

# ROLE OF DIFFUSION WEIGHTED IMAGING TO DIFFERENTIATE BETWEEN BRAIN ABSCESS AND CYSTIC/NECROTIC BRAIN TUMOR

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## ABSTRACT

**Objective:** To evaluate the role of diffusion weighted imaging in differentiating brain abscess from cystic/necrotic brain tumor at 1.5 Tesla MR machine.

**Material and Methods:** The study was conducted at the Radiology Department of Khyber Teaching Hospital, Peshawar, Pakistan from January 2013 to December 2015. Diffusion weighted (DW) imaging was performed on fifty four patients having ring enhancing lesion/s in brain. These lesions were categorized into abscess and neoplastic lesions on the basis of diffusion restriction. The observations were compared to histopathological results which were obtained in all these patients. Sensitivity, Specificity, positive and negative predictive values and diagnostic accuracy of DWI were calculated.

**Results:** DWI was found to be 96% sensitive, 97% specific with positive predictive value of 96%, negative predictive value of 95% and diagnostic accuracy of 96% in differentiation of abscess and cystic/necrotic brain tumor.

**Conclusion:** DWI is non-invasive, fast and accurate method to differentiate between abscess and cystic/necrotic brain tumor.

**Key Words:** Ring enhancing lesions, Diffusion weighted imaging (DWI), Brain, MRI, abscess, cystic/necrotic brain tumor.

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## INTRODUCTION

Ring enhancing lesions of the brain are one of the common abnormalities seen on neuroimaging and may result from a variety of etiological factors i.e. infectious, inflammatory or neoplastic lesions (either primary/metastatic)<sup>1</sup>. Exact differentiation between brain abscess and cystic or necrotic brain tumor by CT/MR imaging is usually difficult<sup>2</sup>. On conventional MR imaging, central portion of brain abscess typically has low signals on T1-weighted images, high signals on T2-weighted images and ring/marginal enhancement on post contrast T1 sequences, while the abscess wall shows low signals on T2-weighted images. However, cystic/necrotic brain tumor may also shows similar picture<sup>3,6</sup>. In addition to similar neuro-radiological appearance, the presenting clinical manifestations are often non-specific. The most common signs and symptoms are those of any

expanding intracranial mass i.e., headache, vomiting, focal sensorimotor deficits, seizures and altered mental status<sup>4,5</sup>.

Certain newer techniques like diffusion weighted imaging and MR spectroscopy are useful diagnostic modalities that may help differentiate between an abscess and cystic/necrotic brain tumor<sup>3,6</sup>. Diffusion-weighted MR imaging provides image contrast which stands in marked contrast in comparison to that of conventional MR sequences<sup>7</sup>. Ebisu et al<sup>8</sup> were the first to recognize the usefulness of DW imaging in diagnosis of brain abscesses. The abnormal high DWI signals in case of abscess are the result of the restricted diffusion of water molecules within the lesion due to high viscosity or cellularity of pus<sup>9</sup>. On the other hand, low signals seen in cystic/necrotic brain tumor on DWI sequences in comparison to the surrounding normal brain parenchyma are because of increased diffusion properties<sup>10,11</sup>.

The purpose of this study is to see the usefulness of DW imaging in differentiating brain abscess from cystic/necrotic tumor and to compare our results with other national and international studies, as to our knowledge until now no published data is available in Khyber Pakhtunkhwa.

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**MATERIAL AND METHODS**

This prospective study was conducted at the Radiology Department of Khyber Teaching Hospital, Peshawar, Pakistan from January 2013 to December 2015. All patients showing ring enhancing lesions in brain were included in the study. Patients with post-treatment tumor recurrence were excluded. All patients were scanned in 1.5 Tesla MRI Machine (Achieva, Phillips). Conventional MR sequences of brain (axial T1, T2, sagittal T2, coronal FLAIR and post-contrast axial, sagittal and coronal images) and diffusion weighted-axial images were taken. Scans were interpreted on basis of signal intensity. Diffusion restriction was defined as hyperintense signals, while facilitated diffusion was described as hypointense signals on DWI compared to normal brain parenchyma. Final diagnosis was made on histopathological results. Percentages, sensitivity, specificity, positive and negative predictive values and accuracy of the study were calculated via SPSS software version 20.

**RESULTS**

A total of 54 patients were studied, thirty two were male (59%) while twenty two were female patients (41%). Mean age was 48 ±15 years. Most common clinical presentations were headache (74%), nausea/vomiting (54%), seizures (51%), fever (25%) and sensorimotor deficit (21%). Signal intensities on DW images are shown in Table 1. Out of 54 patients, 24(44.5%) lesions showed high signals on DW images thus depicting diffusion restriction, while 30(55.5%) lesions did not show diffusion restriction. On histopathological examination, 24(44.5%) of the total 54 cases had been diagnosed as brain abscess (14.8% bacterial and 29.6% tuberculous), while 30 cases (55.5%) were neoplastic lesions (24% gliomas and 31.5% metastasis). The accuracy of DW imaging is shown in Table 2. Various T<sub>1</sub>W and DW<sub>1</sub> finding are shown in Figure 1.

**Table 1: Diffusion Weighted Imaging findings**

Final Diagnosis (on histopathology results)		Signal intensities on DW images	
		Hyperintense	Hypo/iso-intense
Abscess 24 cases (44.5%)	Bacterial 8 cases (14.8%)	8	0
	Tuberculous 16 cases (29.6%)	15	1
Cystic/necrotic brain tumor 30 cases (55.5%)	Gliomas 13 cases (24%)	0	13
	Metastasis 17 cases (31.5%)	1	16

**Table 2: Accuracy of DW imaging**

Sensitivity	96%
Specificity	97%
Positive predictive value	96%
Negative predictive value	95%
Diagnostic accuracy	96%

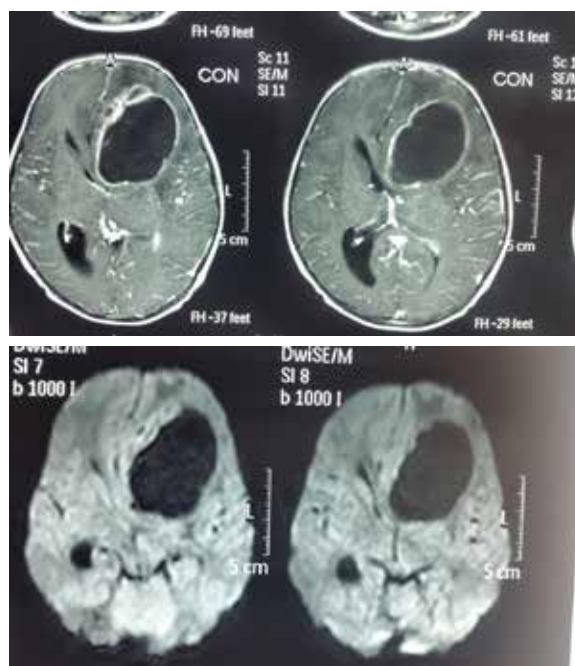


Fig 1: (a) T1W post –gadolinium axial image and (b) DWI at the same level showing ring enhancing cystic lesion in left frontal lobe which demonstrates free diffusion suggestive of cystic glioma.

**DISCUSSION**

Both CT and MR imaging reveal a high sensitivity for diagnosing ring enhancing brain lesions. However, are less specific for differentiating between cystic/necrotic brain tumor and abscess. Newer techniques like MR spectroscopy and DW imaging offer promising results in characterization of these lesions. DW imaging is more practical to be utilized in clinical use<sup>12</sup>, It is acquired as fast echo planar imaging technique and requires less imaging time<sup>7,13</sup>. MR spectroscopy in comparison to DWI is more time consuming, less specific in lesions near bone or skull base and less reliable in case of smaller lesions<sup>14,15,16</sup>.

On diffusion weighted sequences, the difference observed in signal intensities between abscess and cystic/necrotic tumor is mainly due to differences in the consistency and viscosity of central contents of lesions. In abscess, the contents consist of thick viscous pus containing inflammatory cells, bacteria and thick proteinaceous material which restricts free Brownian movement of water molecules thus causing restricted diffusion on diffusion weighted images<sup>17</sup>. While in case of cystic/necrotic tumors, the cavities contain thin

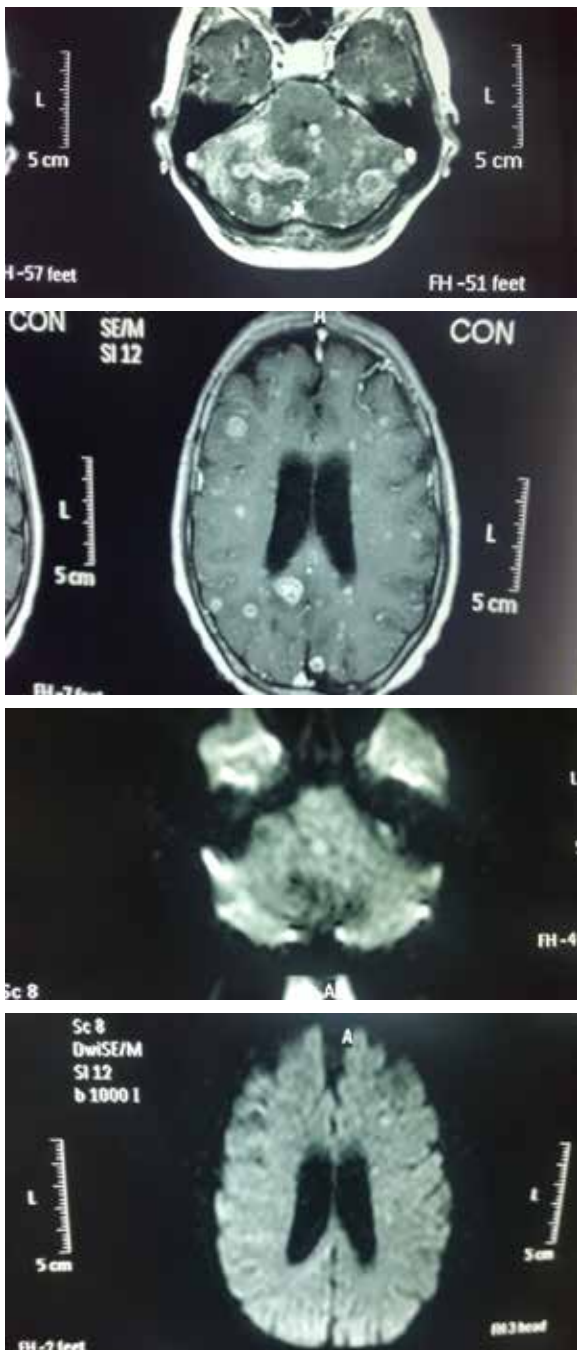


Fig 2: (a) T1W post-gadolinium image at level of posterior fossa and (b) bodies of lateral ventricle showing ring enhancing lesions in both infra- and supra-tentorial regions which on DWI at same levels (c) and (d) show free diffusion suggesting metastatic deposits.

necrotic debris, more serous fluid and few inflammatory cells as compared to abscess thus causing free diffusion on DW images appearing as low signals<sup>6</sup>.

In our study, signal intensities of abscess (bacterial and tuberculous) were markedly high as compared to cystic/necrotic tumor. All bacterial cases and majority



Fig 3: (a) multiple thick-walled ring enhancing lesions in right para-sagittal region which on (b) DWI shows restricted diffusion suggesting tuberculomas.

of tuberculous 15 cases abscesses showed high signals on DWI, while only one case of tuberculomas in frontal lobe showed low signals, most probably due to partial treatment (Fig 4). These results are in agreement with Alam et al<sup>12</sup> and Kim et al<sup>6</sup>.

Majority of cystic/necrotic brain tumors in our study showed low signals on DW images 29 cases except one case of metastatic breast disease. The possible explanation to this may be change in the cellular contents of the cystic/necrotic component of tumor<sup>8,11</sup>. Some tumors show haemorrhagic transformation which makes the contents more viscous, thus causing restricted diffusion<sup>12</sup>. Overall, this study showed high sensitivity (96%), specificity (97%), PPV (96%), NPV (95%) and diagnostic accuracy (96%). Apparent diffusion co-efficient (ADC).

### LIMITATIONS

There were few limitations of this study which may have affected the results.

### CONCLUSION

Diffusion-weighted imaging is a fast, sensitive and non-invasive diagnostic imaging technique to differentiate between abscess and cystic/necrotic brain tumor when used in addition to conventional MR imaging.

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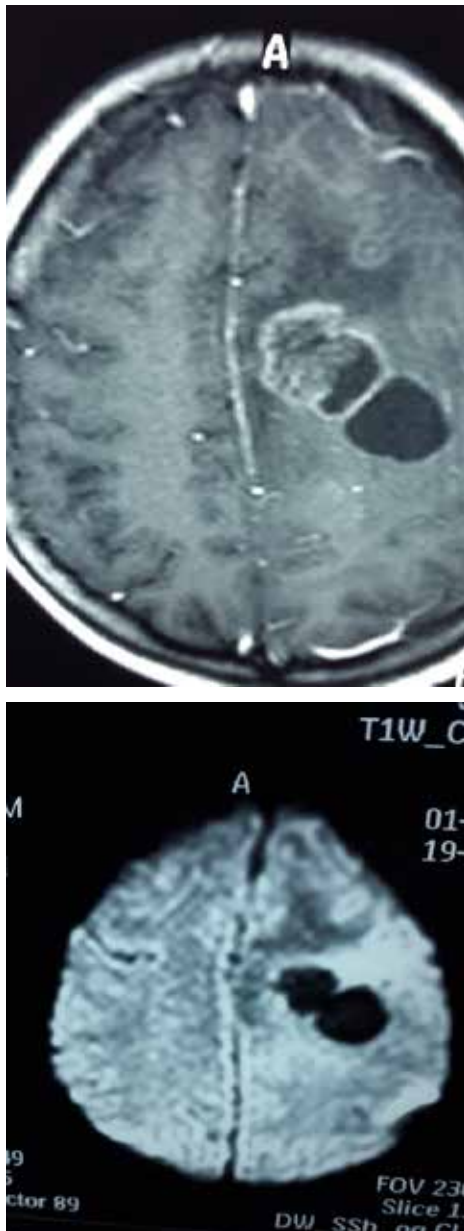


Fig 4: (a) Post-gadolinium T1W axial image showing ring enhancing lesion in left high frontal region revealing free diffusion on (b) DWI, was initially reported as neoplastic lesion but later on previous history of anti-tuberculous treatment and CSF reports proved these lesions to be partially treated tuberculomas (false negative case).

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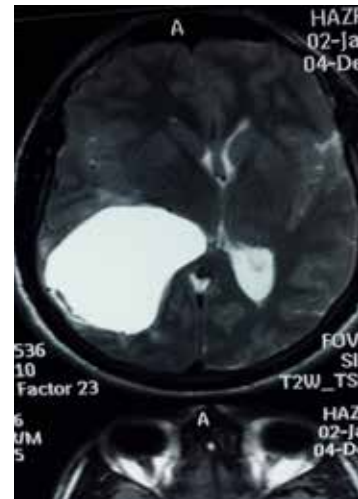


Fig 5: (a) T2W axial image showing fluid intensity lesion in right parietal region, which on post-gadolinium axial scan (b) reveals marginal enhancement and free diffusion on (c) DWI suggestive of astrocytoma.

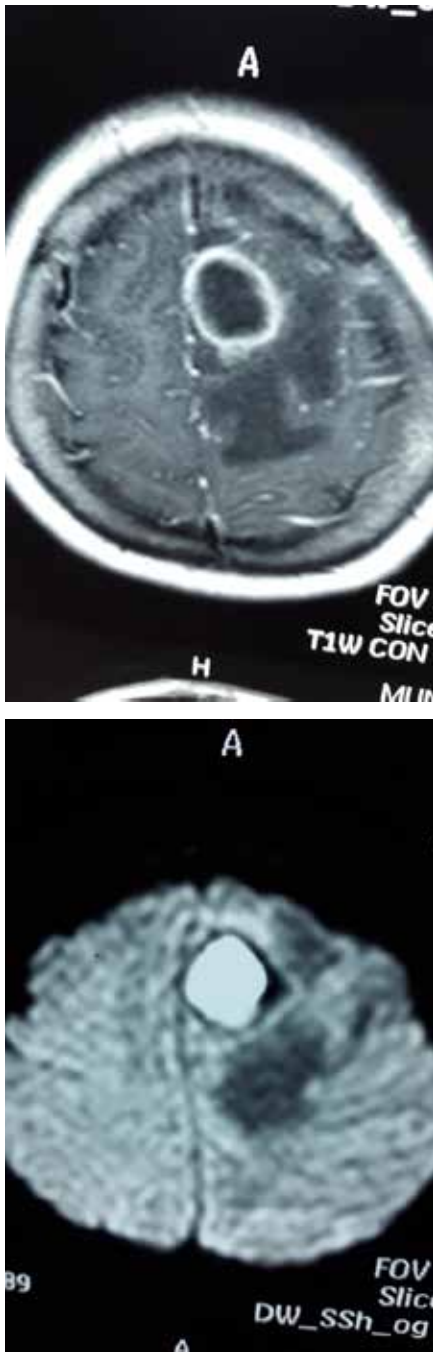


Fig 6: (a) Post- gadolinium axial image of vertex of brain showing ring enhancing lesion in left para-sagittal region which demonstrates restricted diffusion on (b) DWI images suggesting brain abscess.

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