

ROLE OF COLOUR DOPPLER ULTRASOUND AND MR ANGIOGRAPHY IN EVALUATION OF EXTRA CRANIAL CAROTID ARTERIES IN STROKE PATIENTS

¹Priyanka Vudumula, ²S. Ranjith Kumar, ³V. Dinesh Kumar Reddy,
^{4*}K.V. Rajasekhar

^{1,2}P.G Resident, Department Of Radiology, Meenakshi Medical College and Research Institute,
Enathur, Kanchipuram, Tamil Nadu, India

³Assistant Professor, Department Of Radiology, Meenakshi Medical College and Research
Institute, Enathur, Kanchipuram, Tamil Nadu, India

^{4*}Professor and Head, Department Of Radiology, Meenakshi Medical College and Research
Institute, Enathur, Kanchipuram, Tamil Nadu, India

*Corresponding author Email- roshoraju@gmail.com

ABSTRACT

Introduction: *The role of Color Doppler USG and MRA in the evaluation of extracranial carotid arteries in stroke patients and to detect the atherosclerotic plaque and to characterize the atherosclerotic plaque with the help of Doppler ultrasound and MRA is described in this purpose of study.*

Materials and Methods: *NASCET Grading of percentage of stenosis, Doppler ultrasound was done and compared with MR Angiography TOF sequence and IV contrast in detection of plaque, plaque characterization and percentage of stenosis.*

Results: *Males are seen to be affected grossly more than females. Systemic hypertension is found to be the most common risk factor associated with stroke and the least was found to be ischemic heart disease. The right side is seen to be more commonly affected by atheromatous plaque followed by left side, with less bilateral involvement. ICA was found to be the most commonly involved site. Most of the cases had no significant stenosis, only few cases showed significant stenosis with hemodynamic changes. Homogenous soft plaques were found to be common than calcified and ulcerated plaques.*

Conclusion: *Both modalities of ultrasound and MR Angiography the advantage of endarterectomy in symptomatic patients is clearly seen with more percentage of stenosis. In combination with MRI, Doppler USG has shown to be a safer, non-invasive and precise way of diagnosing and measuring an extracranial component of carotid disease and thereby helping to accurately treat it.*

Keywords: *Plaque, gadolinium enhanced MRA, Carotid Doppler ultrasound, Time of flight sequence, Stenosis, Peak systolic velocity, extra cranial carotid pathology*

INTRODUCTION

Stroke is a neurological deficit due to focal injury of the CNS by vascular phenomena, including infarction, intra parenchymal hemorrhage and intra cerebral hemorrhage (ICH) and is one of the major causes of disability and death worldwide. . Advances in science, neuropathology and neuro imaging have improved the understanding of infarction, ischemia and hemorrhage in the CNS.

Carotid ultrasound can be the first-line diagnostic imaging procedure performed prior to carotid endarterectomy in symptomatic patients or TIA. In the use of HR ultrasound, the greatest merit of USG is its capacity to identify, characterize and assess plaques with a greater chance of embolization. If hemorrhage is considered by many to be the precursor to plaque ulceration, plaque can be characterized into comparatively high-risk categories. ^[1]

A reproducible 3D image of carotid bifurcation with improved sensitivity for high grade stenosis is provided by MR Angiography. The value is that it is possible to test further ICA, aortic arch and proximal broad arteries, Circle of Willis, and the posterior circulation, and it is not operator-dependent.

Objectives of the Study

In current study, our objective is to describe the role of Color Doppler USG and MRA in the evaluation of extracranial carotid & vertebral arteries in stroke patients and to detect the atherosclerotic plaque and to characterize the atherosclerotic plaque with the help of Doppler ultrasound and MRA.

MATERIALS AND METHODS

This is the prospective study carried out on 40 patients who came to Meenakshi Medical College Hospital and Research Institute with symptoms and signs of a stroke from February 2019 to august 2020. After getting written consent from patients both Color Doppler ultrasound and MR Angiography (TOF and Gadolinium contrast MRA), imaging was done and the findings of both the modalities are compared, the percentage of stenosis is given based on NASCET Classification ^[2,3].

Patient in the supine position. A soft pillow placed under neck to extend neck as much as possible. The patient demanded that the neck be rotated to the other side and that the ipsilateral shoulder be lowered as far as possible. The examiner was sitting on the patient's right foot. Poster lateral and far poster lateral transducer locations were used to test the carotid arteries from the anterior, lateral and posterior-lateral approach in longitudinal and transverse views of the carotid arteries.

For MRA patient is positioned inside the MRI unit. A usual MRI exam consists of two to six sequences and it depends on the type of examination done. Each sequence has a specific image orientation and targets a particular structure in particular orientation. The total time required can vary from 10 to 60 minutes depending on what examination and sequence are going on. Gadolinium is injected through intra venous route in case contrast is needed; lesion having higher vascularity will enhance based on the enhancement diagnosis can be made.

Machines used: Volusion S6 Pro Ultrasound Machine and Siemens 1.5 Tesla MRI Machine

RESULTS**Table 1 – Age distribution of patients**

Age in years	No of patients	Percentage
41-50	6	15
51-60	12	30
61-70	15	37.5
71-80	7	17.5
TOTAL	40	100

Table 2 – Showing gender distribution

Gender	No of patients	Percentage
MALE	29	72.5
FEMALE	11	27.5
TOTAL	40	100

Table 3 – Clinical history and comorbidity

Clinical history	Total cases	No of patients	Percentage
Diabetes mellitus	40	18	45
Hypertension	40	23	57.2
Hyperlipidemia	40	9	22.5
Myocardial infarction	40	2	5

Table 4 – Showing side affected

Side affected	No of patients	Percentage
Right	18	45
Left	15	37.5
Both	7	17.5
Total	40	100

Table 5 – Showing the characteristic of atheromatous plaque examined by USG

Plaque Morphology	No of patients	Percentage
Soft plaque	20	50
Irregular plaque	3	7.5
Ulcerated plaque	6	15
Calcified plaque	11	27.5
Total	40	100

Table 6: showing comparison of doppler with MRA time of flight in detecting extracranial carotid stenosis

Area involved	Total cases	Doppler		TOF MRA	
		No of cases	Percentage	No of cases	Percentage
CCA	20	6	30	6	30
BULB	20	12	60	12	60
ECA	20	3	15	3	15
ICA	20	11	55	11	55
VA	20	2	10	2	10

Table 7: showing comparison of doppler with gadolinium enhanced mri in detecting extracranial carotid stenosis

Area involved	Total cases	Doppler		Gadolinium Enhanced MRA	
		No of cases	Percentage	No of cases	Percentage
CCA	20	14	70	14	70
BULB	20	6	30	6	30
ECA	20	2	10	2	10
ICA	20	10	50	10	50
VA	20	5	25	5	25



Figure 1. Gadolinium Enhanced MRA

The Figure 1 showing complete obstruction of right sided intra and extra cranial portion of ICA and USG Doppler shows hypoechoic thrombus in right ICA causing complete luminal occlusion



Figure 2. MRA TOF

The MRA TOF diagram in Figure 2 shows loss of the left inner carotid artery portions of normal cranial and extra cranial intensity likely to complete occlusion. USG shows near complete occlusion of extra cranial portion of left ICA.

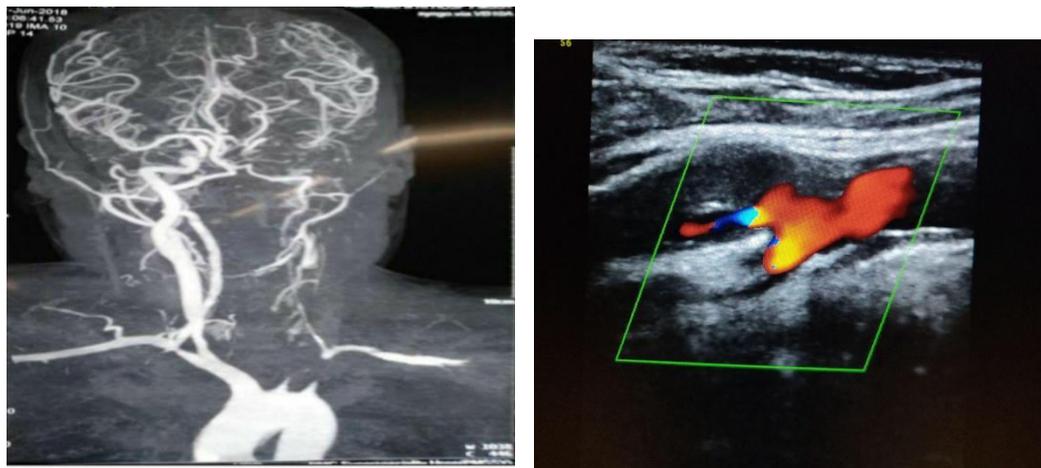


Figure 3. Gadolinium MRA

The Figure 3 shows non visualization of left common carotid and vertebral arteries and USG showing irregular soft plaque in left internal carotid artery causing 70-80% luminal narrowing.

DISCUSSION

Stroke treatment relies on making the most specific diagnosis possible by clinical and laboratory assessment (Brown and Call 2000) ^[4]. The advantage of endarterectomy in symptomatic patients with more than 70% carotid stenosis was specifically seen in two randomized controlled trials, the North American Symptomatic Carotid Endarterectomy Trial (NASCET) ^[5] and the European Carotid Surgery Trial (ECST) (C.RANKE 1999). The same findings indicated a lack of any surgical gain for 30 percent diameter lesions. Another randomized study, a symptomatic carotid

surgery study, demonstrated a distinct surgical intervention benefit for a patient with at least 60% stenosis.

Among vascular imaging techniques, USG is special since it can characterize the plaque, something most other investigations cannot do. There may be prognostic benefit for sonographically diagnosed plaque and it is valuable for selecting the best medical and surgical treatment. Doppler contrast with Gadolinium-enhanced MRA and TOF MRA findings in the NASCET scoring assessment of stenosis. It has been observed that there is a higher association between Doppler and MRA for higher stenosis stages. Both MRA and ultrasound are accurate for diagnosing occlusion. Abnormal effects on both doppler and MRA are equivalent in our analysis. H palomaki et. Alin's analysis concluded that at age 42, the occurrence of stroke rises after 60 years. In our study, the age group most affected by stroke was 51-60 years and it was 37.5 percent in 61-70 years and 30 percent in 51-60 years, followed by 41-50 years, which was 15 percent in 61-70 years and 30 percent in 51-60 years ^[6]. It was observed that 72.5% of the patients (29/40) were male and 27.5% [11/40] were female. The family history of stroke research was done by Schulz U. G. R. Flossmann E and Rothwell and found that 23% of stroke patients have a positive family history of stroke. 23 patients [57.5 percent] had hypertension and 19 patients [45 percent] had diabetes mellitus ^[7]. The anatomy of the plaque has a stroke connection, ulcerated plaques suggest that a part of the plaque is dislodged and has a better risk of obstructing the vessel. 50 percent of patients had soft tissue plaque in the latest study and 27.5 percent of cases had calcified plaque. Stenosis grading was carried out using NASCET criteria. Comparisons of Gd enhanced MRA with Doppler effects are seen in Table 6. In our analysis, CCA is involved in 14 cases, and Gadolinium-enhanced MRA indicates CCA involvement in 14 cases, and Doppler indicated ICA involvement in 10 cases, and the same is verified by Gadolinium-enhanced MRA. J. M. Serfaty, P. Chirossel, J. M. Chevallier et al ^[9] concluded that Table 7 shows a comparison of doppler with MRA flight time and shows anomalies in the bulb in 12 patients [30 percent] and TOF MRA confirms the same cases. CCA is involved in 6 cases in our study, and CCA involvement in 6 cases is seen in TOF MRA. Doppler demonstrated ICA activity in 11 cases in this analysis, and the same is confirmed by Gadolinium-enhanced MRA. Results were consistent with Paul J. Nederkoorn's ^[8].

CONCLUSION

One of the essential causes of mortality is stroke or CVA. Cerebral infarction, which accounts for 80% of strokes, will lead to atherosclerosis of the arteries supplying the brain. A safer, non-invasive and reliable way of diagnosing and testing an extra cranial component of carotid disease has been shown to be USG coupled with MRI.

REFERENCES

- [1]. Damani R. A brief history of acute stroke care. Aging. 2018;10(8):1797–8.
- [2]. D. H. Evans, J. A. Jensen, M. B. Nielsen. Ultrasonic colour Doppler imaging. Interface Focus. 2011;1(4):490–502.
- [3]. Young GR, Humphrey PRD, Shaw MDM, Nixon TE, Smith ETS. Comparison of magnetic resonance angiography, duplex ultrasound, and digital subtraction angiography in assessment of extracranial internal carotid artery stenosis. J Neurol Neurosurg Psychiatry. 1994;57(12):1466–78.
- [4]. Brown B, Call K. Stroke : Stenosis US Findings '. 1989;541–3.

- [5]. Saba L, Mallarini G. A comparison between NASCET and ECST methods in the study of carotids: Evaluation using Multi-Detector-Row CT angiography. *Eur J Radiol.* 2010;76(1):42–7.
- [6]. Hemorrhage I, Langhorne P, Fearon P, Ronning OM, Kaste M, Palomaki H, et al. Stroke Unit Care Benefits Patients With Systematic Review and Meta-analysis. 2013;3044–9.
- [7]. Flossmann E, Rothwell PM, Comment SE. Heritability of Ischemic Stroke in Relation to Age , Vascular Risk Factors , and Subtypes of Incident Stroke in Population-Based Studies. 2004;819–25.
- [8]. Nederkoorn PJ, Van Der Graaf Y, Hunink MGM. Duplex ultrasound and magnetic resonance angiography compared with digital subtraction angiography in carotid artery stenosis: A systematic review. *Stroke.* 2003;34(5):1324–31.
- [9]. Serfaty JM, Chirossel P, Chevallier JM, Ecochard R, Froment JC, Douek PC. Accuracy of Three-Dimensional Angiography in the Assessment of Extracranial Carotid Artery Disease. 2000;(August):455–63.