



BJGH

Brazilian Journal
of Global Health
Revista Brasileira
de Saúde Global

Carotid intima-media thickness as a predictor of coronary artery disease: implications of subclinical atherosclerosis

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ABSTRACT

OBJECTIVE

To describe the correlation between carotid intima-media thickness (cIMT) and the presence of coronary artery disease (CAD).

METHODS

This is a narrative literature review. Observational studies, meta-analyses, systematic reviews, and randomized clinical trials from 2016 to 2024 were considered.

RESULTS

cIMT is recognized as a subclinical indicator of atherosclerosis and a predictor of CAD, serving as a cardiovascular risk marker. It is associated with risk factors such as systemic arterial hypertension (SAH), type 2 diabetes mellitus (T2DM), dyslipidemia, and smoking. SAH and T2DM promote oxidative stress and inflammation, contributing to increased cIMT. Evidence indicates that antihypertensive and lipid-lowering therapies may reduce cIMT. Smoking also worsens this condition, favoring the deposition of atherosclerotic plaques. The global prevalence of elevated cIMT is 27.6% among people aged 30 to 79, reflecting the universality of atherosclerosis. cIMT progression shows sex-related differences, generally being higher in men due to variations in atherosclerosis composition and morphology between sexes. Studies suggest that reducing risk factors, such as controlling SAH and T2DM, may slow cIMT progression and decrease coronary events.

CONCLUSION

Carotid intima-media thickness appears to be significantly associated with coronary artery disease, representing a marker of subclinical atherosclerosis and cardiovascular risk.

KEYWORDS

Atherosclerosis; Carotid intima-media thickness; Coronary artery disease.

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DOI:

INTRODUCTION

Atherosclerosis is a chronic and progressive inflammatory disease characterized by the accumulation of lipids and inflammatory cells in the arterial wall, leading to the formation of atherosclerotic plaques and a reduction in blood flow. This process is associated with the development of various cardiovascular diseases, including coronary artery disease (CAD), one of the leading causes of morbidity and mortality worldwide.¹

In the early stages of atherosclerosis, thickening of the intimal and medial layers of the arteries occurs, a phenomenon known as intima-media thickness (IMT). When evaluated in the carotid arteries, this parameter is termed carotid intima-media thickness (cIMT) and is considered an early marker of subclinical atherosclerosis.^{2,3}

The measurement of cIMT is performed via carotid artery ultrasound, a non-invasive, widely available, and low-cost method capable of identifying structural vascular changes before the appearance of clinical manifestations of cardiovascular disease.⁴

Various cardiovascular risk factors are associated with an increase in cIMT, including systemic arterial hypertension, diabetes mellitus, dyslipidemia, smoking, advanced age, and genetic predisposition. The presence of these factors contributes to endothelial dysfunction, oxidative stress, and the progression of the atherosclerotic process.⁵⁻⁸

Studies have demonstrated that increased cIMT is associated with a higher risk of cardiovascular events, such as acute myocardial infarction and stroke, making it an important cardiovascular risk marker and a potential predictor of coronary artery disease.^{3,9,10}

This study aims to describe the relationship between cIMT and the presence of coronary artery disease, analyzing its utility as a cardiovascular risk marker and discussing the main factors associated with its progression.

METHODS

Study Design

This is a narrative-type literature review involving the selection of articles on atherosclerosis, carotid intima-media thickness, and coronary artery disease.

Data Collection Procedure

Articles on the topic were selected from the PubMed, SciELO, and Google Scholar platforms using the descriptors: atherosclerosis, intima-media thickness, and coronary artery disease.

The selection of articles was conducted according to previously established inclusion and exclusion criteria. Thus, scientific studies exploring the correlation between atherosclerotic disease and carotid intima-media thickness (cIMT) with coronary artery disease were included. Observational studies, meta-analyses, systematic reviews, and randomized clinical trials discussing aspects pertinent to the topic were considered.

Additionally, the reference lists of relevant studies were analyzed to identify potential works pertinent to the present study. Studies that did not meet the specified inclusion criteria, such as those where the descriptors were not directly addressed, were excluded.

The selection of articles was initially performed through the reading of titles and abstracts. Subsequently, a further screening was conducted through the full reading of the articles. The studies that satisfied the inclusion and exclusion criteria composed the final sample.

Data Analysis Procedure

Data extracted from the selected studies were organized according to methodological characteristics, the population studied, and main findings related to carotid intima-media thickness and its association with coronary artery disease. Subsequently, a qualitative analysis of the literature was performed to identify patterns, associated risk factors, and clinical implications described in the included studies, allowing for the synthesis and interpretation of findings relevant to the theme.

RESULTS AND DISCUSSION

The literature analysis highlights that carotid intima-media thickness (cIMT) may present a significant association with cardiovascular risk factors and the presence of coronary artery disease. Epidemiological studies indicate that atherosclerosis is more prevalent in men than in women, especially between the ages of 45 and 64, with a progressive increase in prevalence at more advanced ages.^{11,12}

Age and systemic arterial hypertension stand out as important predictors of increased cIMT. Studies demonstrate that elevations in systolic blood pressure and aging are directly related to the increase in intima-media thickness, reinforcing the role of these variables in the progression of subclinical atherosclerosis.¹³

Furthermore, individuals with hypertension, dyslipidemia, and diabetes mellitus present significantly higher mean cIMT values compared to individuals without these conditions. These findings reinforce the association between metabolic risk factors and the progression of atherosclerotic disease.¹³

Type 2 diabetes mellitus is particularly associated with metabolic changes, such as chronic hyperglycemia and vascular inflammation, which contribute to endothelial dysfunction and increased arterial wall thickness. Studies show that diabetic patients are more likely to develop increased cIMT and, consequently, higher cardiovascular risk.^{14,15}

Dyslipidemia also plays a major role in this process, as elevated levels of total cholesterol and low-density lipoprotein (LDL) favor lipid deposition in the arterial wall and the formation of atherosclerotic plaques. Recent research demonstrates a significant correlation between elevated LDL levels and increased cIMT.¹⁶

Smoking constitutes another relevant factor for the progression of atherosclerosis. Toxic substances present in cigarettes promote oxidative stress and vascular inflammation, contributing to endothelial injury and lipid deposition in the intima-media layer of the arteries.¹⁷

Another important aspect identified in the studies is the difference between sexes in cIMT progression. Men tend to present higher intima-media thickness values at younger ages, while in women, a significant increase occurs after menopause, possibly related to the reduction of the protective effect of estrogen.¹²

Moreover, evidence demonstrates that increased cIMT is associated with a higher risk of cardiovascular events, including myocardial infarction and stroke. Longitudinal studies indicate that every 0.1 mm increase in intima-media thickness is related to an approximate 10% increase in the risk of future coronary events.^{9,14}

On the other hand, interventions aimed at controlling cardiovascular risk factors show a positive impact on reducing cIMT progression. The use of antihypertensive medications, lipid control therapies—especially statins—and lifestyle changes can contribute to delaying the advancement of atherosclerosis and reducing the risk of cardiovascular events.^{8,9}

Thus, the literature findings reinforce that cIMT constitutes a useful marker in cardiovascular risk assessment, allowing for the early identification of individuals with a higher probability of developing coronary artery disease and enabling more effective preventive interventions.

CONCLUSION

Atherosclerosis remains one of the primary causes of global morbidity and mortality, with coronary artery disease being one of its most severe manifestations. cIMT has been widely studied as a non-invasive biomarker for the early detection of subclinical atherosclerosis. Furthermore, cIMT has shown itself to be an independent predictor of CAD, even after adjustments for traditional risk factors such as hypertension, dyslipidemia, diabetes mellitus, and smoking.

The assessment of cIMT via carotid ultrasound is a well-established and widely available methodology in clinical practice, allowing for the early identification of individuals at risk and the implementation of preventive interventions. These interventions, including lifestyle changes and pharmacological therapies, can delay the progression of atherosclerosis and reduce the incidence of cardiovascular events.

Therefore, the measurement of cIMT should be considered an essential practice in cardiovascular risk assessment,

especially in high-risk populations. However, it is crucial to continue investing in research that deepens the understanding of the biological mechanisms underlying cIMT and its interaction with other cardiovascular risk markers.

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