

CAROTID PLAQUE CHARACTERISTICS AND ITS PREVALENCE IN PATIENTS WITH CORONARY ARTERY DISEASE: AN OBSERVATIONAL STUDY

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Abstract

Background and Aims: To evaluate the prevalence and clinical significance of carotid artery plaque, in patients with coronary artery disease.

Material and Methods: A total of 1000 patients with 40-80 years of age with coronary artery disease were enrolled. Carotid ultrasonography was performed in all these patients.

Results: Among 100 patients with carotid artery disease, 36 had a carotid plaque. In plaque-positive cases, a majority of patients were in a 50 – 60-year age group. Dyslipidemia was found to be the most common risk factor for carotid plaque. In 36 plaque-positive cases, 20 (56%) were having the plaque at the carotid bulb and 16 (44%) were having the plaque at the common carotid artery. Out of 36 cases, 16 (44%) were hyperechogenic, 8 (22%) were calcified, 6 (17%) were moderate echogenic, 6 (17%) were low echogenic.

Conclusion: High-resolution B-mode ultrasonography is a useful non-invasive method to evaluate carotid atherosclerosis. Carotid plaques of the common carotid artery are a surrogate marker of atherosclerosis and associated with cardiovascular events. Routine screening of patients with coronary artery disease may be considered.

Keywords: Carotid artery stenosis, coronary artery disease, cardiovascular events, atherosclerosis, carotid ultrasonography.

Introduction

Carotid artery disease has a well-known association with coronary artery disease. Both share common pathophysiologic pathways, including endothelial dysfunction, atherosclerosis, and thrombotic disease. The identification of patients with increased risk of atherosclerosis is important for prognosis as well as for optimizing the benefits of treatment. Screening of patients with increased risk of atherosclerosis is important for more effective prevention of cardiovascular disease, because preclinical (silent) atherosclerotic plaques may develop in the arteries slowly over several decades before they rupture or obstruct an artery becoming clinically manifest. Nowadays, screening methods are available for detecting the presence and stability of such plaques. High-resolution B-mode ultrasonography is a very useful non-invasive method to evaluate carotid atherosclerosis. It enables evaluation of carotid intimal medial thickness, plaque characteristics, and degree of stenosis.

The evaluation of subclinical atherosclerosis, defined as elevated CIMT or the presence of carotid plaques, in

addition to clinical risk factor assessment is a sensitive method to assess future cardiovascular risk.

Material and Methods:

This study was conducted in the Department of Medicine, Maharaja Yeshwant Rao Hospital, M.G.M. Medical College Indore, India (ICCU and Medical wards) in 6 month period from April 2010 to September 2010.

This study was an observational study that involved 50 known CAD patients identified based on their history, clinical examination, ECG records, and coronary angiograms. In these 66 were male and 34 were female.

Inclusion Criteria

Patients having coronary artery disease of 40–80-year age group

Exclusion Criteria

1. Haemodynamically unstable patients.
2. Patients with poor quality of the carotid image.

3. Patients suffering from chronic liver disease, chronic kidney disease, any malignancy
4. Patients who refused to be a part of the study.

Method of Collection of Data

Detailed clinical history and cardiovascular system examination performed and findings were noted. Evidence of diabetes mellitus, hypertension, obesity, dyslipidemia collected and detailed history regarding smoking, alcohol, family history of CAD, history of cerebrovascular accident, or peripheral vascular disease was taken. The patients were selected as per inclusion criteria and subjected to the carotid Doppler examination.

The data gathered from the carotid Doppler examination were as follows-

- Carotid Plaque-Focal structure encroaching into the arterial lumen by at least 50% of the surrounding Intimal medial thickness (IMT) or localized thickening of ≥ 1.2 mm.
- IMT was measured in a 1 cm long segment just proximal to the carotid bulb in the common carotid artery. In the presence of plaque, the IMT was measured at the segment without plaque.
- Peak systolic velocity (PSV) of the common carotid artery (CCA).
- Peak systolic velocity (PSV) of the internal carotid artery (ICA).
- Peak systolic velocity ratio of ICA/CCA.
- Measurement of vessel lumen was done from a frozen real-time image, the plaque characteristics were seen on the real-time image.

Carotid Ultrasonography

All carotid ultrasonography examinations were performed with the use of GE LOGIQ 3 sonographic machine equipped with a 7.5 to 12 MHz linear-array transducer. With the subject in the supine position and the neck in slight hyperextension the common carotid artery, carotid bulb, and the extracranial part of the internal carotid artery were identified on both sides and IMT were measured as the distance between the luminal intimal interface and the medial adventitial interface. The severity of carotid atherosclerosis was evaluated by the presence and various characteristics of plaque.

Position of the Patient and Examiner

Patients were held in the supine position. The head was hyperextended by placing a small pad or roll beneath the neck to assist visualization of the soft tissue at the mandibular angle. The patients were comfortably positioned with the head resting on the table surface to avoid neck muscle tension that would hamper penetration of the ultrasonic sound waves.

The patient's arms were adducted and extended with the shoulders relaxed. The examination was done sitting on the patient's right side as in abdominal sonography. For the examination of specific vessels, the patient is told to turn the head to the opposite side while keeping the neck relaxed. It is best to scan the left side of the neck first so that patient can watch the initial part of the examination on the monitor. The patient is told not to speak, to breathe quietly and evenly, and to swallow as little as possible to avoid motion artifacts. The transducer should press very lightly on the skin to respect the pressure sensitivity of the cervical soft tissues and laryngeal area. Also, excessive transducer pressure on carotid bifurcation could provoke a vagal response by irritating the carotid sinus receptors (carotid sinus syndrome).

Informed consent was taken from all patients involved in this study and is approved by the local ethics committee.

Results:

The carotid examination was done and the presence or absence of carotid plaques was evaluated. Plaque positive cases were further assessed with other well-established risk factors of CAD. Various characteristics of plaque were also assessed using carotid Doppler and B mode ultrasonography.

Among plaque positive cases (n=36), 24 patients (67%) were male and 12 patients (33%) were female.

Among plaque negative cases (n=64), 44 patients (69%) were male, and 20 patients (31%) were female.

Among plaque positive cases, majority of pts were in a 50 – 60-year age group (61%), followed by a 40–50-year age group (22%), followed by 60–70-year age group (11%), followed by 70-80 year age group (6%).

While among plaque negative cases, the majority of patients were in a 40–50-year age group (50%) followed by a 50 -60-year age group (29%), followed by a 60–70-year age group (19%), followed by 70-80 year age group.

Among the plaque positive cases, dyslipidemia was found to be the most common risk factor in 26 (72%) followed by obesity, smoking equally, followed by hypertension and alcohol.

Among the plaque negative cases, obesity was found to be the most common risk factor in 30 (47%) followed by smoking, followed by Hypertension and dyslipidemia equally.

Among 36 plaque positive cases, 20 (56%) had plaque at the carotid bulb and 16 (44%) had plaque at the common carotid artery.

Among plaque positive 36 cases, 16 (44%) were hyperechogenic, 8 (22%) were calcified, 6 (17%) were moderate echogenic and 6 (17%) were low echogenic.

Out of 36 plaque positive cases, 20 (56%) were having significant stenosis i.e. (40% or more) and 20 patients had peak systolic velocity ratio of ICA/CCA > 1.5 .

Discussion:

Cardiovascular diseases are the leading cause of death worldwide and its incidence is increasing especially in the Asian population. It is well known that atherosclerosis is very common in coronary and carotid arteries, and both share common risk factors. Common risk factors include age, sex, smoking, diabetes, hypertension, dyslipidemia, obesity, and hypothyroidism. Other emerging risk factors for atherosclerosis include Apolipoprotein B, Plasminogen activator inhibitor (PAI-1), fibrinogen, and C-reactive protein (CRP). Carotid plaque of the common carotid artery is a surrogate marker of atherosclerosis and is associated with cardiovascular events.¹⁻⁶ Therefore, knowing the status of carotid artery disease in patients with coronary artery disease is very important. In patients undergoing coronary artery bypass grafting, carotid artery stenosis is a potential cause of peri/post-operative stroke, with the prevalence of 3% in unilateral stenosis, 5% in bilateral stenosis and 7% in total carotid occlusion.⁷ Patients with coronary and peripheral artery disease carry twice the risk than with coronary artery disease alone.⁸ It is also evident that plaque characteristics and their anatomical location at branching points and arterial curves are similar in both coronary and carotid arteries.⁹ But the extent of association of these two arterial systems is less well elucidated. Recently, carotid plaques have been recommended as a non-invasive tool for primary prevention of cardiovascular events.

As per the European Carotid Surgery Trial, patients with the bilateral carotid disease were more likely to have had a previous myocardial infarction and to suffer a fatal event.¹⁰

Carotid plaque is easily detected by B-mode ultrasonography. In this study, we sought to evaluate the prevalence and clinical significance of carotid plaque, in patients with coronary artery disease.

Atherosclerotic plaque is initially revealed sonographically by an increase in the combined thickness of the intima and media layers, and subsequently by echogenic material that encroaches on the arterial lumen. Homma and colleagues found that the normal intima-media thickness in the common carotid artery, as measured in areas void of plaque, increases linearly with age from a mean of 0.48 at age 40 year to 1.02 at age 100 year follows the formula $(0.009 \times \text{age}) + 0.116$.¹¹ In addition to age-related change, the intima-media thickness also increases in response to early plaque formation, and this measurement is used, therefore, as a marker for cardiovascular and cerebrovascular risk in a variety of clinical settings.

The walls of arteries contain three distinct layers the innermost layer is intima, the middle layer or muscular layer and the outer layer is adventitia. The intima and adventitia produce parallel echogenic lines, with an intervening echo void that represents media.

Normal Flow Characteristics:-

In normal arteries flow is laminar. This laminar pattern may be disrupted by vessel tortuosity, kinks, or branching. These normal flow disturbances are shown by Doppler spectral broadening. The most noteworthy normal flow disturbance occurs at carotid bifurcation, where a vortex is established in the bulbous portion of the common carotid artery (CCA) and internal carotid artery (ICA). The size of the vortex related to anatomical factors, like the diameter of lumen and degree of angulation between ICA and ECA. It has been observed that atherosclerotic plaque originate mainly in the region of flow reversal.

About peak systolic velocity in ICA, the reported mean values for normal adults range from 54-88 cm/sec and ICA velocity exceeding 100 cm/sec should be viewed as potentially abnormal. Peak systolic velocity in ECA is 77 cm/sec (mean) in a normal individual and maximum velocity does not normally exceed 115 cm/sec.

Duplex Features of Abnormal Carotid Arteries:-

The principal arterial pathology detected with B mode sonography is atherosclerosis. Atherosclerotic plaque is represented by echogenic material that encroaches in the lumen and produces a flow of void in the color duplex image. Plaque echogenicity may be correlated qualitatively with the composition of the plaque, measured by total intimal medial thickness. A measurement greater than 1.2 mm (lumen to adventitia) indicates the presence of plaque. According to ARIC STUDY (Atherosclerosis Risk in Communities), carotid IMT and presence or absence of plaques improves prediction of coronary heart disease risk.¹²

Low Echogenic Plaque:-

Fibrofatty plaques that contain a large amount of lipid material are the least echogenic type of plaque and this plaque may be so faintly echogenic to identify sonographically. In general fibrofatty plaque is less echogenic than sternocleidomastoid muscle.

Moderately Echogenic Plaque:-

The echogenicity of plaque increases in proportion to its collagen content. Hence fibrous plaque in which collagen content is a prominent component is moderately echogenic. In general terms, this plaque is more echogenic than the arterial adventitia. The echogenicity is usually uniform but localized hypoechoic areas may be seen when focal deposits of thrombus or lipid material are present.

Strongly Echogenic Plaque with Shadowing:-

Dystrophic calcification occurs in plaque in areas of hemorrhage and necrosis and calcifications generate strong reflective foci may be focal or diffuse.

High-resolution sonography is extremely sensitive to calcification and areas as small as 1mm diameter may be detected. Acoustic shadows from large calcification may be extremely troublesome, since these shadows may obscure the arterial lumen and the wall surface. Opposite the plaques, therefore they may prevent the acquisition of determination of severity and significance of atherosclerotic involvement at a specific location.

Higher the echogenicity, the higher the risk of myocardial infarction and stroke independent of the degree of stenosis and cardiovascular risk factors. Subjects at high risk for ischemic vascular events may be identified by ultrasound assessment of plaque morphology.¹³

As patients with coronary artery disease may have associated carotid artery disease, they can be considered for routine screening for carotid artery disease.

Conclusion:

Carotid and coronary arteries are the two most common sites of involvement of atherosclerosis. High-resolution B-mode ultrasonography is a useful non-invasive method to evaluate carotid atherosclerosis. Carotid plaques of the common carotid artery are a surrogate marker of atherosclerosis and associated with cardiovascular events. Patients with coronary artery disease may be considered for routine screening for carotid artery disease.

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