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Relationship of Coronary Artery Disease with Carotid Artery Stenosis as Assessed by Carotid Doppler Ultrasound

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ABSTRACT

Introduction: Atherosclerosis is a systemic disorder that often involves multiple arterial beds such as carotid, coronary and peripheral arteries. The progressive simultaneous increase in the degree of carotid artery stenosis (CAS) with CAD (Coronary Artery Disease) has raised the valid speculations of a same mechanism of stenosis in both the arterial fields. **Objective:** The objective of this study was to correlate CAS severity with CAD severity by comparing Ultrasound measurements of CAS in study group subjects with evidence of significant CAD on coronary angiography and control group subjects with normal coronaries or non-significant CAD coronary angiography. **Methodology:** This case control study was conducted at Cardiology Department/Punjab Institute of Cardiology Lahore, Punjab, Pakistan from 1/2/2016 to 30/7/2016. In this study the Non Probability consecutive sampling technique was used. The Sample size was 86 with 43 case and 43 control population. **Results:** The average age of the patients was 53.45±10.16 years. The female to male ratio was 1:1.9. In this study 46% had normal carotid arteries with no evidence of atherosclerotic plaque. Clinically significant Carotid artery stenosis (>50%) was found in 0% of patients with normal coronaries and in 4.3% of patients with non-significant CAD. Similarly, clinically significant CAS was found in 10%, 20%, 50%, and 45.5% of patients with 1 VD, 2 VD, 3 VD and LMD, respectively. In this study there was the positive correlation between the CAS and CAD severity while comparing cases and control groups. **Conclusion:** The principle result of this study is that the degree of carotid artery disease is positively correlated to the severity of CAD.

Keywords: Carotid artery stenosis, coronary angiography, b-mode ultrasonography, coronary artery disease.

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INTRODUCTION

Atherosclerosis is a multisystem disease which often involves multiple arterial beds like, carotid, coronary and peripheral arteries.[1] The progressive simultaneous increase in the degree of carotid artery stenosis with coronary disease severity have raised the postulations of a common mechanism of stenosis in both the arterial fields.[2] Concurrent CAS and CAD are often found in clinical settings and has valuable prognostic implications in asymptomatic individuals and in symptomatic patients who are candidate for revascularization of either or both of these vascular trees. In people with typical atherosclerotic risk factors without any previous history of cardiac complication, the mere detection of a carotid bruit is associated with the greater risk of MI and cardiovascular mortality.[3]

Intense research has been done, and is ongoing, to assess the value of carotid artery study in complementing the established cardiovascular risk factors in predicting the outcome of cerebrovascular and coronary artery disease. The easy accessibility of the carotid arteries, due to their superficial location and size, makes them most suitable for study.[4] The effect in the CIMT of the carotid artery has been used as primary variable in the evaluation and detection of the progression or regression of atherosclerotic process in lipid lowering treatment.[5] Concomitant atherosclerotic disease in the internal carotid arteries (ICA) and the coronary arteries increases the risk of an adverse outcome in different clinical settings, such as individuals with no symptoms, stroke patients, and the patients undergoing CABG. B-mode ultrasound assessment of CIMT provides measurements of arterial wall abnormalities and thus a non-invasive assessment of the degree of atherosclerotic change.[6]

The positive relationship between CAD and atherosclerotic risk factors like hypertension, dyslipidemia, diabetes mellitus and smoking is evident in several studies, however, such correlation were contradictory with carotid artery stenosis.[7] There is a commonly accepted relationship between coronary and carotid artery disease, suggesting that atherosclerosis is a multisystem disease affecting both the vascular beds but it has not been fully elucidated that to what extent this association and correspondence supervenes. It appears that risk factors (age, diabetes, hypertension, smoking and dyslipidemia) are similar for both the conditions, though the effects in both vascular beds may not be the same.[8]

Nevertheless, the exact relationship between these two arterial systems is so clear, with some conflicting study reports. Further study is warranted to recognize the full extent of risk factors for coronary artery and carotid artery disease.

Objective

The objective of the study was to correlate CAS severity with CAD severity by comparing Ultrasound measurements of CAS

in study group subjects with evidence of significant CAD on coronary angiography and control group subjects with normal coronaries or non-significant CAD coronary angiography.

METHODOLOGY

Study Design: Case control study.

Setting: The study was conducted in Cardiology Department/Punjab Institute of Cardiology Lahore, Punjab, Pakistan.

Duration: 6 months from 1/2/2016 to 30/7/2016.

Sample Size: 86 patients (43 in each group).

Operational Definitions:

1. Carotid Artery Stenosis (CAS)

CAS is defined as the maximum percentage of atherosclerotic obstruction of right and left internal carotid artery (ICA), determined by B-mode Doppler ultrasound, as well as the peak systolic (PCV) and peak diastolic values. Disease severity is defined as the maximum stenosis measured either on the right or left ICA. Using the criteria defined by the Society of Radiologist in the Ultrasound Consensus Criteria[9] (Karen Quirk and Dennis F. Bandyk, 2014) lesion severity is categorized as:

Degree of stenosis (%)	Primary parameters		Additional Parameters	
	ICA PSV(cm/s)	Diameter reduction	ICA/CCA PSV ratio	ICA EDV(cm/s)
Normal	<125	None	<2	<40
1-49	<125	<50	<2	<40
50-69	125-230	≥50	2-4	40-100
≥70 but less than near occlusion	>230	≥50	>4	>100
Near occlusion	High, low or undetectable	Visible	Variable	variable
Total occlusion	undetectable	Visible, no detectable lumen	Not applicable	Not Applicable

2. Carotid Intima Media Thickness (CIMT):

The measure of the area of maximum thickness at the near and far walls of the right and left common carotid artery is taken as the carotid intima media thickness (CIMT). The mean maximum IMT will be recorded as the CIMT.

3. Coronary Artery Disease (CAD):

Patients will be stratified according to the number of involved vessels as follows (Patel MR et al., 2014):

(a) Normal coronaries: No disease in any coronary arteries

(b) Non-significant CAD: Individuals not meeting the criteria for clinically significant CAD,

(c) Clinically Significant CAD: Clinically significant CAD was defined as coronary stenosis >70% in one or more major epicardial coronary arteries (left anterior descending artery, left circumflex artery, right coronary artery) or its branches. Significant lesions in one, two, and all three arteries is abbreviated as 1VD, 2VD, 3VD respectively

(d) LMD: > 50% stenosis of the left main coronary artery, with or without concomitant lesions in other vessels.

Sampling Technique

Non-Probability consecutive sampling technique was used.

Sample Selection

Inclusion criteria

- Case Subjects: Confirmed CAD at angiography - defined as significant lesions in one or more of the major coronary vessels.
- Control Subjects: Patients who are suspected of having CAD, recruited on the basis of normal coronary arteries or non-significant coronary artery disease at angiography.

Exclusion Criteria

- Subjects previously diagnosed with type I diabetes mellitus (DM) or

Familial hypercholesterolemia.

- Patients with arrhythmias.
- 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, where more than 2 segments were not visualized.
- Patient's refusal.

Statistical Analysis

The collected data was analyzed using SPSS (Statistical Package for social sciences release 20.0; SPSS, Inc; Chicago, IL) system for Windows. Mean ± SD (Standard deviation) is used to express continuous variables and categorical variables were presented as frequencies and percentages.

The relationship between CAS extent and CAD severity was expressed using Spearman correlation. Multinomial logistic regression models were used for CAS extent as the dependent variable, with adjustment for CAD severity, age, sex, smoking status, and presence of Type II DM, Hypertension, Dyslipidemia and family history of coronary artery disease. p values <0.05 were considered statistically significant.

RESULTS

The mean age of the patients was 53.45±10.16 years with minimum and maximum ages of 30 and 80 years respectively. The male to female ratio of the patients was 1.9:1. The mean waist circumference value of the cases group patients was 92.30±7.97 cm while the mean waist circumference value of the control group was 91.48±7.88 cm. The mean total cholesterol value of the cases group was 205.69±30.60 mg/dl while the mean total cholesterol value of the control group was 185.51±18.04 mg/dl. In control population the cases with normal coronary arteries were 20(23.3%) and the cases with non-significant CAD were 23(26.7%). In cases population the 1& 2 VD cases were 10(11.6%) respectively, 3 VD cases were 12(14%) and the cases with LMS were 11(12.8%).

Table 1: Frequencies of CAS severity by the degree of CAD extent

CAD extent(N)	CAS severity					
	Normal	1-49 %	50-69%	> 70 %	Near occlusion	Total Occlusion
Normal Coronaries (20)	18	2				
Nonsignificant CAD (23)	13	9	1			
1 VD (10)	4	5	1			
2 VD (10)	2	6	2			
3 VD (12)	2	4	4	2		
LMS (11)	1	5	3	1	1	

In this study 46% had patent carotid arteries without any evidence of atherosclerotic plaque. Clinically significant CAS (>50%) was found in 0%, 4.3%, 10%, 20%, 50%, and 45.5% of patients with normal coronaries, non-significant CAD, 1 VD, 2 VD, 3 VD and LMS, respectively.

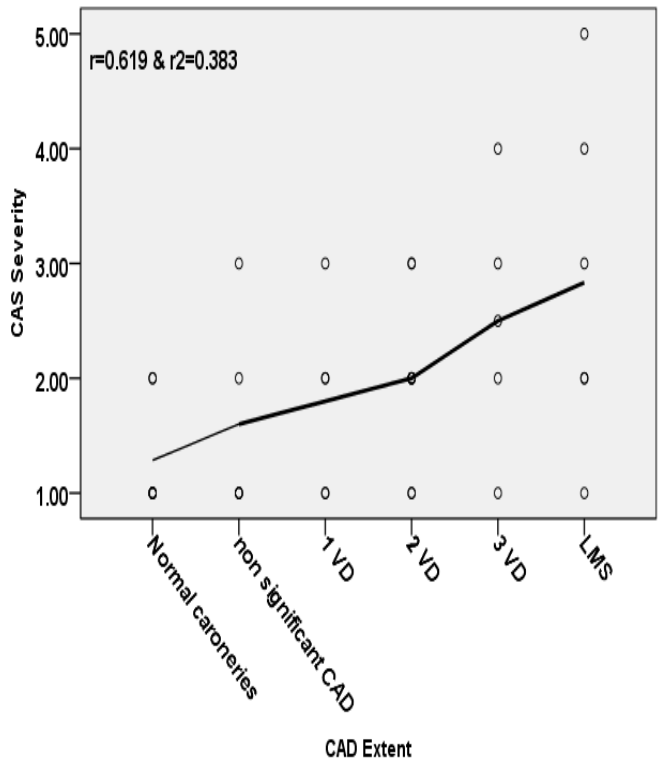
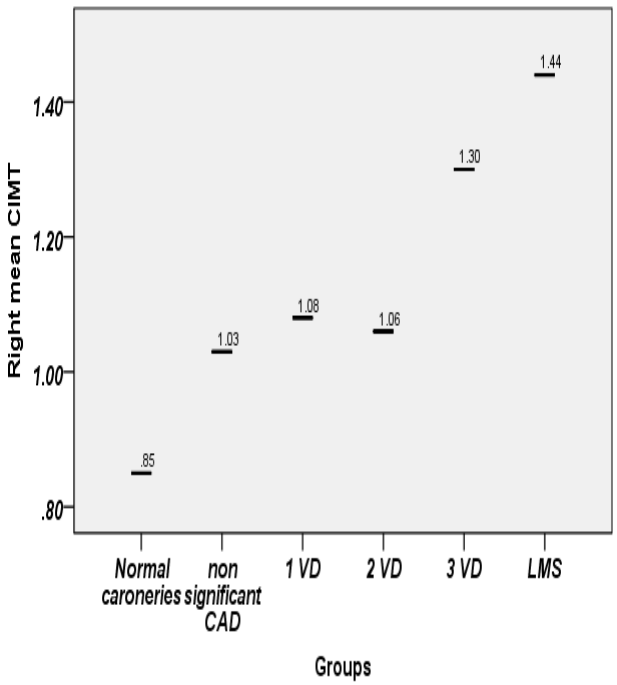


Figure 1: Correlation between the CAS severity with CAD extent

CAS severity [1= Normal, 2=1-49%, 3=50-69%, 4=>70%, 5= Near Occlusion]

The above graph shows the positive correlation between the CAS severity and the CAD extent of the patients in study groups.



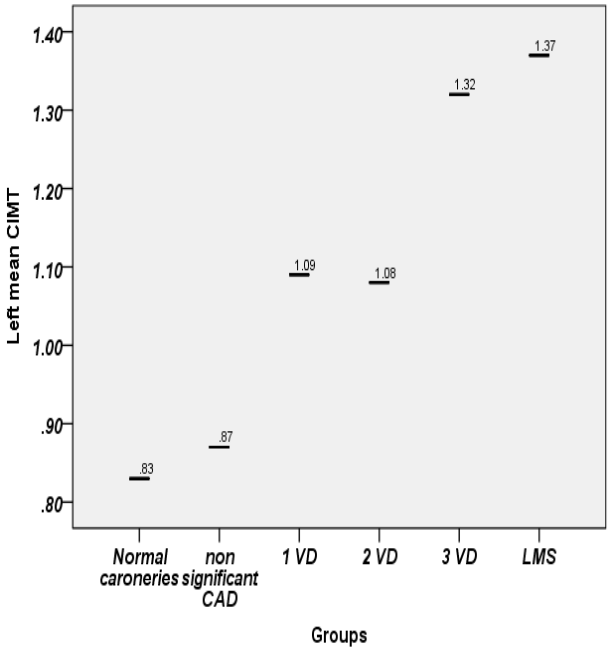


Figure 2: Correlation between mean CIMT (in mm) with CAD extent in study groups

The above graphs show the positive linear correlation between the mean CIMT and the CAD extent of the patients in study groups.

DISCUSSION

This case control study was conducted in Cardiology Department/Punjab Institute of Cardiology Lahore, Punjab, Pakistan to correlate carotid artery disease extent with CAD severity by comparing Ultrasound measurements of CAS and

CIMT in case group with evidence of significant CAD on coronary angiography and in control group subjects with normal coronaries or non-significant CAD coronary angiography.

The principle result of this study is that the degree of carotid artery disease is directly related to the severity of CAD. Tanimoto S et al, (2005) found that the frequency of CAS > 50% was 14%, 21% and 36%, in patient with 1 VD, 2 VD and 3 VD, respectively.[10] These rates of CAS are similar to our patients with some difference among the patients with 3 VD. Tanimoto et al, (2005) concluded that the carotid artery stenosis is more common in with CAD in Japan and Western countries. For elderly patients with multivessel CAD screening of carotid artery stenosis is highly recommended. In another study by Kallikazoros I et al, (1999) CAS > 50% was found in 5%, 13%, 25%, and 40% of patients with 1 VD, 2 VD, 3 VD, and LMS, respectively.[11] It was reported that the frequency of asymptomatic CAS ranged between 2% to 18% in screened populations, but among the patients with coronary artery disease, as high as 30% of individuals had significant CAS.[12]

Arie Steinvil et al concluded in their study that the severity of internal carotid artery (ICA) stenosis is correlated directly to the degree of CAD, although the frequency of clinically significant ICA stenosis is lower in certain CAD groups than previously reported. The extent of CAS and CAD severity were directly proportional ($r = 0.255$, $p < 0.001$). Clinically significant CAS with >50% narrowing was present in 5.9% of individuals with normal coronaries and non-significant CAD. Similarly, clinically significant CAS was present in 6.6%, 13%, 17.8%, and 31.3% of individuals with 1VD, 2VD, 3VD, and LMD, respectively.[13]

In this study Clinically significant CAS (>50%) was found in 0%, 4.3%, 10%, 20%, 50%, and 45.5% of patients with normal coronaries, non-significant CAD, 1 VD, 2 VD, 3 VD and LMS, respectively.

The findings in this study support previous studies where increased CIMT was correlated with evidence of angiographically proven CAD. In the study of Geroulakos, Gorman, Kolodiki et al,(1994) the CIMT (CCA) was correlated with the extent of CAD found at angiography.[14] Ward Riley, a leader in the field of CIMT in atherosclerosis, makes important points in his editorial comment. The value of CIMT as a risk factor for CAD is succinctly captured in the following statement: "Many population-based studies in several countries have now largely projected that carotid intima-media thickness is a reliable predictor of future cardiovascular events among adult men and women and is almost as predictive as all of the known risk factors combined."[15]

This study shows support for CIMT as an independent predictor for CAD.

The paucity of research regarding CAD in South Asian population needs serious redress. The growing prevalence of CAD in South Asian population begs the question that, are we merely witnessing a society in social and economic transition, where CAD is considered to be due to changes in diets and lifestyles associated with a population shift from rural to urban? The irony of the negative consequences of development and upward social mobility, imperative for social transformation, needs to be brought to the attention of the society and policy decision-makers.

Limitations of this research in terms of generalizing the findings to the larger population need to be stated. The limitations are inherent in the study design, which recruited subjects undergoing coronary angiography for a suspected clinical diagnosis of CAD. The study population, a total of 86 subjects, was thus highly selected, without the possibility of case-matching, particularly for the dominant risk factors like hypertension and Diabetes. Better definition of the impact of each of the risk factors on carotid artery disease and consequently CAD should be the role of future studies.

Despite these impediments, a number of important perspectives have emerged from this study, which would be of value in planning future research in this important field. The cardinal finding in this regard is the positive correlation of the CIMT and CAS with the extent of the coronary vessel involvement in CAD. Ultrasound has thus demonstrated its value as a tool to explore the pathogenesis of CAD, and to monitor its expected growth in prevalence in the South Asian population.

CONCLUSION

According to this study there is the positive linear correlation between the CAS severity and CAD extent and also the positive correlation of right and left mean CIMT with CAD extent of study groups was noted.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

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Dr. Muhammad Kashif Zafar Assistant Professor, Cardiology Punjab Institute of Cardiology, Lahore	Analysis the data, Drafting the article	
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