Identification of asymptomatic carotid plaques in high-risk middle-aged adults at a tertiary care center in Lahore

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ABSTRACT

Background and Objective: There is no comprehensive regional data for Pakistan regarding the frequency of carotid plaques and associated risk factors. Early detection of atherosclerotic plaques by noninvasive screening methods can help reduce the disease burden. As asymptomatic plaques are also one of the major causes of stroke in middle-aged individuals, the present study aimed to identify the frequency and clinical presentation of asymptomatic carotid plaques in high-risk middle-aged patients in the local population.

Methods: This cross-sectional study was conducted at the Department of Radiology, Shaikh Zayed Hospital Lahore, Pakistan. A total of 366 subjects aged 45-81 years old were screened for any atherosclerotic plaques at the bilateral extracranial carotid artery tree by consultant radiologists through Doppler ultrasound (DUS). Multi variable logistic regression was applied to determine the variables having an independent association with the development of carotid plaques.

Results: Carotid artery plaques were diagnosed in 156 (42.62%) patients. Age, sex, hypertension, dyslipidemia, and diabetes mellitus showed an independent association with carotid plaques (p-value < 0.001). The present history of smoking was not associated with carotid plaques (p-value > 0.005).

Conclusion: The diagnostic accuracy of DUS is high for the detection of sub-clinical and clinical carotid plaques. Early identification of asymptomatic carotid plaques in high-risk individuals with diabetes and hypertension can save from debilitating cardiovascular diseases.

Keywords: Carotid artery plaques, Doppler ultrasound, diabetes, hypertension, asymptomatic.

Introduction

Atherosclerosis is the most common cause of coronary artery disease (CAD) and stroke. There are several imaging modalities, such as computerized tomography, magnetic resonance angiography, and ultrasonography to diagnose atherosclerotic carotid plaques (CP). It is recommended to use noncontact standard economical imaging tools in all patients with suspicion of CP.[1] Radiological assessment based on imaging of carotid vessels is more objective and reliable.[2] Duplex Doppler ultrasound (DUS) is the most widely used modality for the diagnosis of CP, with excellent accuracy comparable to that of angiography due to the lack of contrast and radiation.[3] DUS assesses different blood flow velocity (BFV) parameters such as end-diastolic velocity, peak systolic velocity (PSV), and PSV ratio. BFV is the basis for the diagnosis of extracranial carotid artery stenosis. Carotid intima-media thickness (CIMT) evaluation by carotid B-US is an alternative surrogate technique to detect subtle atherosclerosis.[3] Assessment of plaque quantity or plaque area is a more influential measurement than CIMT because it predicts any preemptive clinical occasion. DUS is a useful approach for the screening and diagnosis of CP, as it is a cost-effective and convenient method.

It has been estimated that 8%-15% of total stroke cases are due to complete and incomplete stenosis of the carotid arteries.[4] CP undergoes various changes, such as ulceration, calcification, thrombosis, and restenosis.[5,6] The subjective assessment of CP by DUS can be made by its echogenicity. Homogenous CP endures more ischemic events than heterogeneous plaques. Heterogeneous CP can easily

ulcerate, rupture, and embolize at stress points such as carotid bifurcation. In ruptured plaques, the atheroma attracts platelet aggregation, resulting in the occlusion of small vessels.[7-9] Various modifiable and nonmodifiable risk factors are associated with myocardial ischemia and stroke. Age, sex, and race are nonmodifiable risk factors. Other potentially modifiable risk factors include diabetes, hypertension, and dyslipidemia.[10] Type II diabetic patients should be routinely evaluated for CAD with abnormal lipid profiles, especially triglycerides and LDL levels. There is a strong positive association between low HDL and hypercholesterolemia with carotid plaques (CPs). [11-14]

The major objective of this study is to determine the frequency of carotid plaque thickness in middle age to older patients using Doppler ultrasonography (USG) and to identify the risk factors of carotid plaque thickness. Detailed clinicopathological associations between CP and risk factors in general masses in Pakistan are rarely reported. Hence, we report the identification of CP in asymptomatic individuals and its relationship with various modifiable and nonmodifiable risk factors from an urban tertiary care center in Lahore, Pakistan.

Methods

This cross-sectional study was approved by the Institutional Ethical Review Board of Sheikh Zayed Hospital Lahore, Pakistan, and carried out at the Department of Radiology of the same hospital from January 2020 to November 2020. A total of 366 patients were included by nonprobability convenient sampling after informed consent. Patients having age 45-64 years were labelled as middle age and those ≥ 65 years were labelled as elderly were included in our study. Patients with a previous history of stroke, Patients with a past or current history of restenosis, carotid artery endarterectomy, carotid stenting, stroke, and/or myocardial infarction were excluded.

Patients were further subdivided into two groups based on the presence and absence of CP which was defined as a focal lesion into the lumen of any carotid artery having a size of 0.5 mm or covering 50% of the area of the lumen. The following baseline characteristics were recorded: age, sex, diabetes mellitus, blood pressure, serum lipid levels, current smoking habits, and body mass index.

The presence of a focal lesion into the lumen of any carotid artery having size 0.5 mm or covering 50% of the area of lumen was labeled as CP.[15] Carotid plaques were measured by Doppler ultrasonography using a GE Voluson Expert 730 machine and probe ranging from 6 to 12 MHz linear array transducer and 36 Hz frequency was adjusted for carotids. A single consultant radiologist with at least 15 years of experience, was assigned to screening of both extracranial carotid artery trees with a special focus on the common carotid artery, bifurcation of the common carotid artery, and internal and external carotid arteries as these are the common sites where plaques are found (Figure 1).

Statistical analysis

The data are expressed as the mean ± SD or frequencies (percentage groups with CP and without CP were compared
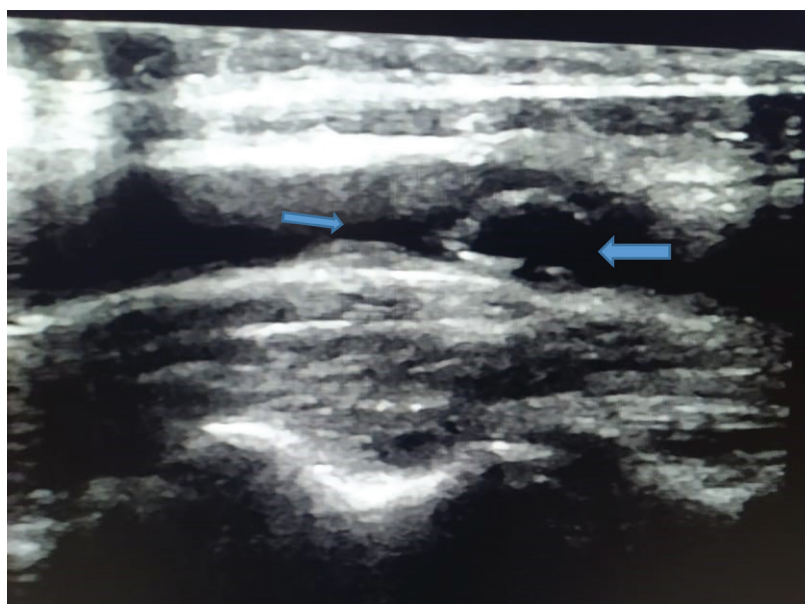

Figure 1. *Sonographic image of the artery demonstrating a heterogeneous, lipid-rich, and calcified plaque at the carotid bulb, causing significant luminal stenosis (>70%) (blue arrows).*

Table 1. Multivariate analysis showing the association of modifiable and nonmodifiable risk factors with carotid plaques.

Variable	Carotid plaques		Odds ratio (95% CI)	*p*-value
	Yes n (%)	No n (%)		
Age				
≤64 years	81 (51.9%)	147 (70.0%)	0.46 (0.30-0.71)	<0.0001
≥65 years	75 (48.1%)	63 (30.0%)		
Gender				
Female (%)	42 (32.7%)	106 (50.5%)	0.36 (0.23-0.56)	<0.0001
Male (%)	105 (67.3%)	104 (49.5%)		
Obesity				
Yes	44 (28.2%)	63 (30.0%)	0.91 (0.58-1.44)	0.71
No	112 (71.8%)	147 (70.0%)		
Hypertension				
Yes (%)	91 (58.3%)	85 (40.5%)	2.06 (1.35-3.13)	0.001
No (%)	65 (41.7%)	125 (59.5%)		
Smoking				
Yes (%)	64 (41.0%)	67 (31.9%)	1.48 (0.96-2.28)	0.07
No (%)	92 (59.0%)	143 (68.1%)		
Diabetes				
Yes (%)	72 (46.2%)	73 (34.8%)	1.60 (1.05-2.46)	0.02
No (%)	84 (53.8%)	137 (65.2%)		
Dyslipidemia				
Yes (%)	116 (74.4%)	123 (58.6%)	2.05 (1.30-3.22)	0.002
No (%)	40 (25.6%)	87 (41.4%)		

using a *t*-test for continuous variables and a chi-square test for categorical variables). Multivariate Cox regression analysis was performed to determine the variables, i.e., sex, age, obesity, diabetes, smoking, hypertension, and dyslipidemia that were independently associated with carotid plaques A *p* value < 0.05 was considered statistically significant.

Results

Carotid artery plaques were diagnosed in 156 (42.62%) patients. The mean age of the patients was 61 ± 12 years, and 46% of the participants were males (Table 1) The multivariate logistic regression analysis of independent predictors, i.e., age, sex, hypertension, dyslipidemia, diabetes mellitus, and current smoking reveals the overall frequency of hypertension (58.3% *vs.* 40.5%, *p* > 0.0001), diabetes mellitus (46.2% *vs.* 34.8%, *p* < 0.002), and dyslipidemia (74.4% *vs.* 58.6%, *p* > 0.002) was higher in patients with carotid plaques than in those without carotid plaques.

Multiple logistic regression analysis showed independent nonmodifiable risk factors for CP like advanced age (age >60 years) and male sex as shown in Table 1.

Comparing the regression analysis in the CP versus non-CP group, the modifiable risk factors, i.e., hypertension,

Table 2. Location and consistency of carotid plaques on DUS w.r.t gender and associated risk factors.

	Right carotid artery	Left carotid artery	Bilateral involvement
Location of plaques			
Common carotid artery	31	35	22
Carotid bulb	14	19	14
Internal carotid artery	5	10	6
Consistency of plaques			
Homogenous	24	42	22
Heterogeneous	26	22	20
Gender			
Males	38	45	31
Females	12	19	11
Risk factors			
Diabetes	20	27	25
Hypertension	29	41	21
Dyslipidemia	31	52	33
Present history of smoking	24	20	20

diabetes mellitus, and dyslipidemia were independent risk factors for CP (Table 1).

The frequency of smoking was also higher in CP patients; however, it did not reach statistical significance, (*p*-value 0.07) Table 1.

In our study, the majority (56.4%) of CPs were located in the common carotid artery and were predominantly of homogenous consistency (62.1%). This study showed predominantly left carotid artery involvement; however, bilateral involvement of both arteries was also noted (Table 2).

Discussion

This study describes the frequency of carotid plaques in asymptomatic high-risk individuals. In addition, this study explores the various modifiable and nonmodifiable risk factors linked with carotid artery disease that predisposes individuals toward a major risk of stroke and myocardial infarction in the local population.

Regarding the patient demographic data; and CP prevalence, no specific differences were identified in loco regional reports. In our study, we excluded known patients with stroke and MI; However, an overall CP prevalence of 42.6% and a significantly higher prevalence in men (57.10%) were noted. In a study by Gul et al. [16] in which they tried to find out sonographic comparison of atherosclerotic changes in carotid arteries of diabetic and nondiabetic individuals, the diagnostic accuracy of ultrasonography of common carotid artery, and internal carotid artery was reported high for the detection of atherosclerosis changes due to diabetes.[16] Colossal studies around the globe from different regions of Asia, Europe, and America in population-based studies showed similar results. Caucasians showed a CP prevalence of 70%, Hispanics showed 52%, and blacks showed 58%.[17] Similar trends were reported by Chinese authors[18]. The rest of the demographics, i.e., mean age and body mass index, and DUS findings such as the location and consistency of plaques, were also comparable.

Various risk factors such as older age, male sex, hypertension, diabetes, dyslipidemia, and present history of smoking were analyzed in our study. Age is always considered an important risk factor for CP. In the present study, multiple logistic regression analysis showed an independent association of nonmodifiable risk factors with CP, advanced age (age >60 years), and male sex (*p*-value < 0.0001). The rest of the conventional modifiable risk factors, hypertension, and diabetes have been significantly associated with CP.

In a study by Naseer et al.,[19] a total of 366 patients underwent bilateral carotid Doppler ultrasound examinations. The results revealed that 156 patients (42.62%) had carotid plaques, with the majority being male (105, or 67.53%). The average age was 61.17 ± 9.54 years, and the average body

mass index was 25.43 ± 3.40 kg/m². The left carotid artery exhibited the highest number of plaques (64 or 41.03%), with the common carotid artery being the most frequent location (88 or 56.41%). Most plaques were homogenous (88 or 56.41%). In concordance with the present study, they also reported common comorbidities as diabetes mellitus, hypertension, and dyslipidemia.

However, on the basis of the results of the present study, this screening predicts the chances of the development of carotid plaques higher in high-risk patients. However, asymptomatic, as similarly reported by Wang et al. [20] where such patients presented with transient ischemic attacks or permanent neurological damage.

Limitations of the Study

First, the study population was from an urban population in Pakistan, and there was a limited representation of data. Second, the cross-sectional study design may have led to selection bias, especially among healthy elderly individuals. However, patients with previous histories of cardiovascular disease and cerebrovascular disease were excluded from this study. It was beyond the scope of this article to segregate rural and urban populations and further evaluate carotid intima thickness, and carotid stenosis and compare them with risk factors. This study cannot asses the quantitative relationship between CP severity and risk factors.

Conclusion

The findings of this study reveal that that there is a higher frequency of CPs in the middle to old-age population referred for carotid artery scans. Advanced age, male sex, hypertension, diabetes, and dyslipidemia are significant risk factors for CPs.

List of abbreviations

CA	Carotid arteries
CAD	Coronary artery disease
CPs	Carotid plaques
DUS	Duplex Doppler ultrasound
CIMT	Carotid intima-media thickness

Conflict of interest
None to declare.

Ethics approval
The ethical approval of the study was issued by the Institutional Ethical Committee of Sheikh Zayed Hospital, Lahore, Pakistan vide letter No. SZMC/IRB/Internal/MD/100/18, dated 07/11/2019.

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