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CAN DIFFUSION WEIGHTED IMAGING REPLACE THE USE OF GADOLINIUM IN DIAGNOSING BRAIN ABSCESS?

Radio-Diagnosis

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ABSTRACT

Brain abscesses (BA) are focal infections of the central nervous system (CNS) caused by pus collection in the brain1. Different radiological modalities are used to diagnose the brain abscess, mainly magnetic resonance imaging (MRI) as it has good soft tissue differentiation. Newer modality in MRI like diffusion weighted imaging (DWI) plays a significant role in diagnosing brain abscess and its management. DWI is a method of MRI in which restriction of diffusion of Brownian motion of water molecules are assessed7. Use of gadolinium contrast helps to diagnose the brain abscess with more confidence. The purpose of this study is to compare the diagnostic performances of (DWI) and gadolinium contrast material-enhanced (CE) imaging in diagnosing brain abscess.

KEYWORDS

brain abscess, DWI, ring enhancement.

INTRODUCTION

Brain abscesses (BA) are focal infections of the central nervous system (CNS) caused by pus collection in the brain. They account for 1–2% of space occupying brain lesions in western countries and 8% in developing countries[1]. Main predisposing conditions are contiguous spread of pathogens (50% of the cases) following otitis or mastoiditis, sinusitis, meningitis, neurosurgery or traumatic brain injury or through hematogenous dissemination. However, the primary site of infection remains unknown in 40% of cases.[2] According to the site of the BA, symptoms may be different; these include in decreasing order: headache, fever, focal neurologic deficit, seizures and mental status changes.

Consequently, the diagnostic and therapeutic management can be challenging.

Imaging has a primary role in differentiating BA from other lesions using MR as the technique of choice for diagnosis and follow-up. Conventional MRI imaging has limitations in the diagnosis of brain abscess. Thus advanced MRI techniques such as diffusion-weighted imaging (DWI), perfusion-weighted imaging (PWI) and proton MR spectroscopy (^{1}H-MRS), and post contrast imaging helps in their diagnostic management[3].

DWI imaging play major role in diagnosing the brain abscess. The principle of DWI is based on the degree of restriction to water diffusion in biologic tissues, which is inversely correlated to the tissue cellularity and the integrity of cell membranes[3].

The motion of water molecules is more restricted in tissues with a high cellular density associated with numerous intact cell membranes (e.g., tumor tissue). The lipophilic cell membranes act as barriers to motion of water molecules in both the extracellular and intracellular spaces. By contrast, in areas of low cellularity or where the cellular membrane has been breached, the motion of water molecules is less restricted.

A less cellular environment provides a larger extracellular space for diffusion of water molecules, and these molecules may also freely transgress defective cell membranes to move from the extracellular into the intracellular compartment.[6,7]

This can be quantified using apparent diffusion coefficient (ADC). Broadly speaking, a lesion can have a high signal intensity on DWI (due to restriction to water diffusion) associated with low ADC score or a low signal intensity associated with a higher ADC score.[4]

Post contrast imaging helps in diagnosing the brain abscess which shows thin smooth rim enhancement which helps in the differentiating the abscess from other cause.

Among the various diagnostic tests available, in this study we the diagnostic performances of (DWI) and gadolinium contrast material-enhanced (CE) imaging in diagnosing brain abscess[4].

AIMS & OBJECTIVES

The purpose of this study is to compare the diagnostic performances of diffusion-weighted imaging (DWI) and gadolinium contrast material-enhanced (CE) imaging in diagnosing brain abscess.

MATERIALS & METHODS

Hospital based cross-sectional study was conducted in the Department of Radiodiagnosis, GIMS, Gadag, Karnataka, India for a period of one year. About 30 patients which were sent in suspicion of abscess / diagnosed as abscess were imaged by 1.5 T PHILIPS MRI machine.

RESULTS

Total number of cases with brain abscess studied were 30. Among which 18 cases were male and 12 were female. Among all cases majority of the patients were in age group of 60-70 years with least number in 20-30 years. Majority of the brain abscess were in the frontal lobe i.e 11 cases.

Table 1 - Number of cases according to location.

S. No	Location	Number of cases
1	Frontal lobe	11
2	Parietal lobe	7
3	Temporal lobe	4
4	Occipital lobe	2
5	Cerebellum	6

Table 2 - Diffusion characterization of abscesses

S. Number	Location	DWI	Mean ADC(mm2/sec)
1	Frontal lobe	Restriction	0.77x10-3
2	Parietal lobe	Restriction	0.68x10-3
3	Temporal lobe	Restriction	0.71x10-3
4	Occipital lobe	Restriction	0.62x10-3
5	Cerebellum	Restriction	0.78x10-3

All the cases of brain abscess showed high signal intensity in the DWI with low signal intensity in the ADC representing diffusion restriction. ADC values are calculated for all the cases. The mean ADC value of the abscess cases in our study: 0.71 x 10^{-3} mm^2/sec. The ADC values were in range of 0.51 x 10^{-3} to 0.92 x 10^{-3} mm^2/sec.

On post contrast imaging all the cases showed smooth ring enhancement. Therapeutic drainage was performed in 4 cases, which revealed abscess and all four had diffusion restriction with low ADC values.

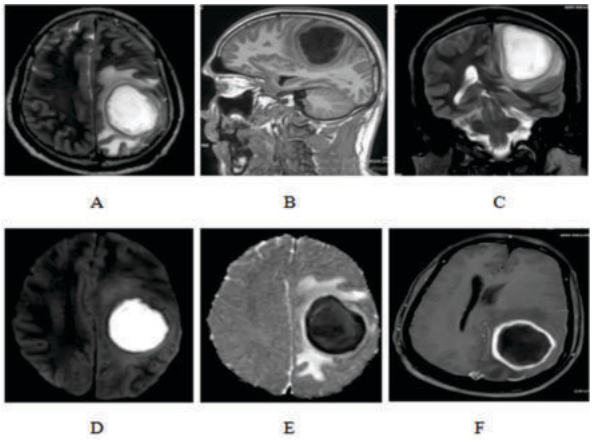

Figure 1 – A and C -T2 WI images showed hyper intense lesion in the left parietal lobe with surrounding edema. B- T1 WI corresponding area showing in the hypo intensity. D and E – DWI and ADC showing restriction in the DWI with low signal intensity in the ADC with ADC value of 0.6x 10^{-3} mm^2/sec F- Post contrast image showing peripheral thin smooth rim enhancement.

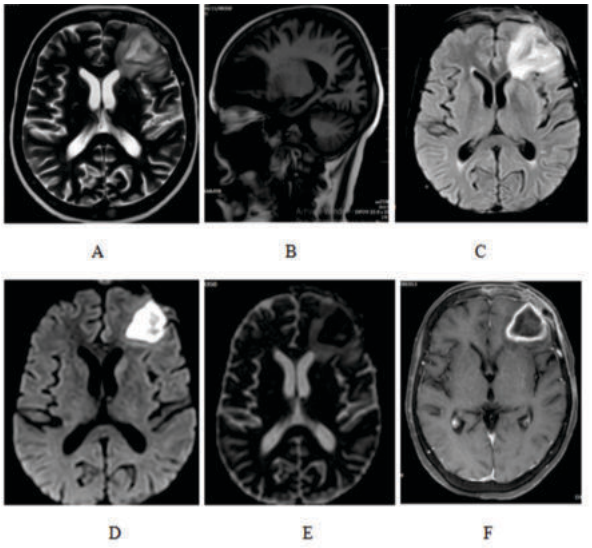

Figure 2 – A -T2 WI hyperintense area in the left frontal lobe with surrounding edema. B- T1 WI corresponding area showing in the hypo intensity. C- corresponding area showing hyperintensity in the FLAIR imaging. D and E – DWI and ADC showing restriction in the DWI with low signal intensity in the ADC with ADC value of 0.6 x 10^{-3} mm^2/sec F- Post contrast showing peripheral thin smooth rim enhancement.

DISCUSSION

Brain abscesses (BA) are focal infections of the central nervous system (CNS) caused by pus collection in the brain. MRI helps in the diagnosing as it has good soft tissue resolution. Conventional magnetic resonance imaging (cMRI) is essential for the identification of the lesion, its localization and its morphological features. However, cMRI does not allow to reliably differentiate BAs from other intracranial mass lesions such as necrotic tumors. Advanced sequences, such as diffusion-weighted imaging (DWI) and post contrast imaging helps in diagnosis and management of brain abscess cases[9].

A ring-enhancing lesion in the brain is a nonspecific finding and a variety of inflammatory and neoplastic processes can have a similar appearance. Moreover, it is important to differentiate between a pyogenic brain abscess and a necrotic neoplasm, as both have different treatments and prognoses[6].

DW imaging is based on the microscopic motion of water molecules and depends mostly on the water located in the extracellular space. Restriction of diffusion of water molecules in extra cellular space is evaluation and appear as restriction / high signal intensity in the DWI, which can be quantified by ADC maps [3]

Necrotic material in cerebral abscesses contains inflammatory cells, a matrix of proteins, cellular debris, and bacteria in high-viscosity pus; all of these factors restrict water motion.

Additionally, water molecules are bound to amino acid groups on the surface of macromolecules, further restricting their motion. Therefore, restricted water motion in cerebral abscesses has increased signal intensity on trace DW imaging and low ADC values [3,4].

The diagnosis of abscess is established with a high level of confidence based on T2w and post-contrast T1w imaging which shows thin smooth peripheral wall enhancement, with central non enhancing area which represents fluid[8].

In our study total 30 patients were studied. Out of 30 cases 18 cases were males and 12 were females. The age group of patients were between 20-70 with majority of patients falling in age groups of 60-70. The brain abscess were seen in all the lobes with frontal lobe predominance accounting for 11 cases. 7, 4, 2 and 6 cases were seen in the parietal, temporal, occipital lobes and cerebellum respectively.

Routine MRI was performed for all the cases, which was added with DWI imaging and post contrast imaging T1 WI. DWI MRI was performed with b value of 0, 500, 1000. Which was further evaluated with ADC maps.

On routine MRI imaging, all the lesions showed high signal intensity in T2 and FLAIR imaging. Corresponding area shows low signal intensity in the T1 WI. On DWI all the cases showed diffusion restriction with high signal intensity in DWI and low signal intensity in ADC. ADC values were calculated for all the cases. The mean ADC value of the abscess cases in our study: 0.71 x 10^{-3} mm^2/sec. The ADC values were in range of 0.51 x 10^{-3} to 0.92 x 10^{-3} mm^2/sec.

All cases were performed with post contrast T1 WI which showed smooth thin peripheral rim enhancement. Therapeutic drainage was performed in 4 cases, which revealed abscess and all four had diffusion restriction with low ADC values.

On routine MRI technique with post contrast imaging detection of abscess had sensitivity of 92% and specificity of 96%. In addition, standard MRI with DWI yielded sensitivity of 90% and specificity of 92%.

As both DWI with conventional MRI and Contrast study with Conventional MRI has near equal sensitivity, DWI can be considered to diagnose abscesses in conditions where contrast can't be given. However, addition of contrast imaging increases the sensitivity to 100%.

CONCLUSION

Assessment of the abscesses by MRI has more sensitivity as it has high resolution of soft tissue. T2WI with post contrast (gadolinium) T1WI can detect the abscess with high sensitivity and specificity. Diagnosing of abscess by Diffusion-weighted MRI is seen to have near equal sensitivity and specificity, thus DWI can replace the use of gadolinium in diagnosing the abscesses in cases where gadolinium can be avoided.

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