

Association of MRI Brain and Carotid Doppler Findings in Patients of Stroke

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Abstract: *This study is a prospective analysis of 100 patients, who presented with the clinical symptom of acute stroke, in them assess carotid artery through gray scale and color Doppler sonography and find an association between carotid artery stenosis with MRI brain and various risk factors.*

Keywords: Carotid, Doppler, Stroke, MRI

1. Introduction

Stroke is defined as the sudden onset of a focal neurological deficit that lasts for more than 24 hours without cause other than a vascular origin. In which the blood supply to the brain part is compromised and consequently the brain tissue is deprived of oxygen and nutrients. After that, within minutes, the brain tissue starts dying. A stroke is a medical emergency. If diagnosed at an early stage, it can prevent large parts of the brain from dying and many patients become disabled [1].

Stroke can occur as a result of an arterial obstruction by any thrombus or any external compression, or it may be due to leakage or rupture of any vessel that supplies that particular part of the brain. So, overall, stroke can be divided into hemorrhagic and ischemic.

Ischemic Stroke accounts for 80 % of all strokes. Ischemic stroke is broadly divided into thrombotic and embolic stroke [2].

A thrombotic stroke is when a blood clot is formed in one of the arteries. A clot may be caused by fat deposition in the wall that keeps on accumulating and later causing stenosis of the vessel lumen [3].

Color Doppler ultrasonography can estimate the degree of stenosis, plaque characterization, and categorizing the plaques with a risk of embolization [4].

Aim and Objective

To assess carotid artery through grayscale and color doppler sonography and find an association between carotid artery stenosis with MRI brain and various risk factors in patients of stroke.

2. Materials and Methods

After approval from the Institutional ethical committee, patients were selected after applying inclusion and exclusion criteria.

Case of ischemic stroke as suggested by MRI brain, after stabilization examines by carotid Doppler and grayscale mode sonography.

Correlation of MRI findings and carotid doppler had done with various risk factors.

Inclusion Criteria

- Patients with symptoms of hemiparesis, hemiplegia, TIA, hemisensory loss, aphasia, etc which show infarct in territories of branches of the internal carotid artery on MRI brain were subjected to carotid Doppler sonography.
- Only acute stroke patients which diagnosed on MRI brain.
- Those who give written and informed consent were included in the study.

Exclusion Criteria

- Those cases that had evidence of posterior circulation stroke and evidence of hemorrhagic stroke are excluded from the study.
- Those cases had evidence of chronic infarct and cardiac disease.
- Patients unfit for MR studies due to any metallic implants, aneurysmal clips, cardiac pacemaker, implanted cardiac defibrillator, cochlear or otologic ear implant, surgical staples, clips or metallic sutures, metallic stent, heart valve prosthesis, etc.

Statistical Analysis: Collected data were analyzed and presented in the form of tables, figures, graphs, and diagrams wherever necessary. Frequency distribution graphical representations are done accordingly.

3. Results

3.1 Age and sex distribution of patients

There were total 100 patients enrolled in the study. Out of which there were 64 males and 36 females. The mean age of the patients that were enrolled in this study was 57.8 years. Most of the patients were in the age group of 51-60 y

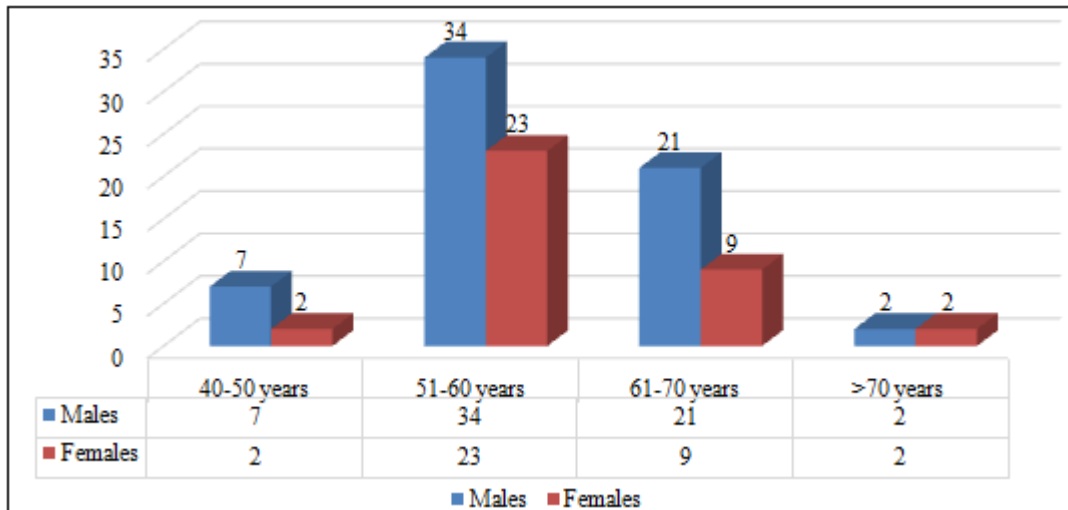


Chart: Sex distribution according to age in examined cases

Carotid Artery Stenosis

In terms of the number of carotid vessels examined

Out of 200 carotid vessels, 90 vessels had plaques. 35(17.5%) carotids were less than 50% stenosis and 55(27.5%) were more than 50% stenosis.

Table: Degree of stenosis with age and number of vessels distribution

Stenosis (%)	41-50yr	51-60yr	61-70yr	>70yr	Total vessels
<50	4	17	10	4	35
50-69	2	13	4	0	21
70 or more	2	9	6	1	20
Near occlusion	1	5	4	1	11
Total occlusion	0	1	2	0	3

In terms of total patients examined

There was a total of 100 patients examined under carotid color Doppler and MRI brain. Out of 100 patients, 86 patients had stenosis i.e. either of their carotid vessels showed stenotic plaques or increased intima-media

thickness. 14 cases had neither stenotic plaques nor increased intima-media thickness on color Doppler examination.

Table: Number of patients with carotid findings

Infarct on MRI patients	Increased IMT	Stenosis with plaque	Normal on Doppler
100	86	65	14

Plaque Characterization

On grayscale examination out of a total of 200 carotids, 90 carotids (65 patients) had 117 plaques. Which were as follows:-

Location of plaque

Out of the total of 117 plaques, 54 plaques were in the carotid bulb region, 44 plaques were in the internal carotid artery, 19 plaques were in the common carotid artery and 1 in the left external carotid artery. More plaques were seen on the left side.

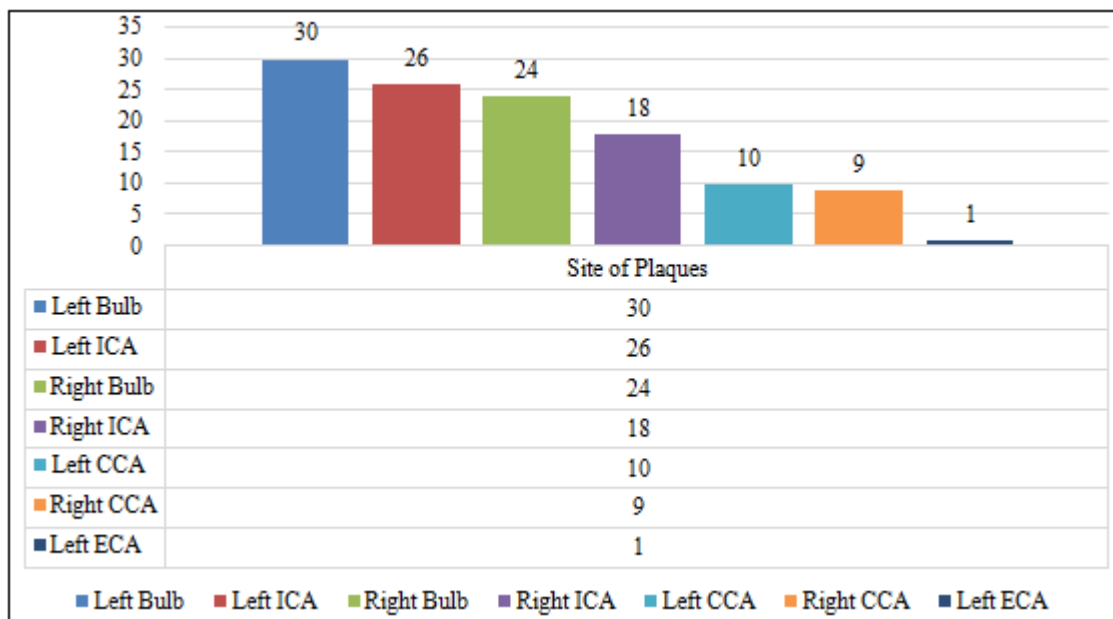


Chart: Site distribution of plaques in carotids

The multiplicity of plaques

Out of 117 plaques, 65 vessels had a single plaque, 23 vessels had double plaque and 2 vessels had more than two plaques. The multiplicity of plaques was more associated with large size infarct on MRI brain.

Table: Number of plaque in a carotid vessel

Number of Plaques	Carotid Vessels
None	110
1	65
2	23
>2	2

Plaque Surface

On grayscale imaging 117 plaques were found in 90 carotids, 45 carotids (50%) were categorized under the category of regular plaque surface that had no significant risk of ulceration, and hence the risk of embolism was minimal in these patients. And, the patients with these types of plaques were having a small degree of stenosis mostly.

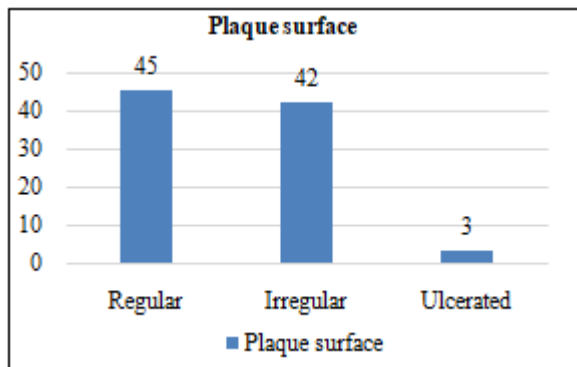


Chart: Surface of plaques on carotid Doppler examination

42 carotids (46%) were categorized under the category of irregular plaque surface that had a significant risk of ulceration and hence the risk of embolism was increased in these patients. In this study, 3 carotids had ulcerated plaques that have a maximum risk of embolization.

Plaque calcification and hemorrhage:-

On grayscale examination, out of 90 carotids 32 carotids (35%) showed calcification and 20 carotids (22%) showed hemorrhage in the plaques. High degree (>50%) stenosis had more intraplaque hemorrhage while low degree (<50%) stenosis had more calcification. All the carotids with 100% stenosis showed the absence of any calcification while all 3 had an intraplaque hemorrhage in them.

Table 7: Calcification and intraplaque hemorrhage with a degree of stenosis

Stenosis	Stenosed vessels	Intraplaque calcium	Intraplaque hemorrhage
<50%	35	13	02
50-69%	21	07	03
70-90%	20	10	05
>90% or Near occlusion	11	02	07
100% or Complete occlusion	03	0	03
Total	90	32	20

Type of Plaque

The plaques have been classified depending on their appearance on USG. Type II plaques were most common.

Out of 90 stenosed carotids, 52 carotids had type I and II plaques which have more intraplaque hemorrhage and large size of the infarct. 22 carotids had type III and 15 carotids had type IV plaques. Only one carotid had completely calcified type V plaque.

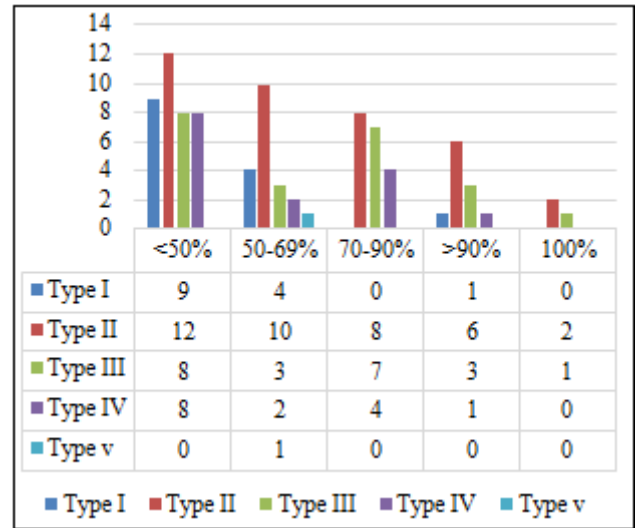


Chart: Type of plaques v / s degree of stenosis

Intima-Media Thickness (IMT)

Out of 100 patients 86 patients had more than 0.8 mm IMT and 14 patients had less than 0.8mm IMT. The mean intima-media thickness in stroke patients was 1.74 mm. 28 carotids were less than 1 mm IMT and 4 carotids were more than 4 mm IMT. There was a significant association with increased IMT and risk factors.

Table: Intima media thickness(IMT) of the carotid artery

Intima media thickness (in mm)	Stroke patients	Carotids
<1	14	28
1-2	62	124
2.1- 3	12	24
3.1- 4	10	20
>4	2	4

MRI brain finding

Middlecerebral artery territory was most frequently involved (88% of stroke patients) while Anterior cerebral artery territory was involved in 12%. According to the site, basal ganglia and internal capsule region were the most commonly affected (55%) sites. Parietal, frontal, and temporal lobes were affected by 50%, 45%, and 35% of patients respectively. All 100 patients diagnosed with acute ischemic infarct on DWI, in which 51 had small size infarct and 49 had large size infarct.

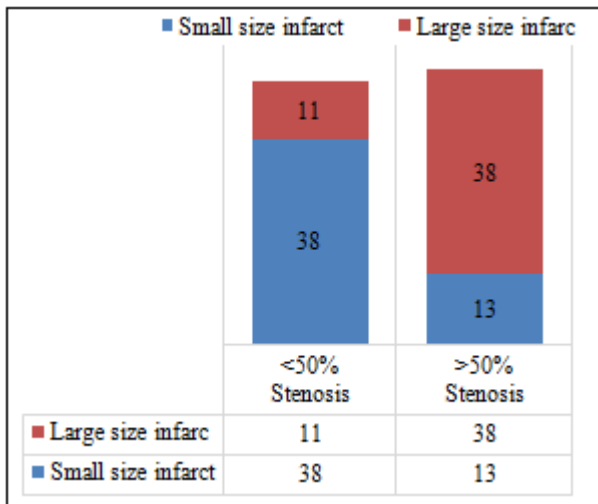


Chart: Correlation of percentage of stenosis with the size of infarction

Risk Factors

Hypertension was most common and diabetes was 2nd most common risk factor in this study.

Table: Risk factors distribution with the sex ratio

Risk Factor	Male	Female	Total
Hypertension	44	20	64
Diabetes	28	22	50
Smoking	35	09	44
Alcoholic	28	04	32

4. Discussion

Cerebrovascular stroke is a leading cause of disability and sometimes death in old age patients. 80% of the stroke are comprised of ischemic stroke. Among the causes of ischemic stroke, carotid artery stenosis is the leading cause whether it is intracranial or extracranial. Diabetes, hypertension, smoking, and alcohol consumption are the predisposing factors in the pathogenesis of carotid artery stenosis secondary to atherosclerosis [5].

Carotid Doppler examination is a very easily available important imaging modality for the evaluation of carotid vessels.

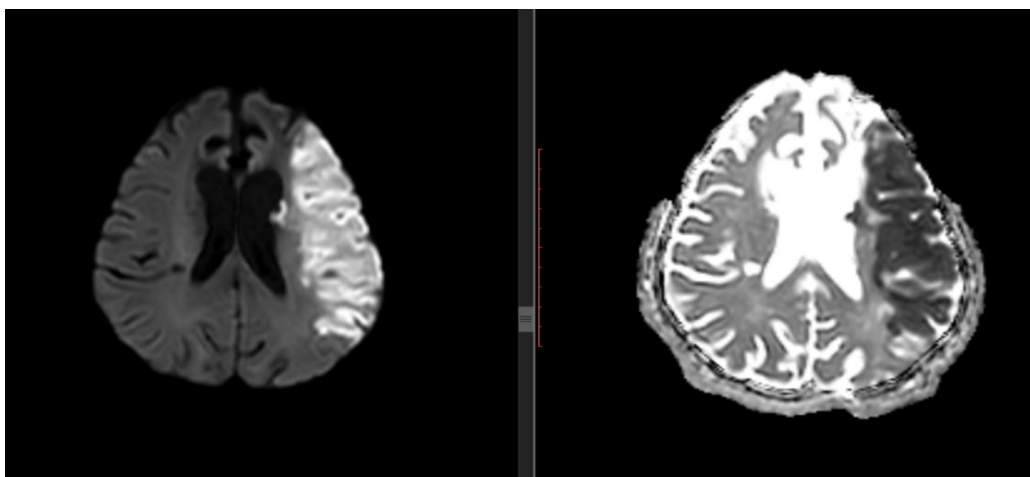
- Out of 100 patients, 64 were males and 36 were females.

- The mean age of the patients was 57.8 years. Most of the patients were in the age group of 51-60 years.
- Out of 200 carotid vessels, 90 vessels of 65 patients had 117 plaques.
- IMT of 172 carotids (86%) was more than 0.8mm.
- The mean intima-media thickness in stroke patients was 1.74 mm.
- CCA bulb(46% plaques) was the most common site of the plaque.
- Hypochoic (type I & II -58% plaques), irregular surfaced(38%) and plaques having internal hemorrhage(22%) were more commonly associated with large size infarct while calcified plaques(35%) were more commonly associated with small size infarct.
- MCA territory was most frequently involved (88% of stroke patients) in infarction.
- There 86% of patients had different degrees of stenosis in the form of stenotic plaque or increased IMT in their carotids.
- There was a significant association (p-value < 0.05) between the size of infarct in MRI brain and amount of stenosis in carotid on color Doppler, 38 patients (77.5%) with less than 50 percent stenosis had small size infarct and 38 patients (74.5%) with more than 50 percent stenosis had large size infarct.
- Hypertension (64% of patients) was the most common risk factor in patients with stroke.
- There was a significant association of risk factors with a degree of stenosis and intima-media thickness.

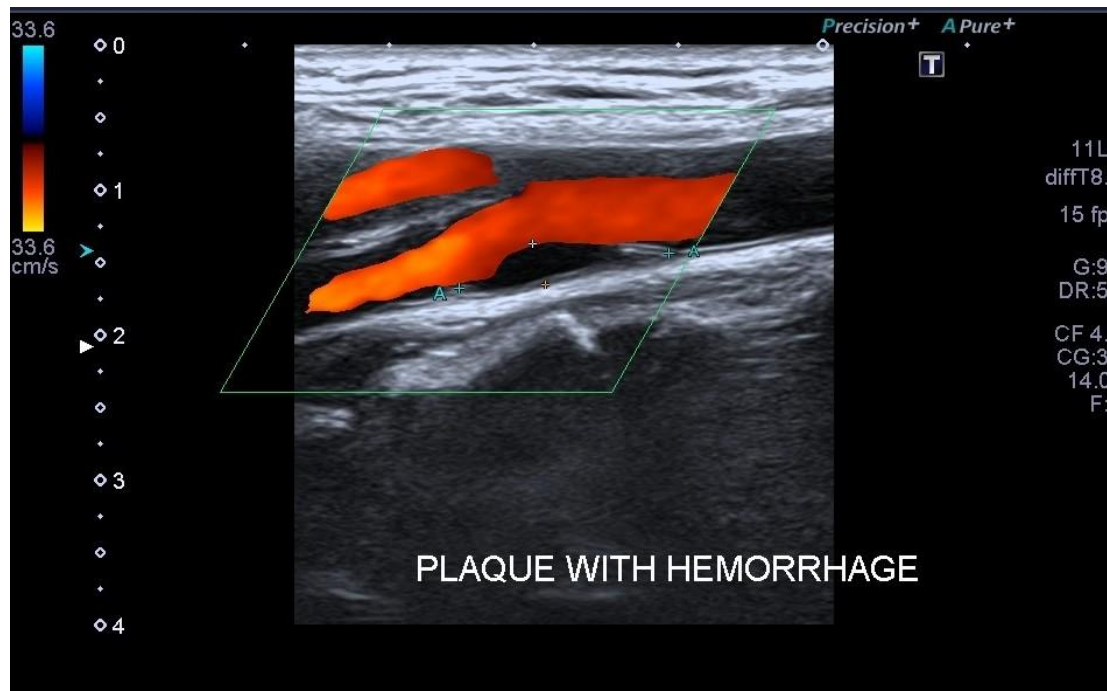
5. Conclusion

The introduction of Doppler imaging has dramatically changed the clinical evaluation of suspected carotid disease. Doppler ultrasound provides a fast, non-invasive, relatively inexpensive, and accurate means for the diagnosis of carotid stenosis. Doctors have long been looking for ways to identify patients suffering from stroke, in the hope that timely intervention may prevent stroke and disability. The present study sheds light on the importance of Doppler ultrasound in this effort to prevent stroke by monitoring atherosclerosis that predisposes a person to brain disease.

Case



DWI hyperintensity with corresponding ADC fall (Infarction) in left MCA territory



Carotid Doppler of the same patient showing intraplaque hemorrhage at left carotid bulb

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