

ORIGINAL ARTICLE

A STUDY ON CORRELATION OF COLOUR DOPPLER AND MRI IN PATIENT OF CEREBROVASCULAR STROKE

Hinal Bhagat¹, Pratik K Pesivadia², Mahesh Vadel³, Purvi D Desai⁴

Authors Affiliation: ¹Assistant Professor; ²Final year Resident; ³Professor and Head; ⁴Associate Professor, Department of Radiodiagnosis & Imaging, Government Medical College, New Civil Hospital, Surat

Correspondence: Dr. Hinal Bhagat, Email: hinal.bhagat@gmail.com

ABSTRACT

Background: Many efforts have been made to correlate symptoms and cerebral events with Colour Doppler and magnetic resonance imaging (MRI). The present study was conducted with an objective to find the correlation between carotid doppler suggesting plaques and MRI of those patients suggesting arterial ischemia/infarction.

Methodology: The present cross-sectional study conducted on cases of acute arterial ischemia as suggested by MRI. After stabilization of cases, thorough gray scale examination on Carotid Doppler was done for intima media thickness, presence, location and characterization of plaques were assessed. Spectral Doppler analysis was done and measurements of Peak systolic velocity, end diastolic velocity were obtained on a frozen image.

Results: Out of 100 patients of stroke, 61 % were males and 39 % were females. There were minor differences in percentage of <50%, 50-69% and 70 or more stenosis detected by colour doppler as compared to gray scale. Sixteen percent of stroke patients had no stenosis on carotid doppler evaluation. Sensitivity of presence of carotid stenosis in stroke patients was 84%. While 75% of patients with <50 % stenosis had small infarct on MRI brain, just 30% of patients with >50% stenosis had small infarct. Seventy percent of patients with >50% stenosis had large infarct on MRI brain while only 25% of patients with <50% stenosis had large infarct.

Conclusion: The present study has shown that Carotid Doppler is an important non invasive diagnostic tool which can be used for screening in high risk asymptomatic patients, patients with history of cerebrovascular events.

Keywords: Colour Doppler, MRI, Cerebrovascular Stroke, carotid

INTRODUCTION

Carotid artery atherosclerosis is a major cause of disabling stroke and death¹ and it is thought to be the predominant etiology of stroke in Western society². Moreover, stroke is the third leading cause of death and the primary cause of disability in the world². "Stroke" is a generic term that describes a clinical event characterised by sudden onset of neurological deficit. However, not all strokes are same.

Compared with medical therapy, surgical endarterectomy or carotid stenting have been proven to decrease stroke in symptomatic patients with severe stenosis³ and in a very selective group of asymptomatic patients suffering of this pathology⁴. Nevertheless, clinical assessment of stroke risk had

not progressed beyond the use of luminal stenosis in spite of evidence to suggest that this is an inadequate predictor of stroke.⁵

The most frequently occluded intra-cranial vessel is Middle cerebral artery. Imaging modalities available for the diagnosis are MRI, Contrast enhanced CT, carotid doppler for imaging of atherosclerotic plaques in carotid artery and angiography. More recently, imaging studies have suggested plaque composition as an independent risk factor for ischemic stroke.⁶

Because of this, many efforts have been made to correlate symptoms and cerebral events with histological studies, color doppler ultrasonography (CDU) and magnetic resonance imaging (MRI). MRI imaging techniques have permitted serial

monitoring of atherosclerotic disease evolution and the identification of intraplaque risk factors for accelerated progresión.⁷ The present study was conducted with an objective to find the correlation between carotid doppler suggesting plaques and MRI of those patients suggesting arterial ischemia/infarction.

MATERIALS AND METHODS

The present study was the cross-sectional study conducted on 100 cases of acute arterial ischemia as suggested by MRI coming to new civil hospital Surat between January to December, 2013.

Patients with symptoms of stroke and transient ischemic attack such as transient episodes of neurological dysfunction, sudden weakness or numbness, hemi-paresis, focal neurological deficits, sudden loss of consciousness, altered sensorium, aphasia, slurring of speech, diminution or loss of vision are included in the study. Those cases who had evidence of posterior circulation stroke and Evidence of hemorrhagic stroke are excluded from the study.

Initially the patients were managed for stroke and after that they were called next day for carotid doppler evaluation. While the doppler was performed, the procedure itself, possible complications and its accuracy had been carefully explained to the patient and/or relative and written voluntary informed consent taken.

Patient preparation

Carotid Doppler is non-invasive very simple very safe procedure with no documented side-effects and almost no contra-indications. The evaluation of carotid arteries was done with patient in supine position with neck extended and head turned to opposite side. Thorough gray scale examination was done for intima media thickness - done in longitudinal section at far wall of Common Carotid Artery and a mean of three values was taken. Presence, location and characterization (type and surface) of plaques were assessed. Measurement of diameter stenosis was done in transverse plane perpendicular to long axis of vessel. Spectral Doppler analysis was done in Common carotid artery, Internal carotid artery and external carotid artery and measurements of Peak systolic velocity, end diastolic velocity were obtained on a frozen image and a mean of two values was taken. After this, Colour Doppler exam was done to substantiate the previous findings, identify regions of turbulence, any undetected areas of plaque or plaque ulceration. Depending upon the need, Power Doppler

was employed to differentiate near complete obstruction from complete obstruction.

RESULTS

Out of 100 patients of stroke, 61 % were males and 39 % were females. It was observed that 46 % patients were aged 60 years or above. Middle carotid artery territory was most frequently involved (92% of stroke patients) while Anterior carotid artery territory was involved in 8%. According to site, Basal Ganglia/ Internal Capsule region was the most commonly affected (76%) site. Parietal, frontal and temporal lobes were affected in 52%, 44% and 16% of patients respectively. The mean Intima media thickness in stroke patients 1.73 mm. Multiple plaques were seen in 44% of stroke patients.

Table 1: Intima media thickness of Carotid Artery

Intima media thickness	TIA* (%)	Stroke (%)
<1 mm	60	18
1-2 mm	28	56
2-3 mm	8	14
3-4 mm	4	10
>4 mm	0	2
Total	100	100

*Transient Ischemic Attack

Table 2: Number and multiplicity of plaques

Plaques in patient	TIA* (%)	Stroke (%)
None	14 (28)	8 (16)
1	28 (56)	20 (40)
2	8 (16)	22 (44)
Total	50 (100)	50 (100)

*Transient Ischemic Attack

Table 3: Grading of Atherosclerotic Plaques

Type of plaques	TIA* (%)	Stroke (%)
Type I	4 (9)	16 (25)
Type II	6 (13.6)	20 (31.2)
Type III	6 (13.6)	12 (18.7)
Type IV	4 (9)	8 (12.5)
Type V	24 (54.8)	8 (12.5)
Total	44 (100)	64 (100)

*Transient Ischemic Attack

Internal Carotid Artery was the most common site of plaque in stroke patients (43.7%), while it accounted for 23% of plaques in transient ischemic attack patients. Most of the plaques (82%) in Transient ischemic attack patients were smooth while in

stroke patients, approximately 46% plaques were smooth surfaced. Irregular plaques were much more commonly seen in stroke patients (43.7% in stroke versus 18% in Transient ischemic attack). Ulcerated plaques were seen exclusively in stroke patients (9.3%). Majority of plaques in stroke patients (43.7%) caused 50-69% stenosis.

There were minor differences in percentage of <50%, 50-69% and 70 or more stenosis detected by colour doppler as compared to gray scale. In stroke patients, Type I was the most common type of plaque causing <50% stenosis while TYPE II

was the most common type causing 50 or more stenosis. 16% of stroke patients had no stenosis on carotid doppler evaluation. 60% of patients had ipsi-lateral carotid stenosis, 24% had bilateral stenosis. None had contra lateral stenosis alone. Sensitivity of presence of carotid stenosis in stroke patients was 84%. While 75% of patients with <50 % stenosis had small infarct on MRI brain, just 30% of patients with >50% stenosis had small infarct. 70% of patients with >50% stenosis had large infarct on MRI brain while only 25% of patients with <50% stenosis had large infarct.

Table 4: Incidence of Carotid artery stenosis by Gray Scale B-Mode Imaging and Carotid doppler

Area % stenosis	Gray Scale B-Mode Imaging		Colour Doppler	
	TIA* (%)	Stroke (%)	TIA* (%)	Stroke (%)
<50	32 (72.7)	18 (28.1)	30 (68.2)	16 (25)
50-69	12 (27.3)	28 (43.7)	14 (31.8)	30 (46.9)
70 or More	-	14 (21.8)	-	14 (21.9)
Near Occlusion	-	2 (3.2)	-	3 (4.7)
Total Occlusion	-	2 (3.2)	-	1 (1.9)
Total	44 (100)	64 (100)	44 (100)	64 (100)

*Transient Ischemic Attack

Table 5: Type of plaque v/s degree of stenosis in transient ischemic attack patients

% of Stenosis	Type of Plaques					Total
	I (%)	II (%)	III (%)	IV (%)	V (%)	
<50	2 (6.2)	0 (0)	6 (18.7)	4 (12.5)	20 (62.5)	32
50-69	2 (16.6)	6 (50)	0 (0)	0 (0)	4 (33.4)	12
70 or more	-	-	-	-	-	-
Near occlusion	-	-	-	-	-	-
Total occlusion	-	-	-	-	-	-

Table 6: Type of plaque v/s degree of stenosis in stroke patients

% of Stenosis	Type of plaque					Total
	I (%)	II (%)	III (%)	IV (%)	V (%)	
<50	6 (33.3)	2 (11.1)	4 (22.2)	4 (22.2)	2 (11.1)	18
50-69	6 (21.4)	12 (42.8)	4 (28.2)	2 (7.2)	4 (14.2)	28
70 or more	-	6 (42.8)	4 (28.5)	4 (14.2)	2 (14.2)	14
Near occlusion	-	2 (100)	-	-	-	2
Total occlusion	2 (100)	-	-	-	-	2

Table 7: Correlation of percentage stenosis with size of infarct

% of stenosis	Infarct size		Total
	Small	Large	
< 50 % Stenosis	18 (75 %)	6 (25 %)	24
> 50 % Stenosis	8 (30 %)	18 (70 %)	26

DISCUSSION

Intima media thickness is considered as a surrogate marker for atherosclerotic disease not only in the cerebro-vascular system, but in the whole arterial system.⁸ It is believed that thickening of the intima media thickness complex greater than 0.8 mm is

abnormal and may represent the earliest changes of atherosclerotic disease.

The mean intima media thickness in TIA and stroke patients was 1.1 mm and 1.7 mm respectively. In this study 73% and 84% of patients showed evidence of plaques in transient ischemic attack

and stroke group of patients respectively. However, this also reflects the increased prevalence of carotid stenosis in ischemic stroke patients.

The multiplicity of plaques was approximately thrice in stroke patients as compared to transient ischemic attack patients. Most of the plaques (81%) in transient ischemic attack patients were smooth surfaced while in stroke patients, irregular surfaced and ulcerated plaques together accounted for 53% of plaques. This is because embolic occlusion of intracranial arteries is the primary cause of stroke and denuded or ulcerated carotid plaque surfaces are common sources of cerebral emboli.

Geroulakos et al⁹ classified ultrasonographic carotid plaques in 5 different types of stenosis, and correlated plaque type with symptomatology (not with pathology), showing the predominance of echolucent plaques in symptomatic patients with stenosis > 70 percent. Lusby et al¹⁰ showed that "haemorrhage in carotid atheromatous plaques plays a unique and major role in the development of cerebrovascular disease". IPH was not only identified in most symptomatic patients but also a close relationship was established between the onset of symptoms and the presence of plaque haemorrhage. Seeger et al¹¹ reported that the composition of plaques from symptomatic patients is significantly different from those asymptomatic. The former contains more total lipid and cholesterol, and less collagen and calcium.

Majority of the plaques (72.7%) caused <50% stenosis in transient ischemic attack patients while the majority (43.7%) caused 50-69% stenosis in stroke patients. This is because intra-plaque haemorrhage and ulceration are considered unstable and lead to abrupt increases in plaque size. So larger plaques (stenosis greater than 70%) were mostly Types 1 and 2 and typically found in symptomatic patients.

One patient misdiagnosed as total occlusion by colour Doppler was correctly diagnosed as near occlusion (with streak of residual lumen: string sign) on power Doppler. These features combine to make power Doppler ultrasound exquisitely sensitive to detecting a residual string of flow in the region of a suspected carotid occlusion. Elevated Internal Carotid Artery Peak Systolic velocity was seen in all (100%) patients with >50% stenosis. The increase in velocity in stenotic zone velocity is directly proportional to the severity of luminal narrowing.

In this study 75% of patients with <50 % stenosis had small infarct on MRI brain, while only 25% of these patients had large infarct. It was seen that

70% of patients with >50% stenosis had large infarct on MRI brain, just 30% of these patients had small infarct. Singh et al,¹² in an interesting paper describing structural MRI findings in 98 asymptomatic carotid arteries with moderate stenosis (50-70%) and subsequent one year evolution to symptomatic status: 36 (36.7%) had IPH on NMR, with 6 cerebrovascular events, ie 16%, (2 stroke and 4 AIT) related to carotid IPH showed, compared to the absence of events in the carotid without IPH. Their statistical analyzes confirmed that the detection of IPH on NMR was associated with an increased risk of cerebrovascular events. In another relevant work involving MRI, Cheung et al¹³ investigated the presence of IPH in the carotid arteries of 217 patients who had symptomatic stenosis less than 50%. IPH was detected in 13% related to the hemisphere ipsilateral symptoms and 7% contralateral.

CONCLUSION

The present study has shown that Carotid Doppler is an important non invasive diagnostic tool. It can be used for screening in high risk asymptomatic patients, patients with history of cerebrovascular events and for determining treatment protocol. Thus it should be used as a first line investigation in these patients.

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