Original Article

Role of Intima-Media Thickness (IMT) in Carotid Artery Doppler in Predicting CAD and its Coronary Angiography Correlation

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ABSTRACT

Introduction: Coronary artery disease (CAD) is rapidly developing epidemic in India due to increasing urbanization and a change to a sedentary lifestyle.

Aim: Aim of study was to determine the value of ultrasound measurements of internal carotid artery intima-media thickness as a surrogate marker for coronary artery disease, to compare measurements of internal carotid artery intima-media thickness with findings of coronary angiography and to establish correlation between internal carotid artery intima-media thickness and various risk factors for coronary artery disease.

Methods: The prospective study comprise of 200 patients who had clinically suspected CAD and undergone coronary angiography admitted to department of medicine and cardiology in our hospital during time period from august 2018 to February 2020. Carotid Doppler of each patients undergoing coronary angiography was done and intima media thickness of bilateral ICA were taken.

Results: The largest increase in intimal medial thickness was observed in hypertensive patient. In our study 138 patients (69%) are male and 62 patients (32%) are female. Males are affected more than female by CAD in our study. Incidence of CAD is highest amongst the patients within range of 51- 60 years that is 39.5%. In the present study, 97.22 % patients having dyslipidemia had IMT > 0.8, while 93.5 % patients having hypertriglyceridemia had IMT > 0.8.

Conclusion: The conclusion of this study is that increase in the carotid intramural thickness have a high and specific likelihood of CAD and that ultrasound examination of the carotid arteries can effectively predict atherosclerosis of the coronary arteries.

Keywords: Coronary angiography, IMT, ICA, Doppler, CAD

INTRODUCTION

Coronary artery disease (CAD) involves reduction of blood flow to myocardium due to atherosclerotic changes in coronary arteries. Types include stable angina, unstable angina, myocardial infarction, and sudden cardiac death.[1]

A common symptom is chest pain or discomfort which may travel into the shoulder, arm, back, neck or jaw. Occasionally it may feel like heartburn. Shortness of breath may also occur. Other associated symptoms may be nausea/ vomiting, palpitation and/ or loss of consciousness.[2]

Risk factors include increasing age, male gender, hypertension, smoking, diabetes, alcohol consumption, hypercholesterolemia, family history and depression.[3]

Pathophysiology of CAD shows that limitation of blood flow to myocardium causes ischemia progressing to infarction and subsequent fibrosis of muscle fibers. Chronic high grade narrowing causes transient ischemia which can lead to induction of ventricular arrhythmia.[4] Atherosclerosis of coronary arteries causes stiffening of walls with deposition of calcium, fatty lipids, and abnormal inflammatory cells- to form a plaque. Calcium phosphate (hydroxyapatite) deposits in tunica media plays a significant role in stiffening of arteries and inducing early phase of coronary atherosclerosis.[5]

ECG and coronary angiography are most commonly used modalities for the diagnosis of CAD. Sonographically, atherosclerotic plaques are first observed as an increase in the combined thickness of the intima and media layers, followed by echogenic material extending towards the arterial lumen. The measurement of the intima-media thickness (IMT) through ultrasonography (US) is a sensitive method of assessing of early-stage atherosclerosis. An IMT over 0.9 mm is an abnormal finding.[6] The increase in the IMT plays an important role as a scanning method for cardiovascular disease (CVD).[7]

With this background, the present study was to determine the value of ultrasound measurements of internal carotid artery intima-media thickness as a surrogate marker for coronary artery disease, to compare measurements of internal carotid artery intima-media thickness with findings of coronary angiography and to establish correlation between internal carotid artery intima-media thickness and various risk factors for coronary artery disease.

MATERIALS AND METHODS:

The prospective study comprise of 200 patients who had clinically suspected CAD and undergone coronary angiography admitted to department of medicine and cardiology in our hospital during time period of august 2018 to February 2020. Ethical approval was taken from Institutional Review Board of NHLMMC (NHL IRB) before commencement of the study.

Carotid Doppler of each patients undergoing coronary angiography was done and intima media thickness of bilateral ICA were taken. Findings of coronary angiography were also taken in consideration and they are compared and correlated with IMT of bilateral ICA. Comparison and correlation was also done between IMT of bilateral ICA and risk factors for CAD.

Criteria for patient selection included all the patients having clinical suspicion of CAD and undergoing CAG. Subjects who were previously diagnosed with genetic dyslipidemia, HIV-positive subjects, Subjects with overt renal, thyroid or liver disease and subjects where the imaging circumstances were very poor, with limited boundary visualization or where there were anatomical constraints, either a high carotid artery bifurcation or a short thick neck were excluded from the study.

Ultrasound imaging procedures were standardized for all subjects using the same protocol. The subject lies supine with the sonographer sitting at the head-end. The ultrasound machine is located to the left of both the patient and the sonographer. The head is slightly extended and turned 35 degrees to the contra-lateral side - Scanning is commenced by holding the transducer in the transverse plane and then sliding it from above the clavicle, to the area of the bifurcation of the carotid artery. Identification of the thyroid gland medial to the vessels, and the internal jugular vein which is compressible, helps to identify the CCA - At the carotid bifurcation, the ECA and ICA are identified and depending on the position of these vessels in relation to each other. The transducer is used to verify the identification of the ECA and ICA. The intima-medial thickness (IMT) of bilateral ICA was measured when the two echogenic lines, representing the lumen-intima interface and the media-adventitia interface, are visualized over a length of 1 cm. Anechoic area between two echogenic line represent tunica media. The segment should be clear of calcified plaque, which obscures the lines and thereby obstruct the measurement of the IMT. Measurements of the IMT were done manually, using the caliper markers of the ultrasound unit. The IMT was measured, as the area of maximum thickness at the near and far walls Of ICA bilaterally. In cases where calcified plaque obscured the IMT one wall was measured. The thickest measurement was imaged and recorded as the final measurement. Images were stored in DICOM format in ultrasound machine.

RESULTS

In our study 138 patients (69%) are male and 62 patients (32%) are female. Males are affected more than female by CAD in our study.

In our study incidence of CAD is highest amongst the patients within range of 51- 60 years that is 39.5%. Majority of patients (60.5%) were more than 50 years of age. Youngest patients in our study is of 25 years and eldest is 78 years, so range is 25 to 78 years. Mean age of our study is 53.07 years. In our study 81% of patients presented with chest pain followed by breathlessness (57%), nausea/vomiting (54%), palpitation (52.5%), loss of consciousness (14%).

Table 1: Gender wise distribution of study participants

Sex	Patients (n=200) (%)	Avg. IMT
Males	138 (69)	1.13
Females	62 (31)	1.12

Table 2: Demographic and clinical parameters among study participants

Variables	Patients (n=200) (%)
Age Group (in years)	
21-30	06 (3)
31-40	23 (11.5)
41-50	50 (25)
51-60	79 (39.5)
61-70	33 (16.5)
>70	9 (4.5)
Complaint	
Chest pain	162 (81)
Breathlessness	114 (57)
Nausea/vomiting	108 (54)
Palpitation	105 (52.5)
Loss of consciousness	28 (14)
Risk factors	
Hypertension	137 (68.5)
Diabetes	67 (33.5)
Smoking	88 (44)
Alcohol consumption	50 (25)

Table 3: Intima-Media Thickness of ICA

ICA IM thickness	Patients (n=200) (%)
<0.8	14 (7)
0.8	14 (7)
0.9	16 (8)
1.0	22 (11)
1.1	30 (15)
1.2	41 (20.5)
1.3	33 (16.5)
1.4	16 (8)

Table 4: Total Cholesterol and Triglyceride level and IMT

	Patients	Patients with IMT		Avg. IMT
		≤0.8	IMT>0.8 (%)	
Total cholesterol (mg/dl)				
<200	1	1	0 (0	1
200-239	55	9	46 (83.6)	0.98
≥240	144	4	140 (97.22)	1.19
Total triglyceride (mg/dl)				
<100	0	0	0 (0)	-
<150	6	3	3 (50)	0.88
150-199	40	15	25 (62.5)	0.94
200-499	154	10	144 (93.5)	1.18
≥500	0	0	0 (0)	-

Table 5: CAD based on vessels involved & IMT

Type of CAD	Patients	Patients having IMT		Avg. IMT
		≤0.8	>0.8 (%)	
SVD	69	23	46 (66.7)	0.98
DVD	77	5	72 (96)	1.15
TVD	54	0	54 (100)	1.28

SVD=Single vessel disease; DVD= Double vessels disease; TVD= Triple vessels disease

Table 6: No. of Risk Factors and IMT

Risk factors	Patients	Avg. IMT
1	65	1.12
2	74	1.09
3	15	1.14
4	6	1.06

Table 7: Age and IMT

Age Group[yrs]	Patients	Avg. IMT
21-30	06	1.01
31-40	23	1.08
41-50	50	1.11
51-60	79	1.13
61-70	33	1.14
>70	9	1.27

In present study, patient was considered hypertensive when systolic BP was ≥140 mm Hg and diastolic BP was ≥90 mm Hg. In present study 68.5 % patients having CAD were hypertensive. In present study, patient was considered diabetic if patients had FBS ≥ 126 g/dl or RBS ≥ 200 mg/l with sign and symptoms of diabetes mellitus. In present study 33.5 % patients having CAD were diabetic. History of 20 bidis or cigarettes/day or more for more than 5 years was considered significant in present study. Smoking was present in 44% of patients having CAD. History of taking alcohol for more than 60 for more than 5 years was considered significant. 25% of patients with CAD were alcoholic in present study.

In the present study, patient was considered dyslipidemic when cholesterol level was > 240. In the present study, 97.22 % patients having dyslipidemia had IMT > 0.8. In the present study, hypertriglyceridemia was considered when triglyceride level was > 150. In the present study, 93.5 % patients having hypertriglyceridemia had IMT > 0.8. In our study, there was an increase in average IMT with increasing age of patients.

DISCUSSION

Measurement of the IMT using US is one of the most sensitive techniques to evaluate early-stage atherosclerosis.[8] IMT was initially measured by Pignoli *et al.* in 1986.[9] It is recommended to perform the measurement 1 cm proximally to the carotid bulb and in the longitudinal plane that shows the intimal reflection and the medial layer. Since the intimal, medial and adventitial transition lines are difficult to distinguish in near-wall measurement, even if they are clearly visible, the images are gain-dependent. The generally accepted view in carotid IMT assessments is to conduct the measurement on the far wall.[1] Thus, IMT was suggested as an independent variable in predicting an angiographic diagnosis of CAD. In those with coronary artery stenosis, a significant relationship was observed between the number of the diseased coronary arteries and the increase in IMT.[11]

Carotid IMT measurement may have clinical significance in predicting the presence of plaques in the carotid arteries, coronary arteries and the arteries in the lower extremities. The increase in IMT is the precursor lesion of atherosclerosis and the presence of plaques must be predicted when there is an increase in the IMT.

The Edinburgh Artery Study revealed that IMT increases parallel to patient age. Indeed, it has been observed that IMT is associated with advancing age and that it is greater in males of all age groups.[12] Furthermore in our study, the association of the increase in IMT with the male sex was observed. A relationship was observed between advancing age and the increase in IMT. Based on these results, focussing the atherosclerotic scanning programs primarily on male sex and on those advanced in age may be more efficient in terms of the scanning costs.

Increased carotid artery IMT readings have been related to a higher risk of ischemic vascular events.[13] The IMT increase measured in the carotid artery is associated with an increased risk for strokes and the stroke rate has been reported to increase in parallel to the annual increase in IMT.[14] In our study, relationship was observed between the increase in the IMT and number of vessels involved in CAD. North American Symptomatic Carotid Endarterectomy Trial and Asymptomatic Carotid Atherosclerosis studies[15] have demonstrated a significant decrease in the risk of CVD following the treatment of the CAS. Therefore, since a statistically significant relationship was observed between an increase in IMT and CAS, CVD was more frequently observed in those with an increase in IMT in our study and IMT may be used as a sonographic indicator of atherosclerosis which may predict the risk for CVD.

In the Cardiovascular Health Study, it was underlined that CAD developed parallel to the annual increase in the IMT measured in the main coronary artery. Furthermore, the IMT measured from the internal carotid artery was observed to be associated with an increased risk of heart attack. In a study that investigated the relationship between the extent of atherosclerosis in the carotid arteries and the increase in the IMT and CAD, a significant association was observed between the increase in IMT and CAD.[14] The results of this study done by Kablak-Ziembicka A et al.[16] have pointed out a 94% probability of CAD in the patients with an IMT of over 1.15 mm with a 65% sensitivity and 80% specificity. In patients with Single vessel disease 46 (66.7%) had IMT > 0.8 mm, in patients with Double vessels disease 72 (96%) had IMT > 0.8 mm and in patients with Triple vessels disease 54 (100%) patients had IMT > 0.8 mm.

CONCLUSION

The largest increase in intimal medial thickness was observed in hypertensive patient. Using multiple regression analysis, age, sex, smoking, hypertension and dyslipidemia were correlated with carotid intimal mural thickness significantly and independently. Carotid intramural thickness increases with advancing age, increase in the carotid intramural thickness have a high and specific likelihood of CAD and that ultrasound examination of the carotid arteries has high degree of correlation with changes seen on coronary angiography.

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