

ORIGINAL RESEARCH

Colour Doppler Evaluation of Extracranial Carotid Vessels in Patients of Coronary Artery Disease

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ABSTRACT

Background: Carotid disease is a common finding in patients with CAD & its presence is associated with worse clinical outcomes, IMT provides incremental value over the traditional risk factors in predicting cardiovascular events. Ultrasonography of the carotid arteries is easily available, cost effective, non-invasive method of evaluation. The purpose of the present study is to evaluate the severity of atherosclerosis in extracranial carotid vessels in patients diagnosed of coronary artery disease.

Materials and Methods: The present study included 30 patients diagnosed as coronary artery disease by coronary angiogram. The conclusions of coronary angiogram were not made available to the radiologist. The patients included in the study were subjected to gray scale & color duplex examination of extracranial carotid arteries. The presence & severity of atherosclerotic disease in the extracranial carotid vessels will be assessed in terms of increased IMT and plaques. Luminal narrowing and spectral wave pattern were evaluated.

Results: Among the 30 patients examined, 25 patients had carotid disease in the form of increased IMT in one or more of the examined vessels. Highest number of plaques were noted in the carotid bulb followed by internal carotid artery. Most of the examined plaques had uniform surface and were predominantly echolucent. The severity of coronary disease is correlated with the carotid atherosclerosis.

Conclusion: With the increase in the number of coronary vessels involved, there was an increase in the percentage of patients with carotid disease in the form of increased IMT or plaque. There was also increase in the percentage of patients with carotid disease with increase in the severity of coronary stenosis.

Keywords: Doppler; coronary artery disease; plaque; IMT.

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INTRODUCTION

Cardiovascular diseases are associated with high mortality & generally undiagnosed before the onset of clinical findings, Hence there is a need for a reliable tool for early diagnosis.

Recently, considerable attention has been directed at the wall thicknesses of the carotid arteries as an early marker of atherosclerotic disease and as a means of showing the effectiveness of medical therapies in treating atherosclerosis. Noninvasive techniques such as B - mode ultrasound can directly assess the intima - media thickness (IMT), which corresponds to the thickness of the histologic intima and media.

Carotid disease is a common finding in patients with CAD & its presence is associated with worse clinical outcomes, IMT provides incremental value over the traditional risk factors in predicting cardiovascular events. The presence of carotid plaques is associated with increased risk of cardiovascular events in patients with CAD regardless of treatment strategy (medical therapy alone or myocardial revascularization).^[1-4] Hence screening of patients with CAD for carotid atherosclerosis is advocated. The use of duplex ultrasonography to detect carotid lesions has a twofold interest in this situation:

Carotid intima-media thickness (IMT) measurement is a promising tool for detecting atherosclerosis in its pre-occlusive phase. Atherosclerosis is a generalized process that affects all arterial beds, and the risk factors for atherosclerosis are shared by all arterial beds including the carotid and coronary arteries.^[1] Thus atherosclerosis in the carotids should reflect coronary involvement, a fact that has been confirmed histologically by autopsy studies.^[3] Extracranial carotid arteries provide excellent and reproducible sites for IMT assessment because of accessibility, adequate size and limited movement.

The rate of change of IMT with age in cross-sectional studies has been calculated to be about 0.01 mm/year in the general population and 0.03 - 0.06 mm/year in patients with coronary artery disease (CAD). Coronary angiography can be used to assess the progression of coronary arteriosclerosis, but it has the limitation that it can be used only in subjects with severe CHD and even then cannot be repeated several times. Also, early atherosclerotic lesions cannot be quantitatively assessed with contrast arteriography based on x-rays. High-resolution B-mode ultrasonography has the advantages that it can be performed repetitively, also be used in asymptomatic subjects, inexpensive and safe and can be used to quantitatively measure structural changes in the wall of superficial large arteries. The use of quantitative outcome variables and repetitive measurements over time greatly reduces the sample size necessary for both epidemiological studies and clinical trials. Because of their easy access to ultrasound scanning, extracranial carotid arteries have been as "windows" to or indicator sites for general and coronary arteriosclerosis.^[5] As coronary arteriosclerosis develops, on the average earlier in life than carotid arteriosclerosis,^[5] the information about the relation between carotid arteriosclerosis and the risk of CHD events has been considered critically important.

Carotid artery IMT exhibits less variability, is associated with cardiovascular risk factors, and increased levels can predict myocardial infarction and stroke. Aggressive management of risk factors can decrease IMT.^[6]

Aim of the study:

- To evaluate the extent / severity of atherosclerosis in extracranial carotid vessels in patients diagnosed of coronary artery disease.

Objectives:

- To assess the morphological & physiological changes that take place in the extracranial portion of carotid vessels in patients diagnosed as having coronary artery disease.
- To correlate the status of atherosclerosis in the carotid vessels with that of coronary vessels.

MATERIALS & METHODS

Study design:

Cross sectional study of 30 patients diagnosed as coronary artery disease at MGM Hospital.

Duration of study:

The study was conducted over a period of two years (October 2019 to October 2021).

Place of study:

Department of Radiology, Kakatiya Medical College, MGM Hospital Warangal, Telangana, India.

Inclusion criteria:

- Age 30 - 70 years. Both sexes.
- Patients diagnosed as coronary artery disease by coronary angiogram in MGM hospital.

Exclusion criteria:

- Patients refusing to give consent for enrolment in the study.

Method of collection of data:

The patients included in the study were subjected to grayscale & color duplex examination of extra - cranial carotid arteries on PHILIPSHD 7 machine using a linear transducer of 7 to 10MHz. The conclusion of coronary angiogram were not made available to the radiologist prior to the conclusion of colour doppler to avoid any bias.

Technique of Carotid Duplex Sonography.

After explaining the procedure to the patient, the patient was made to lie in supine position and chest being elevated with a pillow and the head being turned to the opposite side of the carotid artery under examination. The probe was placed on the medial side of the sternocleidomastoid to identify the carotid artery and examined in transverse and longitudinal views starting from origin to its bifurcation. Then internal carotid artery was examined both in transverse and longitudinal planes starting from bifurcation to the maximum length it was traceable. The proximal part of external carotid artery was examined in both transverse and longitudinal plane. All arteries were carefully examined with regard to wall changes.

RESULTS

The study was carried out on 30 patients who were diagnosed of coronary artery disease by coronary angiography at Kakatiya Medical College/MGM Hospital in a two-year period starting from October 2019 to October 2021. These 30 patients were examined by carotid Doppler for the evaluation of carotid atherosclerosis.

The patients had age groups ranging from 35 to 70 years with maximum number of patients between 60 to 70 years. 21 patients were male and 9 were female.

The results are tabulated and percentages calculated with depiction in the form of pie diagrams and graphs for easy understanding.

Table 1: Age & Sex Distribution

Age	Male	Female	Total
31 - 40 Years	3	-----	3
41 - 50 Years	8	1	9
51 - 60 Years	5	1	6
61 - 70 Years	6	4	10
71 - 80 Years	2	----	2
Total	24	6	30

Table 2: Risk Factor Wise Distribution

Risk factor	N= 30	Percentage %
Hypertension	19	63.3%
Diabetes mellitus	14	46.6%

Smoking > 10 years	12	40%
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Distribution of carotid disease:**Table 3: Right Common Carotid Artery**

IMT	No. Of patients	Percentage %
<0.9	20	66.6 %
>= 0.9	10	33.3 %
Total	30	100%

Out of total 30 patients, 10 patients i.e., 33.3% had increased IMT in the right CCA. 20 patients (66.6%) had normal IMT in the right CCA.

Table 4: Left Common Carotid Artery

IMT	No. Of patients	Percentage %
< 0.9	16	53.3 %
>= 0.9	14	46.6 %
Total	30	100%

Out of total 30 patients, 14 patients (46.6%) had increased IMT, 16 patients (53.3%) had normal IMT in the left CCA.

Table 5: Right Internal Carotid Artery

IMT	No. Of patients	Percentage %
< 0.9	18	60%
>= 0.9	12	40%
Total	30	100%

Out of total 30 patients, 12 patients (40 %) had increased IMT, 18 patients (60%) had normal IMT in the right ICA.

Table 6: Left Internal Carotid Artery

IMT	NO. OF PATIENTS	PERCENTAGE %
<0.9	11	36.66%
>= 0.9	19	63.33%
Total	30	100%

Out of total 30 patients, 19 patients (63.3%) had increased IMT, 11 patients (36.6%) had normal IMT in the left ICA.

Table 7: Extent of Carotid Disease

No. Of vessels with Increased IMT	No. of patients	Percentage
None	5	16.6%
One	7	23.3%
Two	7	23.3%
Three	5	16.6%
Four	6	20%
Total	30	100%

Out of a total of 30 patients, 5 patients (16.6%) showed normal IMT in all the examined vessels. There was increased IMT involving a single vessel in 7 patients (23.3%), two vessels in 7 patients (23.3%), three vessels in 5 patients (16.6%) and four vessels in 6 patients (20%).

Table 8: Distribution of Atheromatous Plaques

Vessel involved	No. Of patients
RCCA	3
RICA	6
Rt carotid bulb	9
LCCA	8
LICA	7
Lt carotid bulb	5
Total no. Of plaques	38

Out of a total of 38 plaques, 14 plaques were noted in the carotid bulbs, 13 plaques were noted in the ICA and 11 plaques were noted in the CCA. So, large number of plaques were noted in the carotid bulbs.

Table 9: Surface of Plaque (n= 38)

Plaque surface	No. Of patients
Uniform	35
Ulcerated	3
Total	38

Out of a total of 38 plaques, 35 plaques were with uniform surface, 3 plaques were with ulcerated surface.

Table 10: Characteristics of Plaques (N= 38)

Uniformly Echolucent	9
Predominantly Echolucent	19
Predominantly Echogenic	8
Uniformly Echogenic	2
Total	38

Out of a total 38 plaques, 19 plaques were predominantly echolucent, 9 plaques were uniformly echolucent, 8 plaques were predominantly echogenic and 2 plaques were uniformly echogenic.

Table 12: Severity of Stenosis in Carotid Vessels

Maximum % Stenosis in carotid vessels	No. of patients	Percentage
0 - 20 %	14	46.6%
21 - 30 %	3	10%
31 - 40 %	7	23.3%
41 - 50%	6	20%
Total	30	100%

All the 30 patients had stenosis < 50 %

Table 13: Distribution of Coronary Disease

Number of Coronary vessels involved	No. Of patients	Percentage
Single vessel Disease	16	53.3%
Two vessel Disease	7	23.3%
Three vessel Disease	7	23.3%
	30	100%

Out of a total of 30 patients, 16 patients (53.3%) had single vessel coronary disease, 7 patients (23.3%) had two vessel disease and 7 patients (23.3%) had three vessel disease.

Table 14: Severity of Coronary Artery Disease:

Maximum % of Stenosis	No. Of patients	Percentage
51 - 70 %	9	30%
71 - 90 %	14	46.6 %
> 90 % (Tight Lesion)	7	23.3 %
	30	100

Out of a total of 30 patients, 9 patients (30%) had a maximum stenosis of 51 - 70 %, 14 patients (46.6%) had a maximum stenosis of 71 - 90 % and 7 patients (23.3%) had a maximum stenosis of > 90 %.

Correlation of Extent of Coronary Disease with Carotid Atherosclerosis

Table 15: Single Vessel Disease (N= 16)

Carotid disease	No. Of patients	Percentage
Increased IMT	11	68.7%
Plaques	9	56.2%

Out of 16 patients with single vessel coronary disease, 11 patients (68.7%) had carotid disease in the form of increased IMT and 9 patients (56.2%) had plaques in any of the examined vessels.

Table 16: Two Vessel Disease (N= 7)

Carotid disease	No. Of patients	Percentage
Increased IMT	5	71.4%
Plaques	5	71.4%

Out of 7 patients with two vessel coronary disease, 5 patients (71.4%) had carotid disease in the form of increased IMT and 5 patients (71.4%) had plaques in any of the examined vessels.

Table 17: Three Vessel Disease (N= 7)

Carotid disease	No. Of patients	Percentage
Increased IMT	7	100%
Plaques	6	85.7%

Out of 7 patients with three vessel coronary disease, 7 patients(100 %) had carotid disease in the form of increased IMT and 6 patients (85.7 %)had plaques in of the examined vessels.

68.7 % of patients with single vessel coronary disease, 71.4 % of the patients with two vessel coronary disease and 100 % of the patients with three vessel disease had carotid disease in the form of increased IMT in any of the examined vessels.

56.2 % of patients with single vessel coronary disease, 71.4 % of the patients with two vessel coronary disease and 85.7 % of the patients with three vessel disease had carotid disease in the form of plaques in any of the examined vessels.

Table 18: Correlation of Severity of Coronary Disease with Carotid Atherosclerosis

Maximum Percentage of Stenosis in coronary vessels	Presence of carotid disease (increased IMT/Plaque)	Percentage
51 - 70 % (N= 9)	6	66.6%
71 - 90 % (N= 14)	13	92.8%
> 90 % (N= 7)	7	100%
Total	30	

66.6% of the patients with a maximum stenosis of 51 - 70 % in the coronary vessels, 92.8% of the patients with a maximum stenosis of 71 - 90 % and 100 % of the patients with a maximum stenosis of > 90 % had carotid disease in the form of either increase d IMT or plaque in any one of the examined vessels.

DISCUSSION

Our present study group consisted of 30 patients with CAD diagnosed by coronary angiography. The extracranial carotid vessels were evaluated in these patients with colour Doppler ultrasound.

Majority of the patients had additional risk factors such as hypertension, diabetes and smoking. B- mode USG of carotid arteries with sufficient visualization of carotid wall structures offers the potential for effective evaluation of early atherosclerotic changes such as thickening of intima - media complex and non-significant carotid plaques and brings into focus the possibility of monitoring atherosclerotic progress in peripheral arteries.

In the present study we used intima media thickness and presence of plaque with a view to evaluating the association between coronary artery status & grade of carotid atherosclerosis. There was a stepwise increase in the number of patients with carotid disease among the patients with increasing severity of CAD, because increased intima media thickness was present in 68.7 %, 71.4 % and 100 % of the patients with single vessel, two vessel & three vessel respectively. This observation closely correlates with the results of previous study done by Ioannis Kallikazoros et al in 1999.

They used duplex sonography and quantitative coronary angiography to assess carotid & coronary artery atherosclerosis in 225 patients with chest pain referred for cardiac catheterization. They concluded that in patients evaluated for chest pain, carotid disease is significantly correlated with severe CAD.

Regarding the location of atherosclerotic plaques in the carotid tree bulb was the most common site of involvement followed by internal carotid artery & common carotid artery. This correlates with the study of Kallikazoros et al .

A Kablak Ziembicka et al (2004) investigated the relation between CIMT and the extent of coronary artery disease & whether IMT is predictive of coronary atherosclerosis in 588 patients.^[7] They also analyzed the coexistence of severe extracranial atherosclerosis in patients with CAD.

Their study showed carotid artery IMT was higher in patients with angiographically confirmed CAD & the number of patients with normal IMT decreases as the number of involved coronary arteries increases. This was also observed in our study as the 31 % had normal IMT with single vessel disease, 29 % with two vessel disease and none of the patients with three vessel disease.

The role of carotid IMT as an indicator of CAD has been assessed in various studies. In the ARIC study which included 13,870 subjects, carotid far wall IMT was consistently greater in those with clinical cardiovascular disease. Visona and colleagues showed that carotid artery IMT in CAD patients (1.45 ± 0.95 mm) was significantly higher than in controls (0.87 mm ± 0.1 mm; p < 0.005). In a study of 75 male patients undergoing coronary angiography for chest pain, Geroulakos et al showed that common carotid IMT was not only higher in patients with CAD, but also had a significant linear relationship with the number of involved coronary arteries. In our study, 25 out of 30 patients with CAD had evidence of carotid disease either in the form of increased IMT in any of the extracranial vessels with or without the presence of plaques.

Clinical importance of concomitant cad & carotid artery stenosis:

Concurrent

CAD & carotid stenosis has important prognostic implications in symptomatic patients who are considered for revascularization of one or both vascular beds as well as in entirely asymptomatic patients. In patients with atherosclerotic risk factors, mere presence of carotid bruit predicts increased risk of MI and cardiac death.^[8-10]

The presence of carotid artery stenosis has been shown in multiple studies to increase the risk of perioperative stroke in patients undergoing CABG. Our study indicated that at least some degree of atherosclerotic carotid disease is frequently detected among patients with extensive CAD, the prevalence of carotid stenosis potentially mandating intervention is lower than previously reported (i.e., in the range of 7 - 11 % in the highest risk anatomic subsets of CAD).^[11]

Since both the sensitivity & specificity of treadmill testing or echocardiography are limited, the introduction of IMT measurement of carotid arteries may contribute significantly to diagnosing the status of patients with atypical chest pain or asymptomatic patients with cardiovascular risk factors. In these patients carotid IMT may be a decisive factor in recommending coronary angiography and may warrant more aggressive risk factor control through the introduction of effective medical treatment.

CONCLUSION

The present study consists of colour Doppler sonographic examination of the extracranial carotid vessels in 30 patients diagnosed as coronary artery disease at Medi Citi Hospital, Ghanpur, Medchal from August 2010 to September 2012.

Therefore, with the increase in the number of coronary vessels involved, there was an increase in the percentage of patients with carotid disease in the form of increased IMT or plaque.

There was also increase in the percentage of patients with carotid disease with increase in the severity of coronary stenosis. IMT measurement should be included as a diagnostic tool, given the paucity of facilities for invasive techniques in India. This will help in early

identification of clinical and preclinical coronary artery disease. Finally, long - term follow up studies from India are required to address the utility of this technique for therapeutic intervention.

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