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Original Research Article

CORRELATION BETWEEN CAROTID INTIMA-MEDIA THICKNESS (CIMT) AND SEVERITY OF CORONARY ARTERY DISEASE IN PATIENTS UNDERGOING CORONARY ANGIOGRAPHY IN SOUTH INDIAN POPULATION

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Abstract

Background: There is an existing debate regarding the use ofcarotidartery intima-media thickness (CIMT) for theearly risk prediction of atherosclerosis. Therefore, the present study was designed to assess the correlation between CIMT and the severity of coronary artery disease (CAD) on coronary angiography as assessed using SYNTAX (synergy between percutaneous coronary intervention with taxus and cardiac surgery) score.

Materials and Methods: A cross sectional, observational study was conducted at a tertiary care center in India from June 2021 to May 2022. A total of 100 patients who were suspected to have CAD or having an indication to undergo coronary angiography were included in the study. Baseline clinical and demographic details were recorded. Blood and biochemical investigations were carried out and risk factors for CAD were recorded among all the patients. Carotid ultrasonography was performed to measure CIMT. The correlation between CIMT and the severity of CAD using SYNTAX score was evaluated.

Results: Mean age of the study population was 55.89 ± 11 years and males were predominant over females (68% vs. 32%). Mean CIMT was 1.03 ± 0.32 mm and mean SYNTAX score was 16.07 ± 11. A strong positive correlation existed between CIMT and SYNTAX score ($r=0.76$; $p<0.001$). CIMT was higher among the patients with double vessel disease ($p<0.001$) and triple vessel disease ($p<0.001$) when compared to the patients with no CAD.

Conclusion: We found a strong correlation between CIMT and SYNTAX score. Hence, CIMT measurement may be beneficial to diagnose early atherosclerosis.

Keywords: Atherosclerosis; Carotid intima-media thickness; coronary artery disease; SYNTAX score

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 07, 2023

1. Introduction

Coronary artery disease (CAD) remains the most alarming cardiovascular disease in India and its prevalence has increased significantly.[1,2] CAD is a multifactorial disease which is a consequence of the interaction of multiple risk factors with varying effects over a prolonged asymptomatic duration. Therefore, early detection of CAD may contribute to effective treatment and reducing mortality.[1]

Systemic development of atherosclerosis involves multiple arterial regions including carotid artery.[3] In this regard, several ultrasound-based indices, such as the measurement of carotid artery intima-media thickness(CIMT) have been suggested for the assessment of prognosis of atherosclerosis in addition to major clinical cardiovascular risk factorsto improve predictive power of the risk score systems such as SYNTAX (synergy between percutaneous coronary intervention with taxus and cardiac surgery) score.[3-5]

The measurement of CIMT is a non-invasive procedure for the early detection of atherosclerosis or for the risk assessment of myocardial infarction and stroke.[6] However, the exact role of CIMT in the clinical screening of CAD has yet to be established. Besides, the association of CIMT with coronary artery stenosis is a matter of controversy and there have only been a few previous studies that have evaluated the association between the severity of CAD and the carotid ultrasound findings. Therefore, the present study was designed to evaluate the correlation between CIMT and the severity of CAD on coronary angiography as assessed using SYNTAX score.

2. Methods

Study design and population

This was a cross-sectional, observational study conducted at a tertiary care center in India between the duration of June 2021 and May 2022. The study was approved by the institutional ethics committee and the written informed consent was obtained from all the patients before enrolment.

Inclusion criteria was consecutive stable patients (aged ≥18 years) suspected to have coronary artery disease or having an indication to undergo coronary angiography as per the current accepted cardiovascular guidelines. Exclusion criteria include patients with severe heart failure, patients with left ventricular ejection fraction <35%, patients who have undergone coronary artery bypass grafting, patients with body mass index <18 and >40, patients on corticosteroids, estrogens, tricyclic antidepressants, monoamine oxidase inhibitors, serotonin reuptake inhibitors, antipsychotics, lithium, or tamoxifen, patients with pericardial disease, and patients with cardiomyopathy.

Data collection and methodology

Baseline clinical and demographic details were recorded. All patients were subjected to the blood and biochemical investigations including complete blood count, fasting plasma glucose and post prandial plasma glucose in diabetic patients, glycosylated hemoglobin (HbA1c) as per indication, kidney function test (serum urea and creatinine), liver function test, serum total cholesterol, low density lipoprotein cholesterol, triglycerides, high density lipoprotein cholesterol, very low-density lipoprotein cholesterol.

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 07, 2023

Carotid ultrasonography

Ultrasonography was performed with SIEMENS ACUSON × 300 vascular ultrasound system. Patients were examined in a supine position with their head tilted backwards. The maximum CIMT was measured manually at the near and far walls of the common carotid artery parallel to the transducer beam, and the lumen diameter was maximized in the longitudinal plane. Carotid lesion was defined as the presence of focal wall thickening that is 50% greater than that of the surrounding vessel wall or as a focal region with CIMT >1.5 mm. All measurements were performed by the same investigator who was blinded to clinical and angiographic data.

Coronary angiography

Coronary angiography was performed by a qualified interventional cardiologist. Angiographic data including the percentage of artery stenosis and the location of all the coronary lesions was obtained from reviewing the angiogram. A certified cardiologist who was blinded to the study protocol has analyzed the coronary angiograms. Stenosis of >50% in at least one main coronary artery was defined as significant CAD.The SYNTAX score was calculated using the online SYNTAX score calculator.

Based on the number of the involved main coronary arteries, the patients were categorized into three groups: (i) patients with single vessel disease; (ii) patients with double vessel disease and (iii) patients with triple vessel disease with or without involvement of left main coronary artery.

Statistical methods

The calculated sample size was 73. But sample collection was continued for a period of one year and was notrestricted to 73. Sample size was calculated using the following formula:

$N = [(Z\alpha + Z\beta)/C]^2 + 3$

Where $C = 0.5 * \ln [(1+r)/ (1-r)]$

Correlation coefficient was r = 0.323, α-level = 0.05 and β-level = 0.20 (power is 80%).

Statistical analysis was performed using SPSS Software (version 15.0, SPSS, Inc., Chicago, IL, USA). Quantitative variables were summarized as mean ± SD and qualitative variables were summarized as frequency counts and percentages. Analysis of normality of the continuous variables was performed with the Kolmogorov-Smirnov test and the Shapiro-Wilk normality test. The Spearman correlation analysis was used for assessing correlation between CIMT and SYNTAX score. P-value of <0.05 was considered as statistically significant.

3. Results

A total of 100 patients who were suspected to have CAD and were indicated for coronary angiography were enrolled in the study. The mean age of the study population was 55.89 ± 11 years and males (68%) were predominant over females (32%). The mean CIMT was 1.03 ± 0.32 mm, and the mean SYNTAX score was 16.07 ± 11. Single vessel disease (SVD) was observed among 21 (21%) patients, double vessel disease (DVD) was observed among 15 (15%) patients and triple vessel disease (TVD) was observed among 33 (33%) patients of the study populationwhereas 31 (31%) patients were without CAD. Dyslipidemia and diabetes mellitus were the major risk factors which were present among 47% and 44% patients, respectively. Baseline characteristics and the risk factors for CAD among the study population are represented in **Table 1**.

On multivariate linear regression analysis, the SYNTAX score represented a correlation coefficient of 0.019 (p<0.001). The standardized coefficient (Beta) for SYNTAX was 0.688.

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 07, 2023

A strong positive correlation (r=0.76) was observed between SYNTAX score and CIMT **(Figure 1)**. **Figure 2** demonstrates the correlation between CIMT and the number of diseased coronary vessels. Based on the number of the involved main coronary arteries, patients were categorized into no CAD, SVD, DVD, andTVD groups.CIMT was found to be statistically significant between no CAD and DVD group (p<0.001) and between no CAD and TVD group (p<0.001). Multivariate linear regression analysis between the variables predicting association of CAD and CIMT are illustrated in **Table 2**.

Table 1: Baseline characteristics and the risk factors for CAD among the study population

Patient's characteristics	**Total (n=100)**
Age (mean ± SD), years	55.89 ± 11
CIMT (mean ± SD), mm	1.03 ± 0.32
SYNTAX (mean ± SD)	16.07 ± 11
Gender	
Male, n (%)	68 (68%)
Female, n (%)	32 (32%)
CAD Distribution	
No CAD, n (%)	31 (31%)
SVD, n (%)	21 (21%)
DVD, n (%)	15 (15%)
TVD, n (%)	33 (33%)
Risk factors	
Diabetes Mellitus, n (%)	44 (44%)
Hypertension, n (%)	39 (39%)
Smoking, n (%)	30 (30%)
Dyslipidemia, n (%)	47 (47%)

SYNTAX: synergy between percutaneous coronary intervention with taxus and cardiac surgery; CIMT: Carotid intima-media thickness

Table 2: Multivariate linear regression analysis between the variables predicting association of CAD and CIMT

Patient's characteristics	**Correlation Coefficients**	**Beta**	**p-value**
Age	-0.001	-0.018	0.816
Gender	0.016	0.023	0.776
Syntax score	0.019	0.688	<0.001
Diabetes mellitus	0.070	0.108	0.186
Hypertension	0.020	0.030	0.673
Smoking	0.027	0.039	0.635
Dyslipidemia	0.006	0.010	0.891

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 07, 2023

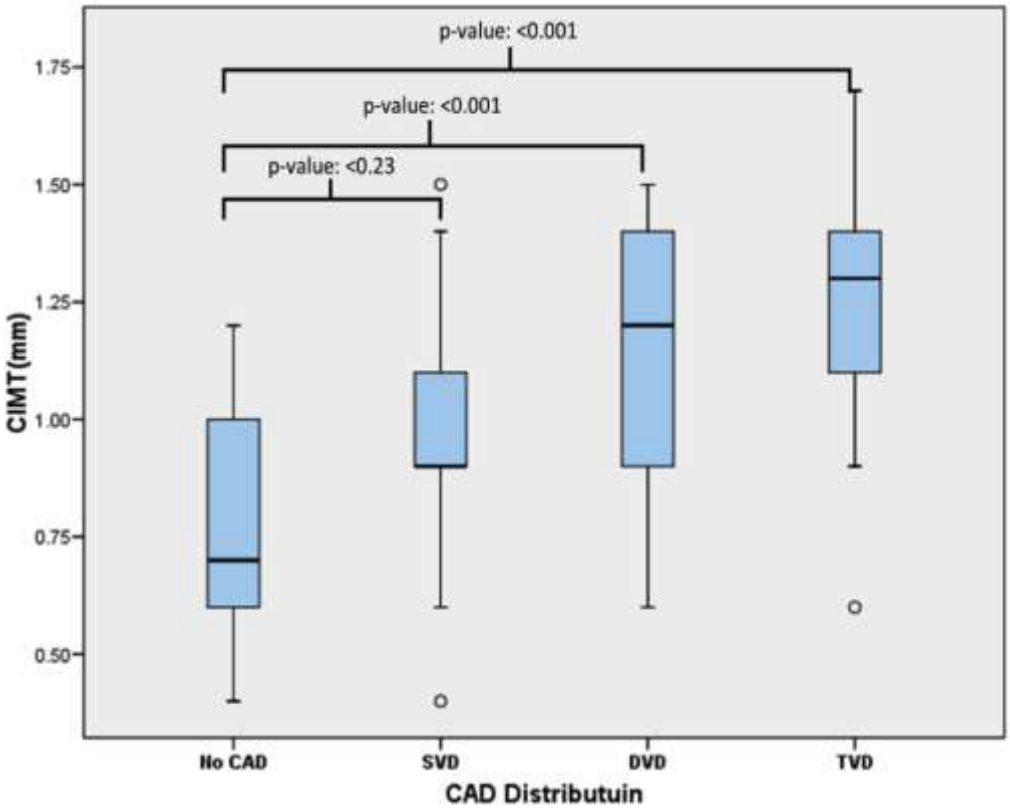

Figure 1: Correlation between CIMT and SYNTAX score

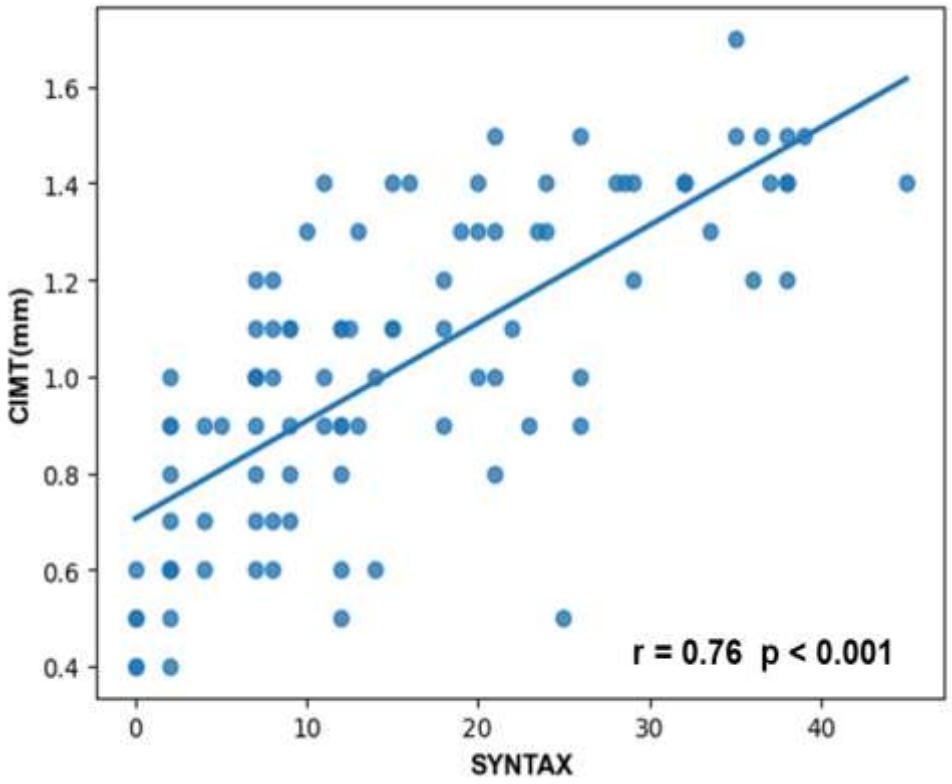

Figure 2: Correlation between CIMT and number of diseased coronary vessels

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 07, 2023

4. Discussion

In this study, the association between CIMT and the severity of CAD has been evaluated. The main finding of our study was that it showed a strong positive correlation between CIMT and SYNTAX score ($r=0.76$; $p<0.001$).Corresponding to our findings, an earlier study by Bryniarski et al., reported mean CIMT as 0.8 ±0.3 mm and the mean SYNTAX score as 7.8 ± 5.4 and the CIMT was found to be positively correlated with SYNTAX score ($r=0.562$; $p<0.001$).[7] Similarly, a previous study by Ikeda et al., demonstrated an overall SYNTAX score of 8.1 ± 14.4 and CIMT as 0.86 ± 0.23 mm. Although their SYNTAX score was lower than the SYNTAX score that we reported (16.07 ± 11), they found a significant relationship between SYNTAX score and CIMT ($r=0.442$; $p<0.0001$).[8] In line with our findings, Kablak-Ziembicka et al., showed that CIMT increases with advancing CAD and patients with mean CIMT>1.15 mm have a 94% chances of having CAD.[9] A recent study by Vishwakarma et al., demonstrated that CIMT is directly proportional to SYNTAX score.[1] They conducted a study on 204 consecutive patients with established multivessel CAD and divided them into three groups according to SYNTAX score <14, between 15 and 24, and ≥25 then, they found nonsignificant difference of the three groups in correlation with CIMT ($p = 0.38$).

On the other hand, there are some contrary studies in literature. Costanzo et al., conducted a study on 204 consecutive patients with established multivessel CAD and reported a high prevalence of carotid lesions among patients with complex CAD, while SYNTAX score did not seem to correlate with carotid atherosclerosis.[10] Saedi et al., conducted their work on 100 consecutive patients with CAD and reported no association between CIMT and SYNTAX score among patients who underwent coronary angiography ($r = 0.103$; $p = 0.3$), but diabetes mellitus and hypertension were found to be related to increased CIMT.[11]

Overall, there are various studies with different results in the literature investigating the relationship between CIMT and the SYNTAX score. Many of them have shown that carotid ultrasound may predict prognosis and the risk of cardiovascular events. Levantino et al., represented a close association between carotid and coronary atherosclerosis, analyzed through SYNTAX score which was in line with our findings.[4] In our study, SYNTAX score had a correlation coefficient of 0.019 ($p<0.001$) indicating that for one-unit increase in SYNTAX score, there will be 0.019 units increase in CIMT, holding all other independent variables constant. The standardized coefficient (Beta) for SYNTAX score in this study was 0.688, indicating a strong positive relationship between SYNTAX score and CIMT ($r=0.76$; $p<0.001$). According to the results of our study, it can be presumed that increased CIMT might reflect the complexity of CAD.

Study limitations

This study has some limitations. First, the study was limited to a smaller sample size. Second this was a single center study therefore it is not possible to generalize the findings to the general population.

Conclusion

Our study demonstrated a strong positive correlation between CIMT and SYNTAX score. Measuring CIMT may reliably predict complexity of underlying CAD and thus may help in prognosticating the patients with CAD.

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5. Source of funding
Nil

6. Conflicts of interests
None

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