# Characterization Of Stroke Using MRI Diffusion Technique

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## Abstract

Diffusion weighted imaging {DWI }is an Magnetic Resonance imaging (MRI) technique in which microscopic water motion is responsible for the contrast within the image. The aim of the current study was to assess the accuracy and sensitivity of spin lattice relaxation time (T1), spin- spin relaxation time (T2), Flair and Diffusion MR techniques in the diagnosing of the stroke, carried at AlZaytona specialist hospital in Khartoum, 25 MRI brain images were selected (13 male and 12 female) with the age range 40-89 who were diagnosed clinically as stroke. MRI was performed with the T1, T2, Flair and were additionally evaluated with diffusion-weighted techniques. one Radiologist was chosen to avoid intra-experience variation. The main results of this study were found that, (DWI) and T2 weighted images techniques had similar accuracy of 100%and sensitivity of 71.4% in diagnosing the stroke. MRI FLAIR technique had sensitivity of 68.75% and accuracy of 88% where T1 weighted images has the least accuracy and sensitivity as 32%and 44.4 % respectively , also study showed that the most affected age range 50-59 years. The study concluded that the diffusion and T2 weighted images are highly accurate for diagnosing stroke

Key Words:MRI T2,DWI,Stroke.

## INTRODUCTION

Astroke is known medically as cerebrovascular accident (CVA), it is the rapidly developing loss of brain function(s), due to disturbance in the blood supply to the brain. As a result, the affected area of the brain is unable to function, which might result in an inability to move one or more limbs on one side of the body, inability to understand or formulate speech, or an inability to see in one side of the visual field. (Sims NR, Muyderman H (September 2009). The traditional definition of stroke, devised by the World Health Organization (WHO) in the 1970s is a "neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours. (Donnan et al 2008)

Strokes can be classified into two major categories: ischemic and hemorrhagic. The Ischemic stroke blood supply to part of the brain is decreased, leading to dysfunction of the brain tissue in that area. There are four reasons why this might happen :Thrombosis (obstruction of a blood vessel by a blood clot forming locally),Embolism (obstruction due to an embolus from elsewhere in the body. Systemic hypo perfusion (general decrease in blood supply, e.g., in shock) ,Venous thrombosis. ( Donnan et al 2008). The Hemorrhagic stroke intracranial hemorrhage is the accumulation of blood anywhere within the skull vault. A distinction is made between intra-axial hemorrhage (blood inside the brain) and extra-axial hemorrhage (blood inside the skull but outside the brain). Intra-axial hemorrhage is due to intraparenchymal hemorrhage or intra ventricular hemorrhage (blood in the ventricular system) ( Donnan et al (May 2008).

Diffusion weighted imaging (DWI) is an MRI technique in which microscopic water motion is responsible for the contrast within the image. DWI has assumed the role of a valuable imaging technique because it provides information that is not

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available on standard T1-and T2-weighted images. By showing hyper acute brain ischemia within minutes after stroke onset, diffusion-weighted imaging has gained importance in the assessment of stroke, whereas CT or T2-weighted images become positive only after several, usually 5 or 6 hours after stroke onset (Schaefer,Grant et al (2000). Sensitivity of diffusion-weighted imaging in the detection of acute infarction has amounted to 60% within 50 minutes and 100% within 2 hours after symptom onset. .(Schaefer,Grant et al (2000) .

Although Conventional standard MRI Protocols is the most commonly performed, but it has many problems where the disease as stroke can be overlapped and not well demonstrated, so another advanced technique should be applied to identify the disease by different presentations and intensities, so the diffusion images were applied and attached to the basic protocols to find out the accuracy of each to increase the diagnostic value. This study will enhance the application of conventional MRI and diffusion techniques for diagnosis the stoke accurately in all stages.

The objectives of the current study was to characterize the stroke using MR diffusion technique as general objectives and to assess the stroke in T1, T2, Flair and Diffusion MR Techniques,Correlate between basic brain sequences and diffusion techniques for appearance of stroke as a specific objectives .

## MATERIAL AND METHODS

25 patients (13 male and 12 female) with the age range between (40-89 years) underwent MRI examinations of the brain with suspected CVA, MRI was performed with conventional sequences, and were additionally evaluated with diffusion-weighted MRI .

Nineteen transverse sections (thickness, 5 mm; gap, 1.5 mm) tilted along the orbitomeatal line and covering the whole supratentorial brain were imaged. Other imaging parameters were as follows: 4,000–6,000/103 (repetition time msec/echo time msec); field of view, 260 mm; matrix size, 96 × 128 interpolated to 256 × 256; and acquisition time, 20 seconds..

All MR investigations were performed on a 1.5-T clinical

imaging system (Toshiba ,flex scan s 2411w-m Excelart Vantage Medical Systems) head Coils(NV SPDR).

For DWI, a multishot, spin-echo/echo planar imaging sequence was used, with a pair of diffusion gradients centered around a 180° pulse (TE, 140 ms; TR, 667 or 1200 ms; 2 averages; matrix size, 1283128; echo planar imaging factor, 13 [13 readout gradients per TR]).To reduce motion artifacts, the head of the patient was supported with soft supportive wedges and straps. For the DWI scans, navigator echoes were used to compensate for patient movements during the acquisitions saturation are used. DWI scans were acquired with diffusion gradients along each of the three principal axes with 3 different b values (1000s/mm2). Total studytime for the examination was minutes.

The data were collected and the analyzed using the simple frequency tables and the equations for calculating the sensitivity and the accuracy of each technique (Sensitivity=TP/TP+FN  X100), and the accuracy was calculated (accuracy =TN+TP/TotalX100). The study was done at the period from August to December 2012, in AlZaytona Specialist Hospital in Khartoum .

## RESULTS

The researchers utilized four MRI techniques as variables ( DWI,T1,T2,FlAIR),to account for the technique that have high sensitivity and accuracy in diagnosis the stroke . The study showed that the male was 52% of the sample where the female was 48% of the study sample. Also that the maximum affected age was the ages range between (50-59)years old. Although all the patients were clinically diagnosed as stroke , the study showed different findings in each MRI protocols ,the diffusion weighted images (DWI) diagnosed successfully all the

**Figure 1 showed the number of cases and percentages in the sample**
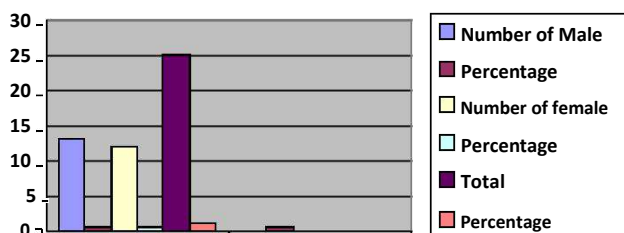


25 cases as well as the T2 weighted images, where the FLAIR technique diagnosed 22 cases out of 25 with an accuracy of 88% where 3 cases were diagnosed as normal, that means its sensitivity is less than the DWI and T2 weighted that they had sensitivity of 71.4 with an accuracy of 100%.the T1 scoreless efficacy in diagnosis the stroke where it was able to diagnose only 8 cases only out of 25 while the other17 cases were not diagnosed in this technique. Similar findings that the DWI was found to have an accuracy of 100% was mentioned by K.J. van Everdingen(1998)and Perkins CJ et al(2001).

Also the diagnosis and the appearance of the stroke in each technique have been assessed, it was found that the FLAIR technique can diagnose the stroke for the patients who were clinically diagnosed as stroke with sensitivity of 68.75 % ,The T1 failed in the diagnosis most of the cases where it diagnosed only 8 cases with the sensitivity of 44.4% , T2 and DWI were found to be similar and they had the same degree of accuracy in diagnosing

**Table 1: showed the age distribution in the study sample**

| Class | Male | Female | Total |
|-------|------|--------|-------|
| 40-49 | 0 | 3 | 3 |
| 50-59 | 6 | 3 | 9 |
| 60-69 | 1 | 4 | 5 |
| 70-79 | 5 | 2 | 7 |
| 80-89 | 1 | 0 | 1 |

**Table 2: Showed the MRI protocols with the positive and negative findings as Stroke and normal in the study sample.**

| MRI Protocols | Number of diagnosed patients |
|---------------|------------------------------|
| Diffusion weighted images (DWI) | |
| Stroke | 25 |
| Normal | 0 |
| T1 weighted images | |
| Stroke | 8 |
| Normal | 17 |
| T2 weighted images | |
| Stroke | 25 |
| Normal | 0 |
| FLAIR images | |
| Stroke | 22 |
| Normal | 3 |

the Stroke (71% ).

The signal intensity as a factor that can be used to diagnose the stroke had also been evaluated, it was found that the stroke should appear as hyper intense signal in DWI, FLAIR, T2 weighted images, all the cases in DWI and T2 were consigned with the standard signal intensity as hyper intense where only 22 cases out of 25 had gotten high signal and for this reason the FLAIR technique failed in diagnosis this 3 cases.

T1 failed in diagnosing the stroke , due to that only 8 cases out of 25 appear with hypo signal intense in the T1 weighted.

## CONCLUSION

The main findings of this study were: MRI Diffusion (DWI) and T2 weighted images techniques had similar accuracy of 100%and sensitivity of 71.4% in diagnosing the stroke, MRI FLAIR Technique has sensitivity of 68.75% and accuracy of 88% where T1 weighted images has the least accuracy and sensitivity as 32%and 44.4 % in respectively. Diffusion weighted images techniques with T2 were recommended for all suspected as stroke cases.

## REFERENCES

1. Baird AE, Benfield A, Schlaug G, et al. Enlargement of human cerebral ischemic lesion volumes measured by diffusion-weighted magnetic resonance imaging. Ann Neurol 1998; 41:581-589.

2. Catherine Westbrook 2003, Handbook of MRI Technique, Second Edition.p.p publication house

3. Chelsea et al2010 Imaging of the Brain and Cerebral Vasculature in Patients with Suspected Stroke: Advantages and Disadvantages of CT and MRI, Current Neurology and Neuroscience Reports 2006, 6:9–16.

4. Donnan GA, Fisher M, Macleod M, Davis SM 2008. "Stroke". Lancet 371 (9624): 1612–23.

5. Esteban JM, Cervera V: Perfusion CT and angio CT in the assessment of acute stroke. Neuroradiology 2004, 46:705–715.

6. K.J. van et al(1998) Diffusion-Weighted Magnetic Resonance Imaging in Acute StrokeStroke.29:1783-1790.

7. Mohr JP, Biller J, Hilal SK, et al.: Magnetic resonance versus computed tomographic imaging in acute strok Stroke 1995, 26:807–812 .

8. M. A. Brown and R. C. Semelka 2003 Basic Principles and Applications, Third Edition,page165-169.

9. N J Beauchamp et al (September 1998) MR diffusion imaging in stroke imaging and therapeutics technology, RadioGraphics S 1283.

10. Norman J.et al 1998MR Diffusion Imaging in Stroke: Review and Controversis RadioGraphics 1998; 18:1269-1283.

11. Nederkoorn PJ etal( 2003 )Duplex ultrasoundand magnetic resonance angiography compared with digital subtraction angiography in carotid artery stenosis.

12. O'Sullivan, Susan.B (2007). "Stroke". In O'Sullivan, S.B., and Schmitz, T.J.. Physical Rehabilitation. 5. Philadelphia: F.A. Davis Company. p. 719.

13. et al(2001)) Fluid-attenuated inversion recovery and diffusion- and perfusion- weighted MRI abnormalities in 117 consecutive patients with stroke symptoms.

14. Richard S. Snell (2006). Clinical neuroanatomy, 6. ed. Lippincott Williams & Wilkins, Philadelphia. pp. 478–485. ISBN 978 963 226 293 2.

15. Sims NR, Muyderman H (September 2009). "Mitochondria, oxidative metabolism and cell death in stroke". Biochimica et Biophysica Acta 1802 ,pages 80–91.

16. Sanelli et al 2004,The effect of varying user-selected input parameters on quantitative values in CT perfusion maps.

17. Schlaug G, Siewert B, Benfield A, et al.: Time course of the apparent diffusion coefficient (ADC) abnormality in human stroke. Neurology 1997, 49:113–119.

18. Tadeusz W. Stadnik, etal(2003) Differential Diagnosis of Bright Lesions on Diffusion-weighted MR Images.23,1.