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Role of Diffusion weighted Imaging in the Evaluation of Intracranial Tumors

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Abstract: *The role of Diffusion Weighted Magnetic Resonance Imaging in the evaluation of various intracranial lesions has been evolving and increasing since its initial introduction as newer uses are being explored constantly. We review the imaging features of 68 cases of intracranial tumors and evaluate the role of diffusion weighted imaging in their diagnosis. Diffusion weighted imaging provides additional information in differentiating various intracranial tumors, in differentiating arachnoid cysts from epidermoid cysts, grading of gliomas, defining cystic/necrotic components of tumors and also helps in differentiating necrotic tumors from brain abscesses.*

Keywords: *Apparent Diffusion Coefficient (ADC), Central Nervous System (CNS), Diffusion Weighted Imaging (DWI), Magnetic Resonance Imaging(MRI)*

I. Introduction

The role of Diffusion Weighted Magnetic Resonance Imaging in the evaluation of various intracranial lesions has been evolving. Though, initially DW MRI is introduced for the early detection of stroke, now it has got various other clinical applications. DW MRI is a relatively recent imaging technique in which water self-diffusion is a source of contrast on MR images. DWI measures Brownian motion of water molecules within the tissue. Molecular water proton diffusion process occurring on a micron scale is imaged non invasively and accurately without the use of any exogenous contrast.

II. Aims & Objectives

To evaluate the role of diffusion weighted imaging in the diagnosis of various intracranial tumors.
To differentiate Arachnoid cysts from Epidermoid cysts by diffusion weighted imaging.
To derive the nature of tumor cellularity which will predict the grading of gliomas.
To identify the cystic/necrotic components of tumors.
To differentiate necrotic tumors from abscesses.

III. Materials And Methods

3.1 Patient Selection:
87 patients were included in our study aged between 15 to 75 years who presented with neurological deficits. Patients were taken up for a preliminary screening CT brain. DW MRI was performed in 87 patients.
3.2 Exclusion Criteria:
19 patients were excluded from the study based on exclusion criteria either before or after performing DW MRI.

IV. Method Of Collection Of Data

Study Design: Prospective cross sectional study
Study Sample: 87 patients.
Study Period: February 2013 to August 2014
Study Area: Department of Radiodiagnosis, Gandhi medical college, Secunderabad.
Study Equipment: Siemens Magnetom Avanto 18 Channel 1.5 T MRI
Ethical clearance from institutional ethics committee has been obtained.

V. Technique

For diffusion weighting the matrix was usually 128x128 and FOV was 21cm. TE and TR were 117 and 3600 respectively. b values used were 0, 500, 1000 s/mm^2 and the gradients were applied in three orthogonal directions and trace images were obtained. The lesions were also characterized based on their intensity on DWI as well as ADC maps into hypointense, isointense and hyperintense. Histopathology was correlated with radiological diagnosis. Sensitivity and specificity were calculated.

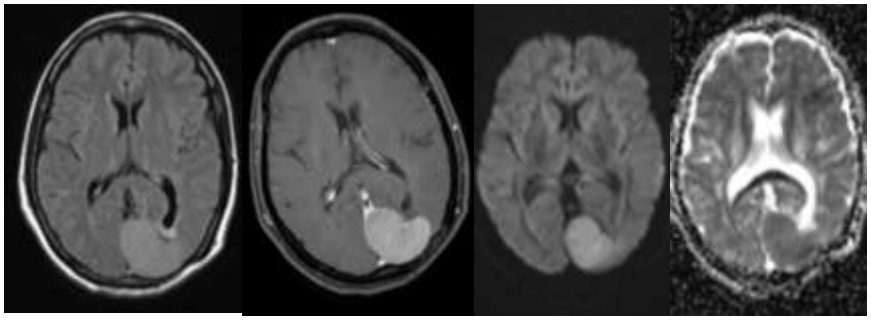
VI. Observations And Results

In the present study, peak age group was between 45-54 years. Of the 68 patients, males comprised majority of the present study group - 35 cases (51.47%) followed by females – 33 cases (48.53%). In this study seizures was the most common presenting symptom in 35 patients(51.5%) followed by headache in 33 patients(48.5%). In the present study, extra axial tumors accounted for 41 cases (60.3%) and intra axial tumors accounted for 27 cases(39.7%). In the present study, gliomas accounted for 19 cases (27.94%) followed by meningiomas - 16 (23.52%). In the present study, most common side involved was the right in 25 patients. Out of 68 patients, lesions were distributed mostly in frontal in 18 cases followed by parietal regions in 17 cases. In our study 35 cases(51.47%) were homogeneously hyperintense on T2WI and 17 cases(25%) were heterogeneously hyperintense on T2WI. Mass effect was seen in 33 cases(48.52%). On contrast administration there was homogeneous enhancement in 22 cases(32%) comprising mainly of meningiomas(14 cases). In our study the sensitivity in diagnosing extra axial tumors was greater(85.3%) than that for intra axial tumors(77.8%).

Overall sensitivity of DW MRI for diagnosing intracranial tumors was 82.3%.

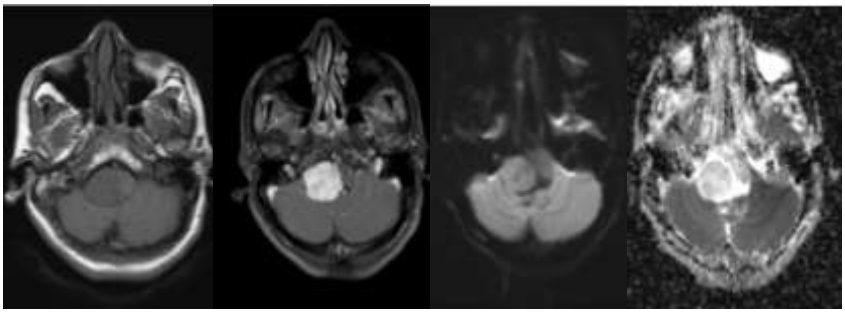
VII. Cases

Case 1:



Well defined, extra axial, T1WI/T2WI/FLAIR isointense lesion seen in left occipital region. Post contrast, intense homogeneous enhancement seen. On DWI, lesion is hyperintense, lesion is hypointense on ADC Map - Meningioma.

Case 2:

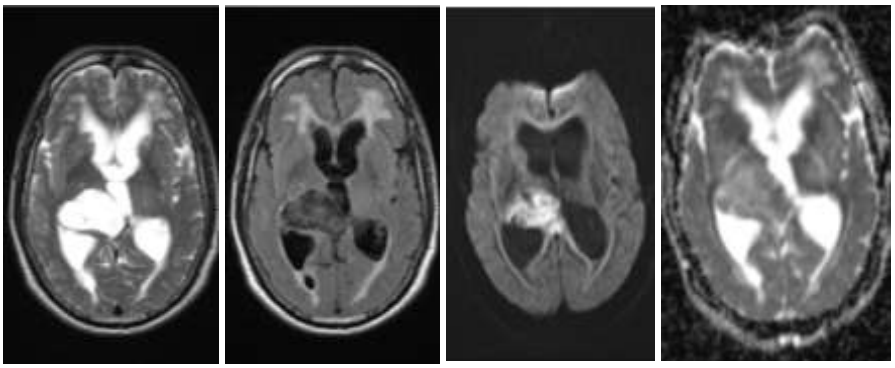


Well defined, extra axial, TIWI isointense lesion seen in right CP angle. Post contrast, intense homogeneous enhancement seen. On DWI and ADC map the lesion is isointense - MENINGIOMA.

Comparative Evaluation Of DWI In Meningioma

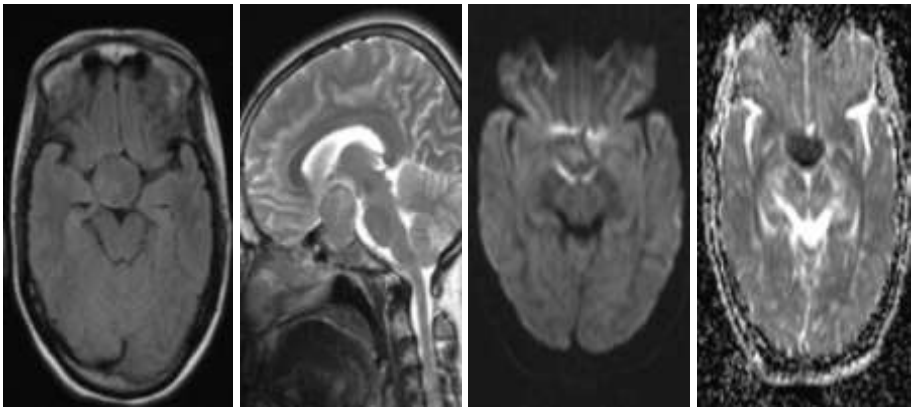
Author	No of cases	DWI Hyper I	DWI Iso I	DWI Hypo I
Christopher G Filippi et al(1)	17	4(ADC Hypo I)	8 (ADC Iso I)	5 (ADC Hyper I)
Sherif A. Khedr et al(2)	31	19	9	3
Present study	16	9	5	2

Case3:



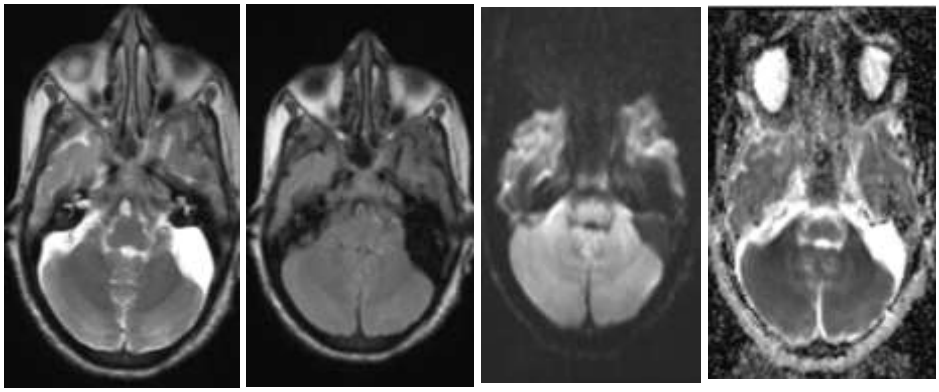
Lobulated, T1WI hypointense, T2WI hyperintense lesion showing heterogeneous signal intensity on FLAIR, seen in right peri mesencephalic region. On DWI, lesion is hyperintense - EPIDERMOID TUMOUR.

Case 4:



T1WI/T2WI/FLAIR Isointense Lesion In Sella Extending Into Suprasellar Region. Post Contrast, Heterogeneous Enhancement Seen. On DWI, Lesion Shows Central Restriction. On ADC Map, Lesion Is Hypointense. - pituitary macroadenoma.

Case 5:

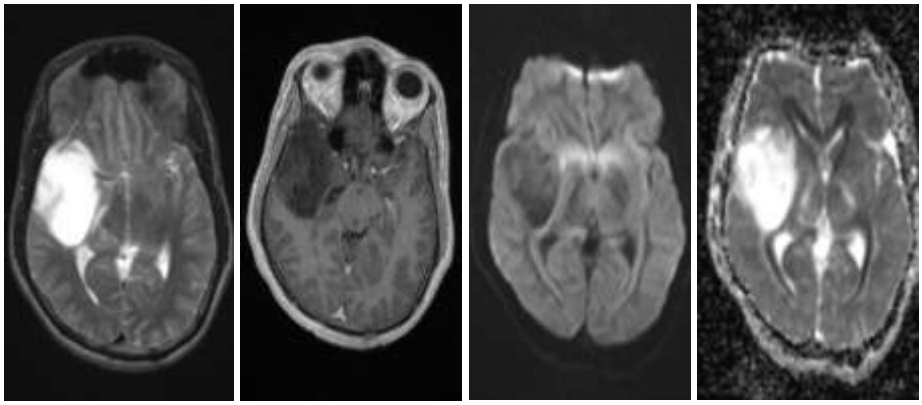


T1WI/FLAIR hypointense, T2WI Hyperintense lesion in left CP angle. On DWI, lesion is hypointense and is hyperintense on ADC map, indicating absence of restricted diffusion - Arachnoid Cyst

Comparative Evaluation Of Arachnoid Cyst Vs Epidermoid Tumour

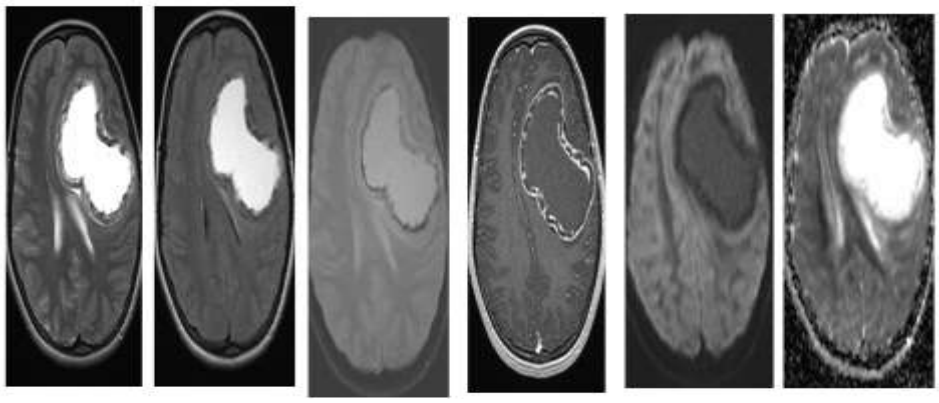
Pathological type	T1WI	T2WI	DWI	ADC	Number Present study	Number Study Ahmed et al(3)
Arachnoid cyst	Low	High	Low	High	8	9
Epidermoid tumor	Low	High	High	Low	4	2

Case 6:



Well defined, T1WI hypointense, T2WI/FLAIR hyperintense lesion seen in right temporal lobe with no edema/mass effect. Post contrast, minimal enhancement seen. On DWI, lesion is hypointense and is hyperintense on ADC map - LOW GRADE GLIOMA.

Case 7:

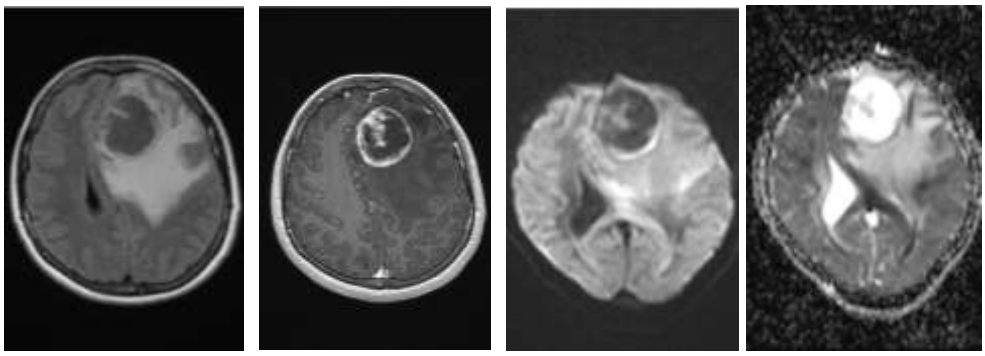


T1WI isointense, T2WI/FLAIR hyperintense lesion, with thick peripheral hypointense wall which is showing blooming on GRE seen in left frontoparietal region, extra axial in location. Post contrast, peripheral rim enhancement seen. On DWI, lesion is hypointense, lesion is hyperintense on ADC map. Histopathology - Meningeal Chondroma.

Rachid Gana et al(4) 2008, reported a case of Meningeal chondroma located in right frontal convexity which showed hypointense signal on T1WI, hyperintense signal on T2WI/FLAIR with peripheral rim enhancement. Lesion showed peripheral blooming on GRE indicating micro calcifications. However diffusion characteristics of the lesion were not specified.

Najjar MW et al(5) 2014, reported another case of meningeal chondroma arising from left fronto parietal convexity showing hyperintense signal on T2WI/FLAIR with irregular rim enhancement.The lesion in the present study showed similar MR imaging features as the cases reported by Rachid gana et al and Najjar MW et al.

Case 8:



A predominantly cystic lesion with solid component seen in left frontal lobe with extensive perilesional edema and mass effect. Post contrast, rim and nodular enhancement seen. Solid portion of lesion shows isointense signal on DWI and ADC map - HIGH GRADE GLIOMA.

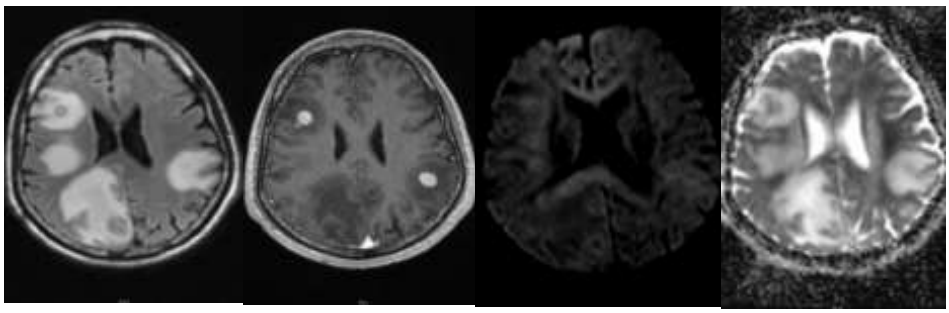
In the present study most(66.7%) of the low grade gliomas showed free diffusion whereas most(77%) of the high grade gliomas showed restricted diffusion.

Comparative Evaluation Of DWI In Cystic/Necrotic Gliomas

	Number of cases	HypoI on DWI	HyperI on ADC map
Kim YJ et al(6)	4	4	4
Desprechins et al(7)	8	8	8
Present study	8	8	8

The diffusion characteristics of the cystic or necrotic tumors in the present study are comparable to the above two studies. DWI helped not only in identifying cystic/necrotic areas of the tumor but also helped in differentiating them from abscesses.

Case 9:



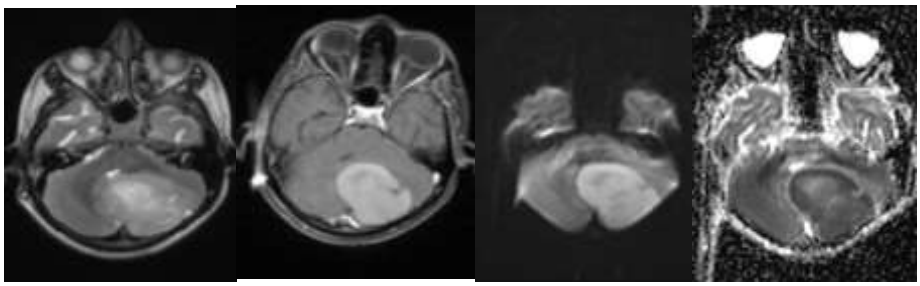
Multiple T1WI/T2 WI/ FlLAIR isointense lesions seen in right frontal and bilateral parietal lobes. Post contrast, intense nodular enhancement of the lesions seen. On DWI, lesions are hyperintense and hypointense signal on ADC map - Metastases.

Comparative Evaluation Of DWI In Intracranial Metastases

Author	No of cases	DWI Hyper I	DWI Iso I	DWI Hypo I
Y. Hayashida et al(8)	26	14	6	6
Present study	5	4	0	1

DWI in intracerebral metastases is not rare, particularly if the primary tumor is lung or breast cancer. However they found that there is no correlation between the metastases showing restricted diffusion and primary pathology.

Case 10:



T1WI hypointense, T2WI/FLAIR hyperintense lesion in left cerebellar hemisphere. Post contrast, homogeneous contrast enhancement seen. On DWI lesion is hyperintense, showing low signal on ADC map.
Histopathology : PNET - Medulloblastoma.

Rodallec M et al(9) 2004, studied diffusion-weighted MR imaging in two adult cases with cerebellar medulloblastoma. Both the cases showed high signal intensity on diffusion-weighted images, with low signal intensity on ADC maps. They concluded that diffusion-weighted MR imaging may be useful for the diagnosis of cerebellar medulloblastoma, due to their high cellularity and high nuclear-to-cytoplasmic ratio.
The diffusion characteristics of adult medulloblastoma reported by Rodallec et al is similar to the case reported in the present study.

VIII. Summary

During the period of nineteen months of the study, 68 cases were evaluated with MRI Brain with DWI. Maximum incidence of lesions was seen in the age group of 45-54 years with a male predominance. Majority of the patients presented with seizures(51.5%) followed by headache(48.5%). Frontal lobe was the most frequently involved region. Extra axial tumors accounted for majority of cases (60.3%).Gliomas(27.94%) constituted majority of the cases. DWI helped in differentiating arachnoid cysts from epidermoid tumors. Based on the diffusion pattern it is possible to differentiate gliomas into low grade and high grade in most of the cases. However there is overlap in DWI findings of low grade and high grade gliomas. Necrotic/Cystic tumors showed lack of restricted diffusion thus enabling differentiation from abscesses. One rare case of adult cerebellar PNET Medulloblastoma was reported in our study which showed hyperintense signal on DWI indicating high cellularity of these tumors. Radiological diagnosis correlated well with histopathology in 48 out of 60 cases in the present study. No histopathological confirmation was obtained for 8 cases of arachnoid cysts.

IX. Conclusion

Conventional MRI provides highly detailed anatomic information and has become a mainstay in the diagnosis of brain tumors. Diffusion weighted imaging provides additional information in differentiating various intracranial tumors, in differentiating arachnoid cysts from epidermoid cysts, grading of gliomas, defining cystic/necrotic components of tumors and also helps in differentiating necrotic tumors from brain abscesses.

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