biopsy which is considered to be gold standard.[17]

MRS provides a facility of analysing the quality of brain metabolites which reflect the integrity of neurons, proliferation or degradation of cell membrane, metabolic energy generation and necrosis of the brain or tumor tissue.[17]

In the present study, the age distribution of patients was 1-70 years of age which was similar to the study by Jindal et al, [18] where it was 1-90 years. In our study, the common occurrence of the intra-cranial lesions was seen in 21-30 years, 31-40 years and 51-60 years age groups which was in accordance with the study by Jindal et al,[18] where the peak incidence was in 5th decade (23.7%) followed by 3rd decade (17.5%) and also with Madan et al & Darweesh et al, [19,20] where majority of subjects with lesions were in 4th & 5th decades & from 20-50 years respectively.

Male to female sex ratio in our study-group, was 2.33 ratio while it was 3:2 in a study by Jindal et al & Madan et al.[18,19] This findings are in agreement with the findings of Al-Okaili et al,[21] who found that the incidence of brain tumors is commoner among males.

Headache (90%) is the most common presenting complaint in patients with brain SOL in our study similar to that reported in other studies by Jindal et al & Benjarge & Kulkarni et al.[18,22]

Out of 29 cases in our study-group where histopathological diagnosis could be established, 20 (69%) were malignant lesions while 9 (31%) were benign lesions. similar results were also noted by Jindal et al & Darweesh et al.[18,20] The incidence of various tumor in our study was similar to that of Goyani et al & Jamjoom[23,24] where neuroepithelial tumors predominated, followed by meningioma, pituitary adenoma & metastatic tumor with minor proportion of malformation tumors & neurinoma. Histopathological Grade IV tumors were commonest in our study similar to that reported by Darweesh et al.[20] In a study by Mahmoud et al,[25] out of 22 non-neoplastic cases, 77.2% were tuberculoma & 22.7% abscesses unlike our study where arachnoid cysts & abscess were most common non-neoplastic lesions.

Cho is the most specific marker of intracranial neoplasm on MRS. Increase in Cho levels and Cho/Cr and Cho/NAA ratios are highly suggestive of neoplasm. In our study, mean Cho:Cr & Cho:NAA ratios were lower in benign as compared to malignant while mean NAA:Cr and NAA:Cr2 ratios were higher in benign as compared to malignant lesions. These results are in agreement with the findings of Brandao and Domingues.[26] Studies conducted by Darweesh et al, Martinez-Bisal et al, Shokry et al & Dawoud et al revealed that Cho peak and Cho/Cr ratio show significant rising trend from low grade to high grade tumors.[20,27-29]

In our study, high-grade primary tumors had higher perilesional Cho/Cr ratio which was absent in metastatic brain lesions. This is in accordance to the study by Faria et al according to whom peritumoral infiltrating neoplastic cells are more in primary high-grade tumors.[30]

In our study, though both intratumoral as well as peripheral mean ADC values were higher in malignant than benign and higher in higher than lower grade lesions yet the difference was statistically significant only for peripheral ADC values (p=0.001) in malignant lesion.

For malignant tumor grading, ADC value calculation was worthy but could not distinguish types of tumor with similar grading. [31] ADC calculation from tumoral area in high grade had higher values than low-grade lesions,[32] suggesting that lesser ADC represent high-grade astrocytoma, whereas higher ADCs suggested low-grade lesion.

In the present study, MRI had 19 true positive, no false positive, 1 false negative and 9 true negative cases, thereby showing it to be 95% sensitive and 100% specific. MRI had a 100% PPV and 90% NPV for diagnosing malignant lesions with an overall accuracy of 96.6%. This was similar to the study by Kumar et al,[33] with high sensitivity of 94.5% but lesser specificity of 75%. Studies conducted by Jindal et al, Zacharaki et al & Rathod et al, revealed variable results with lesser accuracy, sensitivity, & specificity for brain lesion on imaging.[18,34,35]

Above discussion suggests that proton MRS and calculated ADC provide reliable information for characterization of tissue in intracranial tumors leading to an improved diagnosis & management of disease and therefore, the prognosis.

LIMITATIONS

The major limitation of our study is relatively small sample size. Hence, a larger study group is required for translating our study results to a large population.

Another limitation may be the use of 1.5T MR scanner. Results may be superior in future studies done on 3T or higher magnetic field scanners.

CONCLUSION

Basis on the observations and analysis of our study results, following conclusions can be drawn:

1. Intracranial SOL is commoner in 2nd to 4th decades and in male.
2. Headache is a usual presenting complaint following by seizure.
3. Majority of intracranial SOL are malignant with glioblastoma multiforme being most common followed by astrocytoma. Among benign lesions, schwannoma and meningioma are the commonest.

4. Nearly half of the tumoral lesions are histopathologically high-grade tumors.
5. On MR-spectroscopy, Cho:NAA & Cho:Cr ratios are significantly higher in high grade and malignant tumors.
6. On diffusion weighted imaging, peripheral mean ADC values are higher in malignant lesion.
7. MR imaging is 95% sensitive and 100% specific in detection of malignancy when coupled with proton MRS & DW imaging.

SUMMARY

To summarize, MRI is a useful tool in diagnosis of intracranial space occupying lesions. MR spectroscopy and diffusion weighted images provide sensitive information needed for understanding the metabolic changes within the lesion helping in further identification and differentiation of intracranial lesions. Though, the present study has the limitation of sample size and short span yet it emphasizes on the imaging information that help in prognostication. The high accuracy in present study must be interpreted in view of the highly strict sampling frame.

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