ORIGINAL ARTICLE

# MAGNETIC RESONANCE ANGIOGRAPHY AND BRAIN ISCHEMIA IN PATIENTS WITH ACUTE STROKE

Rohana Naqi, Muhammad Azeemuddin, Humera Ahsan, Waseem Akhtar

Department of Radiology, The Aga Khan University Hospital, Karachi - Pakistan.

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## ABSTRACT

**OJECTIVE:** The purpose of the study is to see presence of arterial diseases on Magnetic Resonance Angiography (MRA) and diffusion positive infarction in patients with acute ischemic stroke. **STUDY DESIGN:** Cross-sectional conducted at Radiology department of the Aga Khan University Hospital. **METHODS:** 124 patients with signs and symptoms of cerebral ischemia were referred for study. 16 patients could not complete the study because of poor cooperation and MRA was not done. 108 patients completed all sequences of the study according to departmental protocol. MRA findings were evaluated with presence of acute brain ischemia on magnetic resonance imaging. Chi square test was applied to see whether arterial disease on MRA correlated with brain parenchymal abnormality on MRI. p-value less than 0.05 were considered as significant. **RESULTS:** In majority of patients (95.34%) the arterial lesion on MRA correlated with acute infarction on MRI (p-value 0.001). 40 patients had arterial abnormality on left side while in 42 patients arterial stenosis was noted on right side while 4 patients had bilateral arterial disease. **CONCLUSION:** A high positive correlation between Magnetic Resonance Angiography and MR diffusion restriction (95.34%) supports an arterial vasculopathy as the basis of this MR signature in acute ischemic strokes. However any occlusive disease of an arterial branch which remained undetected by MRA could have been the result of any discordance seen in this study.

**Key words:** Magnetic Resonance Diffusion Weighted Imaging, Magnetic Resonance Angiography, Acute Ischemic Stroke.

## Introduction

In the last decade or so MR imaging has revolutionized the investigation of stroke providing new opportunities in detecting morphological changes associated with stroke, for which MRI has proved to be highly sensitive.[1] These imaging techniques include Diffusion Weighted Imaging (DWI), MR Perfusion Imaging and MR Angiography.[2] MRA, in addition, can also be used to display major vascular anatomic details in stroke patients without any need of contrast injection.[3] We hypothesized that arterial lesion on Magnetic Resonance Angiography (MRA) would commonly be associated with diffusion restriction within the first 24 hours of stroke.

**Correspondence :** Dr. Muhammad Azeemuddin
Department of Radiology,
Aga Khan University Hospital,
Stadium Road, P.O. Box 3500, Karachi 74800
Pakistan. Tel. No: 34930051 - Ext. 2020
Email: muhammad.azeemuddin@aku.edu

## Materials and Methods

This is a retrospective study from 20th January 2007 to 10th October 2009. 124 patients with signs and symptoms of focal cerebral ischemia of less than 24 hours in duration were referred for MRI examination. These patients included 75 men and 49 women (age range 27-89 years). Out of these 124 patients, 77 were referred from emergency, 8 were outside referrals and 39 were referred from clinics in our centre. Inclusion criteria were all patients referred to the radiology department of Aga Khan University Hospital Karachi, with relevant clinical symptoms and / or signs and symptoms of focal cerebral ischemia. Patients who were claustrophobic or had a pacemaker or an intracerebral aneurysm clip were excluded from the study.

1.5 T MR whole body system (SIEMEN AVANTO) was used in performing all imagings, usings diffusion

weighted imaging multislice, echo planar imaging with p-values between 0 and 1000 s/mm$^2$. Intracranial MRA used a rapid (7 minutes) 3-dimensional Time-of-Flight technique obtained in the region of the circle of Willis, and was performed at the same time as diffusion weighted images.

## Data Analysis

The MRA's were reviewed by 2 observers ( one with clinical experience of radiology of about 20 years and the other with experience of three years) blinded to the clinical condition and diffusion weighted image data. Lesions seen on MRA were identified either as occlusion or stenosis. Any initial disagreement was finally agreed with consensus. Any lesion on MRA, stenosis or occlusion was labelled as arterial lesion. Chi square test was applied to see whether arterial disease on MRA correlated with brain parenchymal abnormality on MRI. p-value less than 0.05 were considered as significant.

## Results

124 patients with signs and symptoms of cerebral ischemia were referred for study. 16 patients could not complete the study because of poor cooperation and MRA was not done. 108 patients completed all aspects of the study; Spin echo MR imaging, Diffusion weighted images, and Magnetic resonance angiography.

MRA showed arterial occlusion in 86 (79.6%) of the 108 patients, while no lesion was identified in the 22(20.4%) patients. 40(46.5) patients had arterial abnormality on left side while in 42(48.8) patients arterial stenosis was noted on right side while remaining 4(4.6) patients had bilateral arterial disease. In 82(95.34%) patients out of 86 the arterial lesion corresponded with the acute infarctions in the same site of brain parenchyma on MRI and it was statistically significant with p-value of 0.001. In 4(4.65%) patients out of 86 discordance was found between MRA and infarction site. In three patients MRA showed stenosis on right side but infract was identified on the contralateral side. MRA was abnormal on left site in one patient but infarct was present on right side.

Arterial occlusions were present in the middle cerebral artery in 42 patients. 18 patients had diseased in posterior cerebral arteries. 4 patients had lesion in ACA, while vertebros-basilar arteries were involved in 22 patients.

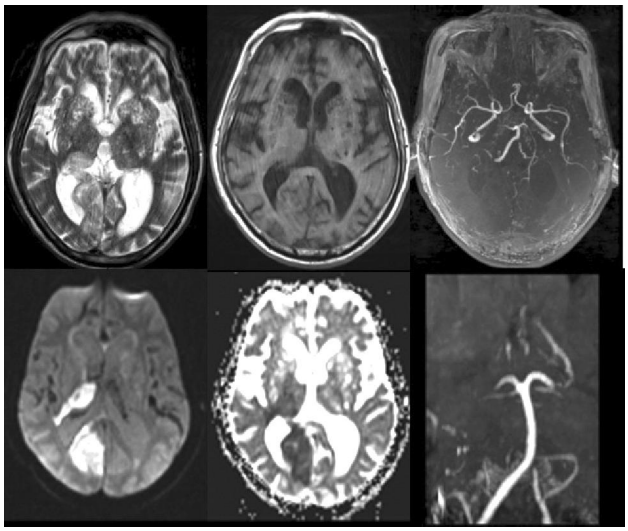

**Figure 1:** MRI and MRA images of a patient presenting with signs and symptoms of posterior circulation stroke. T2, T1, Diffusion and ADC images show an area of acute ischemic infarction in right posterior cerebral artery territory. The MRA findings completely correlates with MRI findings showing occlusion of right Posterior cerebral artery

## Discussion

Diffusion-Weighted (DW) MR imaging has a substantial impact on early stroke diagnosis and therapy. In contrast to CT and conventional MR imaging without diffusion weighting, DW imaging provides detection of lesions in the first hour after the onset of clinical symptoms.[4] Furthermore, DW imaging is superior in detecting very small ischemic lesions due to the high signal intensity-to-noise ratio and has the capacity of differentiating between chronic and acute lesions.[5]

This study has shown a high positive correlation between Diffusion Weighted Images and arterial vasculopathy thus partially confirming our initial hypothesis. This high frequency of correlation of Diffusion Weighted Images with arterial vasculopathy (79.6%) suggests an arterial vascular basis in acute ischemic stroke. In our study, however 22(20.4%) of the 108 patients with Diffusion restricted areas had a normal MRA. This could be the result of missed small arterial lesion on MRA, like M3 branch or more distal branches or occlusive disease of lenticulo-striate artery. Alteration in tissue perfusion in the presence of patent vessels or an alternate mechanism could have been possible measures in some cases. Hence, inspite of

correlations, the information from MRI, MRA and DWI did not show entire concordance.

Few possibilities may be considered in cases where MRA and DWI were seen to be discordant. For one, patients with diffusion restriction areas and having normal MRA, the possibility of an arterial defect having a resolution below that of MRA cannot be ruled out. The finding of smaller diffusion restricted defects with normal MR Angiography gives credibility to this theory. Local or alternate mechanism of tissue ischemia, however, cannot be disregarded.

Using conventional angiography Fieschi C et al have shown a short term negative detection rate of cerebral arterial occlusive disease in upto 20-30% of patients with strokes.[6]

While Foulkes MA et al, in stroke data bank, have shown inability to determine a mechanism in upto 30% of cases.[7]

Brant-Zawadzki M et al, in a review of MR imaging in cerebral ischemia have shown better detection rate of arterial occlusion with conventional angiography or high resolution MR angiography with greater arterial definition and MRI conducted early after onset of stroke.[1]

Conventional angiography was not used in this study for confirmation of MRA results, which may be considered as a limiting factor.

Polak JF et al, have however, found similar rates of detection between MR angiography and conventional angiography in internal carotid artery stenosis.[8]

However, in cases of occlusive disease for intracranial lesions, the sensitivity and specificity of MR angiography and arteriography have not been widely tested.[9]

European cooperative acute stroke study group recommends recombinant tissue plasminogen activator as currently approved therapy for stroke, which works by opening large cerebral arteries, occluded by thrombo-embolic material, when administered intravenously within 3 hours of ischemic infarct.[10] This gives a reason to believe that the best guide to start therapy should be arterial imaging (MRA, Trans-cranial Doppler ultrasound or angiography.

The optimal treatment of patients with a diffusion restriction and normal MRA is one of speculation. Some patients may have an arterial occlusion below the resolution of the MRA. The prevailing thinking is that these may be amenable to recanalization with tissue plasminogen activator therapy, although it is acknowledged that these branch occlusions have a high and early rate of spontaneous recanalization. In other cases, however, there may be altered tissue perfusion and microcirculation as the basis for this change.[11] Perhaps this group of patients might specifically benefit from reperfusion therapies that might work on the micro circulation.[12]

## Conclusion

Concordance was frequently found (95.34%) between the infarcted tissue (Diffusion restriction) and arterial changes as shown by MRA. Discordance between MRA lesions and Diffusion restriction (4.65%) may have resulted from arterial branch occlusions which is undetected by MRA or from an alternate mechanism. In 10 (9.2%) patients diffuse atherosclerosis was found with no significant focal lesion. No lesion was identified in the others 12(11.11%) patients.

We therefore assessed the diagnostic usefulness of combined DWI and MRA obtained within 24 hours of admission in acute ischemic stroke. It may contribute to the improvement of diagnosis particularly useful in centres where facility of diffusion weighted sequence is not available.

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