ORIGINAL ARTICLE

DIFFUSION MRI IN PATIENTS WITH EARLY ISCHEMIC BRAIN STROKE

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ABSTRACT

OBJECTIVES: To determine the frequency of ischemic brain lesions by diffusion magnetic resonance imaging in patients with early ischemic stroke (within 24 hrs.) having normal computerized tomography brain. **PATIENTS AND METHOD:** This was a cross sectional study conducted at Department of Radiology Allied Hospital, Faisalabad from August 2011 to June 2012. A total of 96 patients with early ischemic brain infarct were included in this study. All patients were examined with spiral CT scanner and immediately thereafter with 1.5 Tesla whole body MR imager, (DWI and ADC images). **RESULTS:** Mean age of the patients was 57.3 ± 9.7 year. Distribution of patients by gender shows 76 patients (79.2%) were male while remaining 20 patients (20.8%) were female. Out of 96 patients with normal CT scan, brain lesions were detected in 32 patients. 49 ischemic brain lesions on diffusion magnetic resonance imaging were detected. Out of these 49 ischemic brain lesions, 25 (51%) lesions were in parietal region, 12 (24.5%) lesions were in frontal region, 7 (14.3%) lesions were in occipital region while 5 (10.2%) lesions were in temporal region. **CONCLUSION:** Diffusion-weighted imaging is a valuable tool, for both expert and novice radiologists, in the early diagnosis of ischemic stroke.

Key words: Ischemic stroke, Diffusion-weighted MRI, ADC

Introduction

Stroke is a leading cause of high mortality and long term disability with an annual incidence of 795,000 each year in United States.[1]

MRI is better than CT for detecting acute stroke of any kind, and should be the diagnostic imager of choice in the emergency room, according to national institute of health resources.

Diffusion MR imaging in patients of acute brain stroke reveals ischemic lesions earlier and more clearly than fluid attenuation inversion recovery (FLAIR) imaging.[2] Diffusion weighted imaging (DWI) shows signs of recent brain ischemic in 52% patients with a normal CT scan. Multiple lesions were detected in 16% of patients, while single lesions were < 2 cm in 76% cases. DWI shows signs of ischemic in 24% patients with transient ischemic attack (TIA) and in 84% patients with stroke.[3] Diffusion MR imaging is now a routine component of the brain MR imaging examination and is critical in the evaluation of stroke patients.[4] DWI may serve as a simple tool to stratify risk among TIA patients and guide early management decisions. For instance, patients of transient symptoms associated with infarction might benefit the most from acute hospitalization and perhaps more aggressive medical, surgical or endovascular therapies aimed at lowering their high risk of early clinical recurrence.[5]

Patients are routinely diagnosed with CT brain with detects infarction at irreversible stage. Diffusion MRI detects brain tissue at risk at an earlier stage within minutes of arterial occlusion before infarction occurs. Brain lesion at this stage is potentially reversible by

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revascularization with thrombolytic therapy which helps in better patient survival, secondary stroke prevention and rehabilitation.

Patients & Methods

This was a Cross-sectional study undertaken in Department of Radiology, Allied Hospital, Faisalabad. Study was carried out over a period of twelve months from August 2011 to June 2012.Ninety six patients who ranged from 30-70 years of age of both genders showing the symptoms of acute ischemic brain stroke within first 24 hours were collected from emergency department of Allied Hospital, Faisalabad. The patients excluded from the study are those with unstable vitals, general MRI contra-indications (metallic implants and pace-makers), patients with intra-cerebral haemorrhage, intracranial mass lesion and infections on plain CT brain. All the patients were examined with spiral CT scanner and immediately thereafter with 1.5 Tesla whole body MR imager (DWI and ADC images). For MRI examination circular polarized head coil was used. The stroke MRI protocol included axial isotropic DWI spin echo sequences and ADC images of 5 mm slice thickness, TR (time to repeat) of 2824 msec, and TE (time to echo) of 89 msec at b value of 1000 mm^2/sec, MR images were post-processed with the use of extended MR Workspace R1.0 (view forum R 6.1 V5) software and a workstation. Infarct size was measured by manually outlining the lesions and the data was collected

Data was analyzed on SPSS version 17. Descriptive statistics was calculated for all variables. Mean and standard deviation was calculated for all quantitative variables like age, number of ischemic brain lesions and size of largest lesion in cm. Frequency and percentages were calculated for all qualitative variables like sex, presence of ischemic brain lesions and site of lesion.

Results

Majority of the patients were between 51-70 years of age and least patients were 30-40 years old with mean age of 57.3 ± 9.7 year (Tab. 1).

Majority of the male patients were suffering from stroke (Tab. 2).

Out of 96 patients with normal CT scan, brain lesions were detected in 32 patients. 49 ischemic brain lesions on diffusion magnetic resonance imaging were detected. Out of these 49 ischemic brain lesions, 25 lesions were in parietal region, 12 lesions were in frontal region, 7 lesions were in occipital region while 5 lesions were in temporal region (Tab. 3 & 4).

Age (Year)	Number	Percentage
30-40	11	11.5
41-50	18	18.7
51-60	37	38.5
61-70	30	31.3
Total	96	100.0
Mean±SD	57.3±9.7	

Table 1: Distribution of patients by age

Gender	Number	Percentage
Male	76	79.2
Female	20	20.8
Total	96	100.0

Table 2: Distribution of patients by gender n=96

Brain lesions	Number	Percentage
Yes	32	33.3
No	64	66.7
Total	96	100.0

Table 3: Distribution of patients having brain lesions n=96

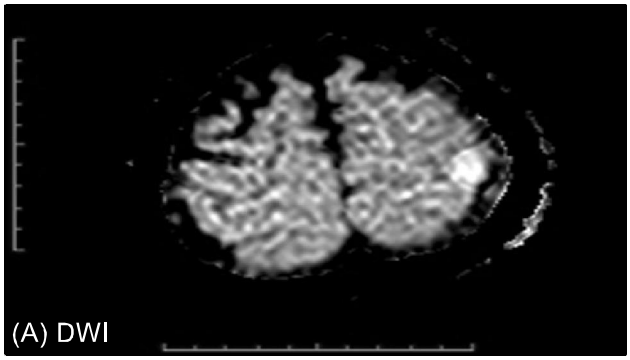
Site	Number	Percentage
Frontal	12	24.5
Parietal	25	51.0
Temporal	05	10.2
Occipital lobe	07	14.3
Total	49	100.0

Table 4: Site of ischemic brain lesions n=49

Discussion

In the early stage of ischemia, CT is the technique of choice to distinguish between hemorrhagic and non-hemorrhagic stroke. However, with CT 30% to 60% of the ischemic lesions are still invisible in the acute stage.[6,7] The major advantage of MRI over CT is its ability to demonstrate very small acute ischemic lesions on DWI.[8] DWI not only confirms the clinical

diagnosis, but also facilitates the recognition of certain patterns of ischemia, thereby providing clues to the underlying etiology. Finally, the presence of acute lesions can also improve the prediction of stroke risk after TIA.[9] The post-infarction treatments available are largely dependent on the timing after infarction to determine the stages of brain damage as reper-



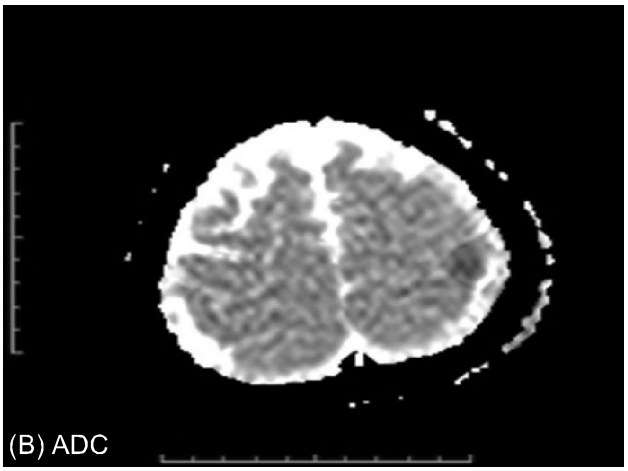


Figure1: 57 year female with acute onset right sided numbness and weakness having **(A)** hyperintense signals on DWI and **(B)** hypopintense signal on ADC sequence in left parietal region suggestive of acute infarct.

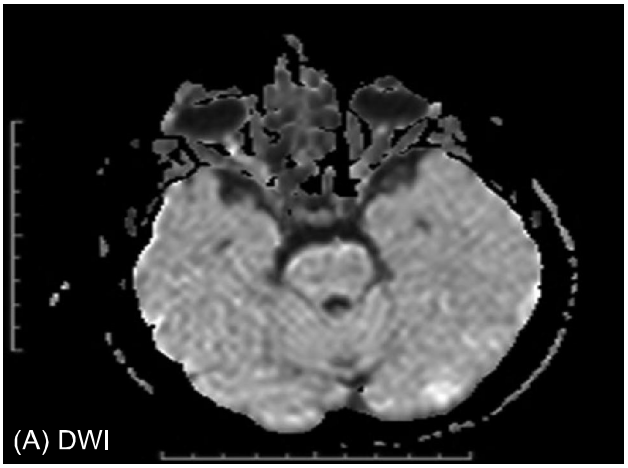


Figure 2: The patient was imaged approximately 6 hours after the onset of acute neurologic deficit with normal CT brain. DWI having high signal intensity and ADC image showing low signal intensity lesion in left occipital region suggesting acute infarct.

fusion with i/v recombinant tissue plasmino-gen activator is only affective within a narrow the rapeutic window.[10]

DWI is currently the only imaging method to investigate diffusion activities of water molecules in vivo; ADC reflects the diffusion speed of water molecules, and the fast diffusion of water molecules can be revealed with a larger ADC value with lower signals of DWI images.[11]

Ischemia induced membrane dysfunction and cytotoxic edema causes restriction of diffusion of water molecules and lead to a decrease in the apparent diffusion coefficient (ADC),[12] which is visualized as a hyperintensity on the diffusion-weighted images (DWI).

Previous studies showed that DWI is able to visualize cerebral ischemic changes within 5 minutes[13] 1 to 3 hours after onset of symptoms.[14] In humans, ischemic changes were detected with DWI as early as 2 to 6 hours after onset of symptoms.[15] Other advantages of DWI are the low number of false-negative investigations (5%),[16] the clear discrimination between ischemic lesions and the non-ischemic brain[17] and the discrimination between acute and chronic ischemic lesions.[16] With these features, DWI facilitates the determination of the type, site, and extent of cerebral ischemia at an early stage. This might help to predict the clinical outcome of stroke patients.

Recent studies showed that in the acute stage after

stroke, DWI is more sensitive for early ischemic changes than T2-w MRI.[18] However, other studies showed that both PD-w imaging[19] and fluid-attenuated inversion recovery (FLAIR) imaging are superior to T2-w imaging in the detection of acute ischemic lesions. Therefore, DWI should be compared with PD-w and FLAIR imaging as well.[20]
In our study, 51% brain lesions on diffusion magnetic resonance imaging were detected. Our results are comparable with the study of Totaro et al.[3]

Conclusion

DW MR imaging helps in directing the treatment of acute ischemic stroke by detecting lesions within minutes instead of hours. Diffusion-weighted imaging has prognostic superiority over conventional MRI. It can also differentiate new strokes from old strokes and discriminate between acute and chronic ischemia.

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