Role of Imaging in Subclinical Atherosclerosis

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Abstract: *Subclinical or preclinical atherosclerosis is a region of growing interest among the clinicians and the investigators as its detection has an impact on the overall risk prediction for developing a future acute cerebro and cardiovascular (CVD) event. Atherosclerosis is a slow and a progressive process and takes years to develop into an clinically silent but can be detected by imaging, providing anatomical information on the arterial wall and function. Carotid intima media thickness is an important independent marker for risk stratification and thus helping in instituting preventive or investigative measures. The flow mediated dilatation gives the functional information on the arterial endothelium. Coronary calcium score determines the total calcium in the coronary arteries and thus the plaque burden and also the future risk of a CVD. This article delves with the various imaging modalities available, the background and their clinical implications and also the technique for studying the parameters used to detect subclinical atherosclerosis.*

INTRODUCTION

Atherosclerosis is the underlying disorder in the majority of he cardiovascular events which is the leading cause of death in the industrialized world. Its increasing prevalence in the urban developing world is a significant cause of mortality and morbidity. Atherosclerosis is a chronic disease beginning in the early years of life. Subclinical arterial disease precedes the clinical manifestation by years and thus has been a subject of importance as it can serve as a better marker for predicting cardio vascular disease (CVD) susceptibility. Identification of individuals with sub-clinical atherosclerosis can alert the physician while the patient is still asymptomatic and allows him to implement preventive measures to manage the risk factors. Studies have shown that intervention at this stage causes regression of the atherosclerosis and decreases the risk of subsequent cardiac disease and stroke.

Traditionally angiography is considered as the gold standard investigation for detecting established atherosclerosis by directly visualizing the luminal stenosis, but it does not have any role in diagnosing subclinical atherosclerosis. Imaging modalities which play a vital role in the detection of atherosclerosis during its early stages before it becomes clinically apparent are:

ULTRASONOGRAPHY (USG)

1. Measurement of Carotid intima media thickness (CIMT) by B mode ultrasound
2. Estimation of Brachial Artery flow mediated dilatation

Vascular computed tomography (CT)

1. Calcium scoring using cardiac (CT)

These imaging tools are useful in predicting the occurrence of CVD more accurately than the traditional risk factors.

CAROTID INTIMA MEDIA THICKNESS (CIMT)

Introduction

Measurement of the carotid arterial wall thickness can be done using B Mode USG. Intima media thickness (IMT) of the carotid artery represents the combined thickness of the intimal and medial layers of the carotid artery. IMT is the distance from the luminal margin of the intima to the media-adventitia echogenic interfaces. More than 0.08mm is considered to be thickened and represents the beginning of development of the atherosclerosis and thus the subclinical atherosclerosis.

CIMT is a surrogate marker for atherosclerosis[1]. It is an independent predictor of stroke and MI and is therefore valuable in estimating the risk of developing a future CVD, particularly for patients with intermediate risk by conventional risk assessment.

The association between CIMT and CVD is well established[2,3]. It has a strong positive predictive value for identifying individuals with angiographically defined CAD (4). Various studies have shown increase in the incidence of stroke and MI in patients with increased CIMT. In a meta-analysis conducted by Lorenz et al (5) on 8 clinical studies, established CIMT as a strong predictor of CVD events. They concluded that an absolute difference of 0.1 mm increases the risk of MI by 10-15 %, in atherosclerosis. Risk In Communities (ARIC) study conducted on asymptomatic subjects the coronary heart disease (CHD) increased in proportion to the increasing IMT. The age and race adjusted risk for CHD increased 5 fold (in women) and 2 fold (in men) with a measurement above 1mm of IMT[6].

Technique

CIMT can be measured using a high frequency gray scale ultrasound. It is non invasive, relative inexpensive, reliable, repeatable without any adverse effects and does not involve radiation. No patient preparation is required, and is therefore done in an OPD setting without any complications or aftercare. It has been recommended by the American Heart Association for evaluation of risk of CVD and is a FDA approved procedure.

Scan is obtained using a high resolution linear ultrasound transducer of frequencies 7-12 MHz an appropriate depth of focus (e.g. 30-40 mm) and optimal frame rate of 25 Hz (>15Hz) is used. Log gain compensation should be around 60 DB. Obtaining an optimal image quality using a perpendicular USG bean with respect to artery and adequate gain settings is prerequisite. The arterial segment should be displayed as a horizontal image with well defined sharp walls, clear lumen without any reverberation artefacts and symmetrical brightness on near and far wall.

The IMT is measured at the end of the Common Carotid artery (CCA) where the double-line pattern is observed along the longitudinal arterial segment. IMT should be measured is made from the plaque free region. Composite scores including both plaque and IMT measure should be avoided.

Measurement can be calculated using manual semi-automated or automated methods.

The two methods used internationally to measure CIMT are:

A) Mannheim carotid Intima-media Thickness Consensus (2004-2006)[7] measurements taken at CCA, Bifurcation (bulb) & ICA
B) American Society of Echocardiography[8]

Measurements taken at distal 1 cm of CCA

This method has shown higher reproducibility ad accuracy

Mean IMT value and the maximal IMT values are calculated and average measurement of arterial segment of both left and right sides are considered.

CIMT values are expressed as percentile of the normal range of values of the represented population and is used to define the risk of future CVD events.

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