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Review

Coronary and carotid atherosclerosis: How useful is the imaging?

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A B S T R A C T

The recent advancement of imaging modalities has made possible visualization of atherosclerosis disease in all phases of its development. Markers of subclinical atherosclerosis or even the most advanced plaque features are acquired by invasive (IVUS, OCT) and non-invasive imaging modalities (US, MRI, CTA). Determining plaques prone to rupture (vulnerable plaques) might help to identify patients at risk for myocardial infarction or stroke. The most accepted features of plaque vulnerability include: thin cap fibroatheroma, large lipid core, intimal spotty calcification, positive remodeling and intraplaque neovascularizations. Today, research is focusing on finding imaging techniques that are less invasive, less radiation and can detect most of the vulnerable plaque features. While, carotid atherosclerosis can be visualized using noninvasive imaging, such as US, MRI and CT, imaging plaque feature in coronary arteries needs invasive imaging modalities. However, atherosclerosis is a systemic disease with plaque development simultaneously in different arteries and data acquisition in carotid arteries can add useful information for prediction of coronary events.

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1. Introduction

Atherosclerosis can lead to life-threatening cardiovascular (CV) events such as myocardial infarction (MI) or ischemic stroke (IS). The majority of events derive from the rupture or erosion of atherosclerotic plaque, with a superimposed thrombus. This may

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completely occlude the lumen (the commonest pathomechanism in MI) or may embolize to occlude a distal branch (as in IS) [1]. The risk of atherosclerotic plaque rupture does not necessarily correlate with stenosis severity, a dissociation revealed in many studies [2,3] and clinical trials, which have shown that statins markedly reduce acute ischemic events [4] with only modest reduction in the degree of stenosis [5].

Imaging atherosclerotic plaque using conventional arteriography has major limitations as it is unable to detect positively remodeled lesions, which do not significantly impinge on the lumen [6]. More recent technology, such as intravascular ultrasound (IVUS) and optical coherence tomography (OCT), can overcome this limitation and even provide information on the plaque type and thickness of the cap and highlight features affecting vulnerability: inflammation, neovascularization, ulceration and calcification (Fig. 1). Determination of the type of plaque prone to rupture might, therefore, help to identify patients at risk for MI [7,8], although these techniques are invasive and not practical for routine daily use. Another feature of plaque instability is low echogenicity and neovascularization [9]. On the other hand, non-invasive computerized tomography (CT) enables not only determination of the severity of luminal narrowing, but also visualization of plaque calcification and positive wall remodeling [10] (Fig. 1). Positron emission tomography (PET) and magnetic resonance imaging (MRI) provide similar information about the carotid circulation. They also assist in demonstrating the extent of disease spread [11], increased c-IMT and unstable plaques, which are at increased risk of causing acute events [12]. These imaging techniques have been validated against histological findings, thus strengthening their potential regular clinical application [13]. This review focuses on imaging modalities that visualize atherosclerosis, assess its features and its predictive value as well as its response to medical therapy.

2. Imaging subclinical atherosclerosis

It has been proposed that indicators of subclinical atherosclerosis, such as c-IMT, carotid total plaque area and coronary artery calcium score (CACS), might usefully predict vascular events.

2.1. Carotid intima media thickness

C-IMT is defined as the distance between the lumen–intima interface and the media–adventitia interface, a measurement that can easily and reproducibly be obtained using Duplex ultrasound [14] (Fig. 1). It has been shown to be closely associated with the risk of developing future ischemic heart disease and stroke. The ARIC (Atherosclerosis Risk in Communities) study indicated that in middle-aged patients for every 1.9 mm increment of c-IMT, the risk for MI or sudden cardiac death increases by 36% [15]. C-IMT measurements also improved traditional risk factors for prediction of CV events. In particular, among intermediate-risk patients, the addition of c-IMT and plaque information led to clinical net reclassification improvement of approximately 9.9% [16]. Likewise, statins trials have consistently shown that a regression in c-IMT is associated with a reduction in CV events [17,18], particularly in patients with intensive therapy [19]. However, these findings have been contradicted by the recent evidence which found no association between c-IMT progression and CV risk in the general

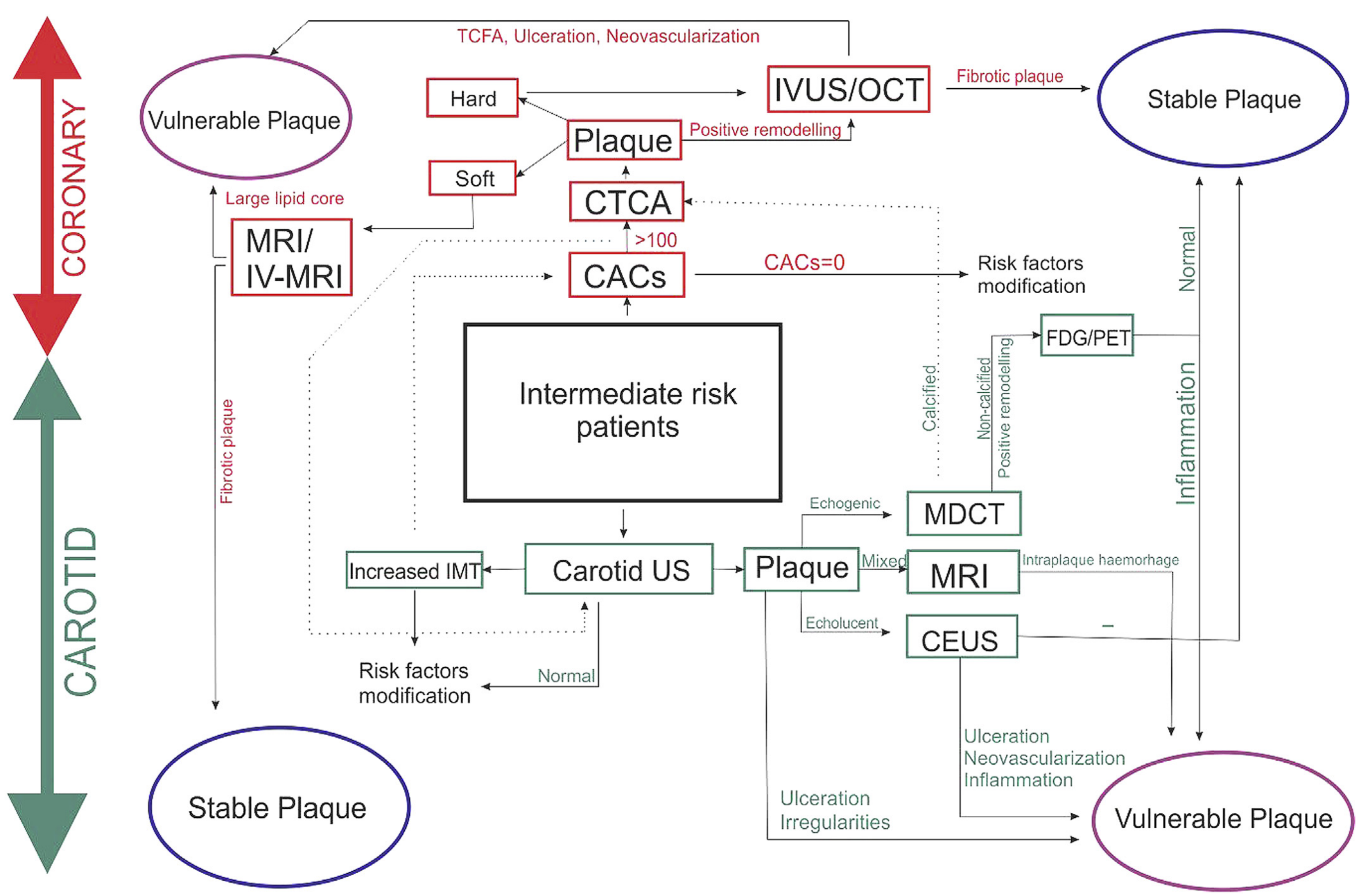

Fig. 1. The usefulness of the imaging modalities in detection of plaque features and its stability. CTCA–CT coronary angiography.