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Research Article

COMPARATIVE EVALUVATION ON DWI, T2 –W AND FLAIR SEQUENCES ON MRI IN ACUTE STROKE PATIENT

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ABSTRACT

Introduction: MRI provides information that is useful for diagnosing ischemic stroke, selecting appropriate patients for thrombolytic therapy, and predicting the prognosis of ischemic stroke. Present study involves the comparative evaluation between DWI, T2-W and FLAIR sequences.

Material and Methods: Sample size: 91 In the present study, patients had MRI after presentation on a 1.5 T MR scanner (with 22 mT m_1 maximum strength gradients, including axial DWI, T2-weighted, fluid attenuated inversion recovery (FLAIR) sequences.

Inclusion criteria: Patient referred to the department of radio diagnosis with clinical diagnosis of acute stroke.**,** Cases of all age group irrespective of sex.

Exclusion criteria: Patient who needed artificial respiration and patient who were otherwise unable to undergo the MR examinations were excluded.**,** Patients with intracranial hemorrhage. All patients referred to the department of radio-diagnosis with acute stroke were clinically evaluated on the basis of history and clinical examination.

Results: Data on reproducibility of MRI scan suggested that DWI clearly delineated recent damage in 91 patients (100%) as compared with 63 (69%) in whom lesions were identified or suspected on conventional T2-weighted images. DWI provided information not accessible with T2-weighted imaging in 63 patients when evidence of lesion multiplicity or detection of clinically unrelated recent lesions was included for comparison. Reproducibility observed for FLAIR (81; 89%) was found to be between DWI and T2-W. Our study also suggested that reproducibility of DWI based MRI service is both feasible and sustainable in the setting of a district general hospital and most clinicians feel that this is a significant improvement to stroke services.

Conclusion: Our results provide clear evidence of a significant diagnostic contribution of DWI beyond this acute phase. In comparison with T2-weighted and Flair sequences, DWI proved to be superior in delineating areas of recent ischemic damage in about one third of all patients. This higher sensitivity of DWI served not only to pinpoint stroke-related infarcts but also helped to detect clinically unsuspected lesions in more number of patients.

INTRODUCTION

Cerebro-vascular disease represents a major source of global mortality, with over 6 million deaths documented annually, and is the second leading cause of death in all income groups worldwide, exceeded only by ischemic heart disease[(1)]. In addition to being a leading source of mortality, cerebrovascular disease is also a significant cause of morbidity. As many as 50 % of stroke survivors do not regain functional independence, and 20 % require institutional care 3 months after stroke onset[(2)].

Two types of stroke can dramatically disrupt this normality, Hemorrhagic stroke, or intra-cerebral hemorrhage, represents 10–15 % of stroke cases. Although the incidence of this type of stroke is low, it is associated with significant morbidity and

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mortality. Up to 38 % of patients that experience hemorrhagic stroke will die within 30 days [3], and approximately half of survivors will remain dependent on others for activities of daily living [4]. Ischemic stroke is more common, representing approximately 85 % of all stroke cases, and has a much lower 30-day mortality rate at approximately 12 %. Morbidity in ischemic stroke may also be severe and is highly dependent upon timely diagnosis and initiation of treatment. An ischemic lesion may also undergo hemorrhagic transformation. A number of clinical tests have been developed over the years to help determine the presence of stroke [5]. Although these tests may aid in the initial triage of acute neurological patients, they cannot match the sensitivity and specificity of an imaging examination, nor is there any clinical test available that can accurately differentiate ischemic and hemorrhagic stroke[6]. Therefore, the initial step in the management of a suspected stroke patient is an imaging examination.

Magnetic resonance imaging (MRI) is usually more sensitive and specific in distinguishing both the stroke mimics and secondary ischemic lesions. Finally, the application of a contrast agent may increase the specificity of imaging. During first 24 hours after an ischemic stroke, proton density weighted and T2-w MRI has 20%- 30% false negative result. This percentage increases to 30-50% during first 3-6 hours after stroke. Diffusion-weighted imaging (DWI) has been shown to contribute significantly to the early detection of acute ischemic infarction and is recognized as a bright lesion because of a drop in diffusivity [7]. This phenomenon of restricted diffusion associated with ischemic damage persists for at least 4 to 6 days. Thereafter, diffusion starts to increase and hyperintensity on DWI studies begins to vanish.

FLAIR is considered one of the most useful MR techniques for investigating white matter (WM) diseases such as multiple sclerosis (MS). The anatomical detail afforded by FLAIR has resulted in its use as the sequence for measuring final infarct volume in several imaging based stroke trials [8]. The timing of FLAIR to optimally measure infarct volume has most often been at day 90 after stroke, although evolution of infarct beyond earlier time points at 30 days or even as soon as 3-7 days after stroke onset may not be significant, supporting the use of an earlier time point to measure infarct volume for trial purposes[9]. The time taken for an ischemic lesion to appear on FLAIR is longer than that taken for the same lesion to appear on DWI, but most FLAIR hyperintensities appear within 6 hrs of symptom onset. The use of this "mismatch" between timing FLAIR and DWI lesion appearances has been suggested as a surrogate marker for strokes of recent onset (within 6 hrs) and therefore may be used for trial purposes targeting therapy at patients with wake-up strokes who are usually excluded from thrombolysis [10].

Three-dimensional phase-contrast magnetic resonance venography (MRV) is the preferred technique in the evaluation of venous thrombosis.

Posterior reversible encephalopathy syndrome (PRES)
Posterior reversible encephalopathy syndrome (PRES) presents clinically with acute/subacute onset headache, seizures, visual changes, altered mental status, and occasionally focal neurologic signs. MRI typically shows symmetrically distributed areas of vasogenic edema predominantly within the territories of the posterior circulation. The abnormalities affect primarily the white matter, but cortex is also involved. The diffusion weighted abnormality is associated with normal or high ADC value, differentiating the vasogenic edema induced by hypertension from cytoxic edema induced by ischemia [11].
The three main categories used in outcome measures by MRI are,

1. DWI lesion volume change,
2. PWI lesion volume change, and
3. recanalization of the occluded vessel on MRA.

Hence present study showed that recent ischemic damage consequence of acute stroke is better shown on DWI sequences than on T2- W on first 3-6 hrs of imaging and may provide further information about the origin of clinical symptoms.

Aim: Comparison of DWI, T2, and FLAIR sequences on MRI to detect infarct in patient with acute stroke.

MATERIAL & METHODS

Source of Data

The main sources of data were patients referred to department of radio diagnosis with clinical diagnosis of acute stroke.

METHOD AND COLLECTION OF DATA

Sample size: **91**

This prospective, observational type of study was performed in our institution.

Inclusion criteria

Patient referred to the department of radio diagnosis with clinical diagnosis of acute stroke.
Cases of all age group irrespective of sex

Exclusion criteria

- Patient who needed artificial respiration and patient who were otherwise unable to undergo the MR examinations were excluded.
- Patients with intracranial hemorrhage.

METHODOLOGY

All patients referred to the department of radio-diagnosis with acute stroke were clinically evaluated on the basis of history and clinical examination.
Scanning was done with:
Magnetic Resonance Imaging (MRI): 1.5 tesla Seimens Avanto machine involving:
T2
FLAIR
DWI

Statistical analysis for calculating sample size

Formula for calculating sample size
Here

$$n = \left[\frac{Z \square\square\square}{E}\right]^2$$

$$= \left[\frac{1.96 \times 0.097}{0.02}\right]^2$$

$$= \left[\frac{\square.19012}{0.02}\right]^2$$

$$= (9.506)^2$$

$$= 91$$

Thus total of 91 sample were undertaken.
Here Z is standard normal varient taken as 1.96 at 5% level of significance

Standard deviation (□) taken as 0.097 and absolute error taken as 0.02 as per previous studies.

RESULT AND DISCUSSION

One of the major causes of death and disability is ischemic stroke. Recent experimental and clinical evidence suggests that brain ischemia persisting for more than 4 to 6 hours will produce permanent neurological damage. Promising new therapies may be useful only in the first few hours of brain ischemia [(12)]. However, patients with stroke symptoms often delay many hours before coming to the hospital. Studies focusing on spreading out of the therapeutic time window and indication for thrombolysis are ongoing, but the adverse effects stemming from reperfusion injury, including hemorrhagic transformation (HT) or massive edema are still a concern [(13)].Therefore, it is important to select appropriate patients based on an assessment of individual risks and benefits for thrombolysis[(14)].

Table 1 Distribution of sample size according to sex

Sex	Sample size	Percentage of sample sexwise
Male	60	66.00%
Female	31	34.00%
Total number	91	100.00%

Table 1 depicted that among the cases incorporated to MRI, incidence of male patients were more than females.

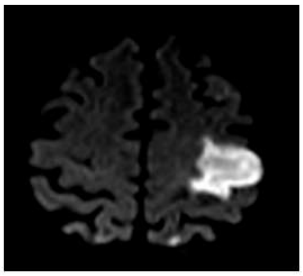
Table 2 MRI findings in T2W, FLAIR & DWI in ischemic stroke

Scan	No. of patients	Percentage of patients
T2W (Hyperintensity)	63	69.00
FLAIR (Hyperintensity)	81	89.00
DWI (Hyperintensity)	91	100.00
t –test= -0.627		
Mean value± Std dev	78.33±14.18	86.00±15.71
SEM value	8.19	9.07
P value= 0.565		

Table 2 suggested that maximum reproducibility in patient's undergone acute stroke observed for DWI-MRI (91) followed by FLAIR and T2W i.e. 81 and 63 respectively. The difference in the mean values of the two groups is not great enough to reject the possibility that the difference is due to random sampling variability. There is not a statistically significant difference between the input groups (P = 0.565).

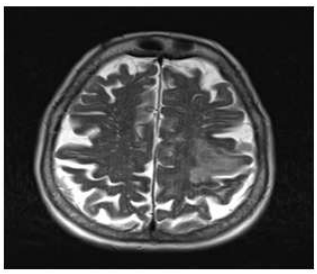
Stroke or cerebro-vascular diseases include some of the most common and devastating disorders: ischemic stroke, hemorrhagic stroke, and cerebrovascular anomalies such as intracranial aneurysms and arteriovenous malformations (AVMs). According to the Global Health Observatory (GHO), stroke is the second most common cause of death during last decade (2000-2011) with a rising trend [(15)]. A stroke, or cerebrovascular accident, is defined by this abrupt onset of a neurologic deficit that is attributable to a focal vascular cause[(16)]. Thus, the definition of stroke is clinical, and laboratory studies including brain imaging are used to support the diagnosis. The clinical manifestations of stroke are highly variable because of the complex anatomy of the brain and its vasculature. The effects of stroke can vary enormously, depending on the area of brain that has been damaged and the extent of the damage. Clinical Features varies from paralysis communication difficulties (problems with speaking, reading, writing and understanding) difficulties with mental processes, such as learning, concentration and memory. Some patients can present with visual disturbances, urinary incontinence, swallowing difficulties and emotional problems etc. It can take time for the full implications of a stroke to sink in. It has physiological, economical and psychological impact on the patients [(17)]. Stroke ranks first amongst all CNS diseases both in frequency and gravity. Approximately 20 million people each year suffer from stroke and of these 5 million do not survive [(18)].

Figure 1



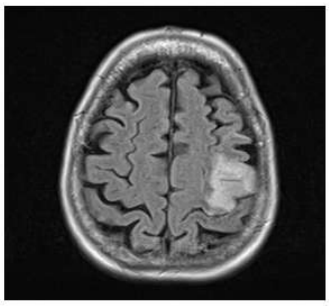
DWI showing area of restriction.

Figure 2



T2WI showing hyperintense area.

Figure 3



FLAIR showing hyperintense area.

These findings represent acute infarct in left fronto-parietal region.

Multimodal magnetic resonance imaging (MRI) is useful for diagnosing ischemic stroke and for determining treatment strategies in the acute phase. In the acute stage, early diagnosis of ischemic stroke and its differentiation from stroke-mimics are important[(19)].Various imaging findings from MRI sequences help determine stroke mechanisms, which affect prognosis, and thereby play an important role in treatment decisions [(20)]. Lesion mismatch profiles on MRI help us to assess potential risks and benefits of thrombolysis by providing information on salvageable tissue or ischemic lesion age [(21)].

Diffusion weighted MR imaging (DWI) is more sensitive than T-2 and FLAIR in detecting acute cerebral ischaemia in minor stroke[(22)]. In the present study, patients had MRI after presentation on a 1.5 T MR scanner (with 22 mT m_1 maximum strength gradients, including axial DWI, T2-weighted, fluid attenuated inversion recovery (FLAIR) sequences.

In the present study, males have high incidence of acute stroke than females i.e. 60 and 31 respectively. Similarly maximum

incidence of acute stroke and subsequent MRI have been observed for age group of 51-65 years followed by 66-75, 36-50, 76-90 and 21-35 i.e. 2, 18, 38, 19 and 14 respectively.

According to Tan *et al*., [23], one hundred and twenty (56 female) patients (median age 79 years; range: 33–97 years) with clinically suspected acute stroke underwent DWI- MRI as the first line of investigation. Simoni, M *et al*. [24] calculated the age-specific sex differences for both CT and MRI in the Oxford Vascular Study (OXVASC) and in an MRI-based clinic cohort. Negative DWI was associated with increasing time between stroke and scan, less severe stroke, younger age and female gender after correcting for other factors Negative MRI (DWI/T2/FLAIR) was associated with younger age and female gender.

A number of clinical tests have been developed over the years to help determine the presence of stroke [5]. Although these tests may aid in the initial triage of acute neurological patients, they cannot match the sensitivity and specificity of an imaging examination, nor is there any clinical test available that can accurately differentiate ischemic and hemorrhagic stroke[6]. Therefore, the initial step in the management of a suspected stroke patient is an imaging examination. A non-contrast computed tomography (CT) examination, often employed at this stage, can quickly exclude the presence of hemorrhage. The absence of hemorrhage supports the diagnosis of an ischemic event, and some evidence of ischemia may be seen in the native CT as well.

MRI is known to be more sensitive than CT in the detection of ischemia, and current experimental MRI studies with Na show even better sensitivity for acute stroke imaging [25]. However, the detection of hemorrhage, especially smaller hemorrhage, is not so straightforward with MRI. Data on reproducibility of MRI scan suggested that DWI clearly delineated recent damage in 91 patients (100%) as compared with 63 (69%) in whom lesions were identified or suspected on conventional T2-weighted images. DWI provided information not accessible with T2-weighted imaging in 63 patients when evidence of lesion multiplicity or detection of clinically unrelated recent lesions was included for comparison. Reproducibility observed for FLAIR (81; 89%) was found to be between DWI and T2-W.

Several studies have shown the capability of DWI to depict morphologic brain changes within the first few hours of focal ischemia, and the usefulness of this technique for determining location and size of brain damage in the setting of acute stroke has been extensively documented ([26]. Our results provide clear evidence of a significant diagnostic contribution of DWI beyond this acute phase. In comparison with T2-weighted and Flair sequences, DWI proved to be superior in delineating areas of recent ischemic damage in about one third of all patients. This higher sensitivity of DWI served not only to pinpoint stroke-related infarcts but also helped to detect clinically unsuspected lesions in more number of patients.

Surveillance of ischemic stroke incidence is critical for the planning, implementation, and evaluation of new stroke preventative strategies, treatments, and public health activities. However, as new diagnostic technologies are introduced over time, avoiding detection bias in determining temporal trends of stroke incidence can be challenging. For example, consider the case of a patient who presents only with non-focal symptoms, such as confusion. Due to the lack of focal symptoms, this event would not have been counted towards ischemic stroke incidence, according to the clinical definition of stroke in past assessments of stroke incidence. However, with MRI that detected a small positive acute infarct, this event could be "ruled in" as an ischemic stroke by imaging, despite the lack of focality. By contrast, consider the case of a patient who presents with focal symptoms, but with negative imaging. Prior to the advent of MRI, this event would be counted toward stroke incidence because of the focal symptoms. However, a negative MRI might suggest that the event represents worsening of an old infarct or a diagnosis other than stroke, and thus the event would be "ruled out" by imaging.

In case of symptoms associated with acute stroke patients subjected to MRI, maximum (78) patients have complaint of H.P. and weakness followed by slurring of speech (44) and deviation of face (16). In addition to this, vertigo, headache and dizziness were also observed in most of the cases i.e. 45, 68 and 48 cases respectively. The signs and symptoms of a stroke often develop quickly. However, they can develop over hours or even days. The type of symptoms depends on the type of stroke and the area of the brain that's affected. H.P. and weakness, slurring of speech and deviation of face are most common symptoms associated with acute stroke. Similarly AdrianaYock-Corrales *et al*., [27] observed the same focal limb weakness, facial weakness, or slurred speech in acute stroke patients incorporated to MRI studies.

Hypertension is a well-documented risk factor for both ischemic stroke and hemorrhagic stroke. Recent studies show, however, that the gradient of the relationship between hypertension and hemorrhagic strokes is steeper than that for ischemic stroke [28]. Data of past history of included cases suggested that among the 91 patients cases, 26 patients were found to have past history of hypertension while in 13 cases past history of diabetes mellitus noticed. 22 patients were found to have past history of both hypertension and diabetes mellitus while in rest of the cases no significant past history was found.

Hypertension is a very common disease and most important risk factor for cardiovascular, renal and atherosclerotic disease. The pathogenesis of hypertension in diabetes type 1 and type 2 is different, but both are most common in acute stroke patients. According to Tuttolomondo *et al*.,[29], diabetes and ischemic stroke are common diseases that frequently occur together. Diabetes is an important risk factor for ischemic stroke and the association between these two conditions has been analyzed by several studies. He found a 2.5-fold incidence of ischemic stroke in men with diabetes mellitus and a 3.6-fold one in women with diabetes mellitus. Tuttolomondo *et al*.,[29] suited that diabetes and hypertension both are most common in patients those experienced acute stroke.

CONCLUSION

Recent ischemic damage consequence of acute stroke is better shown on DWI sequences than on T2- W imaging and may provide further information about the origin of clinical symptoms. These obtained sequences should be added to Flair evaluation for improving reproducibility. Adding DWI to imaging protocols for patients with acute stroke is recommended.

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