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Coronary Artery Disease and Atherosclerotic Disease

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RELATION OF CORONARY ARTERY DISEASE TO ATHEROSCLEROTIC DISEASE IN THE CAROTID, ILIAC AND FEMORAL ARTERIES EVALUATED BY ULTRASOUND

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ABSTRACT

Objective: To develop association between the angiographically significant coronary artery disease (CAD) and atherosclerotic disease in the carotid, iliac and femoral arteries as measured by ultrasound.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: This study was conducted at Adult cardiology department of AFIC/NIHD Rawalpindi for a period of six-months, from Jan 2019 to Jun 2019.

Methodology: Patients fulfilling the inclusion criteria were recruited in present study after their informed consent. Coronary angiography was performed by standard right-left diagnostic via the right radial or right femoral artery with a 6-French sheath. After angiogram patients with CAD were assessed for the atherosclerotic lesions in carotid and lower limb arteries, by ultrasound duplex scanning (UDS) performed by classified radiologist. The recorded variables were entered and analysed in SPSS.

Results: The mean age of the studied patients was 61.3 ± 10.725 years. A total of 100 patients underwent coronary angiography: 1 vessel was involved in 7% of patients, 2 vessels in 18%, 3 vessels in 62% and 3 vessel with LMS in 13%. Detecting peripheral atherosclerotic lesions by ultrasound duplex scan (UDS), increased intima-media thickness (IMT) or plaques in carotid arteries were found in 58 patients (58%). In lower limb arteries, IMT or plaques were present in patients (38%) and a stenosis >70% in 5 patients (5%). Severity of coronary artery disease (CAD) was correlated to extra-coronary atherosclerosis: Carotid and lower limb arterial atherosclerosis. Linear regression analysis revealed that the coronary artery disease is significantly related to lower extremities peripheral artery disease (p=0.001) and carotid Doppler findings (p=0.007). Our results showed that carotid artery stenosis and severe PAD (diffused atherosclerotic stenosis and complete occlusion in all segments) indicates coronary pathology significantly.

Conclusion: It is useful to screen the peripheral circulation by non-invasive tests, such as UDS in patients with multi-vessel CAD. Patients with extra-coronary atherosclerosis and angiographically confirmed ischemic heart disease need aggressive therapy for secondary prevention and a careful follow-up.

Keywords: Atherosclerosis, Coronary artery disease, Peripheral artery disease.

INTRODUCTION

Atherosclerosis is a chronic pathological inflammatory process. It is responsible for potentially fatal clinical manifestations, such as ischemic heart disease and ischemic stroke, which usually develop when a thrombus formation overlaps an atherosclerotic plaque with broken or eroded surface[1].

Atherosclerosis is considered a systemic disease. The outcome of patients with atherosclerosis in coronary, carotid or leg arteries is worse compared to a normal population. Moreover, patients with symptomatic lesions in one vascular bed often have additional asymptomatic atherosclerotic lesions in other vascular lesions. Patients with atherosclerosis in multiple vascular regions have a worst prognosis than patients with atherosclerosis in one vascular bed only[2].

The pathological process in atherosclerosis can have a similar impact on all vessels in the body, leading to coronary artery disease (CAD), cerebrovascular disease (CVD), and peripheral

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arterial disease (PAD). PAD is observed in 12-14% of the general population. It often co-exists with CAD and CVD, particularly in older people[3].

In one of the studies one hundred and two consecutive patients admitted for coronary angiography for suspected CAD participated in the study. All patients underwent B-mode ultrasound for evaluation of carotid, iliac and femoral atherosclerosis. Intimal-medial thickness >1 mm in the peripheral vessels was considered as evidence of atherosclerosis. Patients with CAD (n=64) had a significantly higher incidence of atherosclerotic plaques in the carotid, iliac and femoral arteries than subjects with normal coronary arteries: 91%, 72%, 77% vs 31%, 47% and 42%, respectively. Extra-coronary plaque was a stronger predictor of CAD than conventional risk factors. Evidence of plaque in patients younger than median age (64 years) had a higher specificity than in patients above median age (77% vs 40%, respectively, $p<0.0001$). Plaque score of the extra-cardiac vessels was significantly higher in patients with multi-vessel CAD than in patients with 1-vessel CAD disease and in subjects with normal coronary arteries ($p<0.001$). Thus, atherosclerotic plaques in the iliac and femoral arteries and, to a lesser extent, in the carotid arteries are strong predictors of CAD[4,5].

Operational Definitions

Atherosclerosis: A process of progressive thickening and hardening of the walls of medium-sized and large arteries as a result of fat deposits on their inner lining.

Coronary Artery Disease (CAD): A disease in which there is a narrowing or blockage of the coronary arteries. Coronary heart disease is usually caused by atherosclerosis (a buildup of fatty material and plaque inside the coronary arteries).

Coronary Artery Stenosis (CAS): Defined as the existence of >50% stenosis in the coronary lumen, while ≤50% stenosis are considered non-significant

Intimal-medial thickness (IMT): It is a measurement of the thickness of tunica intima and tunica media, the innermost two layers of the wall of an artery.

Carotid Artery Stenosis: It is a narrowing of the carotid arteries, the two major arteries that carry oxygen-rich blood from the heart to the brain. Also called carotid artery disease, carotid stenosis is caused by a buildup of plaque (atherosclerosis) inside the artery wall that reduces blood flow to the brain.

Peripheral Arterial Disease (PAD): It is a narrowing of the peripheral arteries serving the legs, stomach, arms and head. ("Peripheral" in this case means away from the heart, in the outer regions of the body.) PAD most commonly affects arteries in the legs[6].

METHODOLOGY

A cross-sectional study was conducted among patients who had been diagnosed with coronary artery disease (CAD) in Adult cardiology department in AFIC/NIHD were prospectively included for a period of 6 months, from 1st January 2019 to 30 June 2019. After taking permission from Hospital ethical committee, written informed consent were taken from the participants who met inclusion criteria and information was recorded in proforma. All the expenses of the tests were borned exclusively by hospital administration. A total of 100 patients of age between 40 to 80 years with confirmed coronary artery disease (CAD) on coronary angiogram were enrolled. Patients with entirely normal coronaries or withrenal failure, decompensated heart failure, cardiomyopathy, Buerger disease or vasculitis were excluded.

Coronary angiography was performed by standard right-left diagnostic via the right radial or right femoral artery with a 6-French sheath. Coronary angiograms were assessed by two distinct cardiologists or resident cardiologists to identify the coronary artery anatomy and the presence of any stenotic lesions in each vessel. Patients were stratified according to the number of involved vessels, as follows: No significant

stenosis, single-vessel disease (1VD), 2-vessel disease (2VD), 3-vessel disease (3VD), and left main disease (LMD, significant stenosis of the left main trunk, with or without concomitant lesions

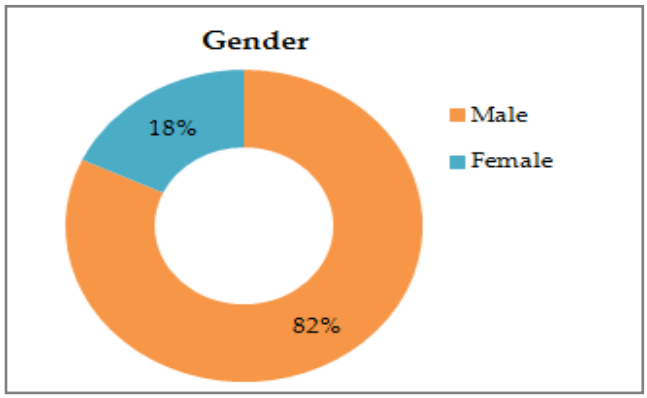

Figure-1: Frequency distribution of gender.

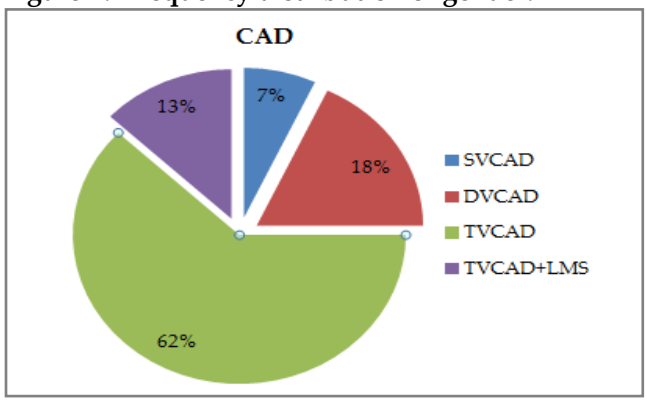

Figure-2: Angiographic profile of patients.

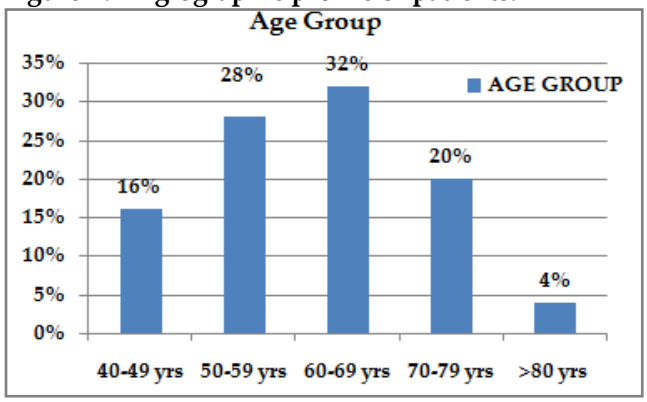

Figure-3: Frequency distribution of age groups.

in other vessels). After angiogram patients with CAD were assessed for the prevalence of atherosclerotic lesions in carotid and lower limb arteries, by ultrasound duplex scanning (UDS) using a continuous-wave Doppler probe, performed by a classified radiologist. The severity of the lower extremity PAD was defined as the greatest stenosis observed on either the right or left side

The Statistical Program for Social Sciences (SPSS) version 23 was used for all statistical calculation. Descriptive statistics were expressed as the mean and standard deviation for numerical variable i.e. age and frequency and percentages for categorical variables i.e. gender, age-group, CAD, PAD etc. The difference between the groups for categorical variables was evaluated by chi-square test. A *p*-value of <0.05 was regarded as statistically significant.

Table-I: Baseline characteristics of patients with coronary artery disease.

Variables	Frequency	Percentages (%)
Age Mean ± SD	61.3 ± 10.725 years	
Age group		
40-49 years	16	16
50-59 years	28	28
60-69 years	32	32
70-79 years	20	20
>80 years	4	4
Gender		
Male	82	82
Female	18	18
Angiography Indication		
AWMI	27	27
NSTEMI	29	29
Angina	19	19
ETT	8	8
IWMI	17	17
CAD		
SVCAD	7	7
DVCAD	18	18
TVCAD	62	62
TVCAD+LMS	13	13
Carotid Doppler		
LT CA	7	7
RT CA	11	11
RT+LT CA	40	40
PAD-LL		
DIFFUSE	5	5
MODERATE	15	15
MILD	18	18

RESULTS

One hundred consecutive patients were subjected to coronary angiography and carotid,

iliac, and lower limb ultrasound scan. The mean age of the studied patients was 61.3 ± 10.725 years, gender distribution is represented (fig-1) i.e., 82% were males and 18% females[1]. Vessel was involved in 7% of patients, 2 vessels in 18%, 3 vessels in 62% and 3 vessel with LMS in 13% (fig-2). The graphical representation of age-groups (fig-3), 32% were from 60 to 69 years whereas greater than 80 years of age were only 4%.

Baseline characteristics of patients recruited in current study (table-I), Angina was present in 19% of the patients, a previous AWMI in 27%; NSTEMI was present in 29% and IWMI in 17%. All the patients underwent coronary angiography: 1 vessel was involved in 7% of patients, 2 vessels in 18%, 3 vessels in 62% and 3 vessels with LMS in 13%. Detecting peripheral atherosclerotic lesions by ultrasound duplex scan (UDS), increased intima-media thickness (IMT) or plaques in carotid arteries were found in 58 patients (58%). In lower limb arteries, IMT or plaques were present in patients (38%) and a stenosis >70% in 5 patients (5%).

Severity of coronary artery disease (CAD) was correlated to extra-coronary atherosclerosis: Carotid was detected in 2 (28.6%) of patients with single vessel, in 6 (33.4%) of patients with double vessel, in 37 (59.7%) of those with 3 vessel CAD and lower limb arterial atherosclerosis was detected in SVCAD, DVCAD and TVCAD were 14.3%, 22.3% and 35.4% of patients respectively. Table-IIa & IIb shows CAD patients involving 3 vessel with LMS are most significantly correlated to carotid stenosis (p=0.001) and lower extremities PAD (p=0.003).

Furthermore, the severe PAD (diffused atherosclerotic stenosis and complete occlusion in all segments) significantly indicates the presence of some coronary pathology (table-IIa & IIb)

Table-II(a): Carotid artery disease correlation with coronary artery disease.

CAD	Carotid Doppler						*p*-value
	LT Carotid		RT carotid		LT+RT Carotid		
	n	%	n	%	n	%	
SVCAD	-	-	2	28.6	-	-	0.066
DVCAD	2	11.1	1	5.6	3	16.%	0.054
TVCAD	3	4.8	4	6.5	30	48.4	0.067
TVCAD+LMS	2	15.4	4	30.8	7	53.8	0.001

Table-II(b): Lower extremity peripheral arterial disease correlation with CAD.

CAD	PAD Lower limbs						*p*-value
	Diffuse		Moderate		Mild		
	n	%	n	%	n	%	
SVCAD	0	0	1	14.3	0	0	0.491
DVCAD	0	0	1	5.6	3	16.7	0.215
TVCAD	3	4.8	9	14.5	10	16.1	0.916
TVCAD+LMS	2	15.4	4	30.8	5	38.5	0.003

DISCUSSION

This present cross sectional study was carried out at Adult cardiology department in AFIC/NIHD, Rawalpindi, to determine the correlation of multi-vessel coronary artery disease with the atherosclerotic disease in carotid and vessels of lower extremities. In this study mean age of patients was 61.3 ± 10.725 years. Male patients were predominant 82%. NSTEMI was the most common indication for coronary angiography 29% followed by AWMI 27%. Sixty Two percent of patients studied had TVCAD. Our study demonstrated that the extent of PAD observed in carotid and peripheral lower extremity ultrasound duplex scanning was significantly associated with the presence and severity of CAD.

Peripheral arterial disease (PAD) of the lower limb is a spectrum atherosclerotic disease,

ranging from mild plaque formation to chronic total vessel occlusion. Patients may remain asymptomatic in mild forms of the disease, but can develop intermittent claudication, rest pain, or tissue loss, including ulceration and gangrene, as the disease progresses. Duplex ultrasonography (DUS) is a primary screening tool used to evaluate arterial disease in carotid arteries and peripheral arteries[6]. DUS is an optimal modality, as it is non-invasive and safe, with relatively no morbidity. Although DUS has been widely studied in the detection of carotid artery stenosis and has been shown to have a high degree of sensitivity and specificity, to date, no validated criteria have been established for defining the severity of peripheral arterial stenosis in the lower limb[6,7].

The occurrence of PAD in the general population has been assessed in different countries. In Brazil, Makdisse *et al*. reported in 2008 a high prevalence of PAD (10.5%) in a population with a mean age of 43.8 ± 14.7 years. PAD is observed in 12-14% of the general population. It often coexists with CAD and CVD, particularly in older people. Most patients with PAD ultimately die as a result of a cardiac or cerebrovascular event[9].

In Japan, Seo *et al* study reported in 2019, the prevalence of CAS in patients with CAD was 25.5%. This prevalence was not significantly different from the 19.6% reported by carotid ultrasound in CAD patients. Asymptomatic CAS was found in up to 50% of patients with multivessel disease. Considering the relationship between CAD and CAS, it is reasonable to consider the presence of CAS in patients with CAD[8-11].

According to register study conducted in the Kemerovo cardiology center it has been proved that isolated involvement of coronary vascular bed is an exemption and that some degree of multifocal atherosclerosis (MFA) is found in most patients with ST-elevation myocardial infarction[12-15]. It is considered that estimating thickness of carotid artery intima-media complex, degree of stenosis of extra-coronary arteries one can not only predict severity of coronary atherosclerosis but also assess total risk of development of vascular catastrophes[16-18].

We emphasize the importance of proactive screening for other concomitant atherosclerotic lesions, particularly in CAD patients having multi-vessel disease, and LMS disease, and/or already diagnosed with other concomitant atherosclerotic lesions.

There were some limitations to this study. First, as a single-center study, patients in our study may not reflect the general population of a large region, and the small sample size may have weakened the statistical power. Second, the diagnosis of PAD in the present study was established only by ultrasound duplex scanning.

CONCLUSION

Our study suggests that in patients with CAD, it is useful to screen the peripheral circulation by non-invasive tests, such as UDS. Patients with the diagnosis of ischemic heart disease and combined extra-coronary atherosclerosis need a careful follow-up and a more aggressive therapy for secondary prevention.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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