Aortic velocity propagation: A novel echocardiographic method in predicting atherosclerotic coronary artery disease burden

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Background: **The major burden of cardiovascular disease mortality around the globe is due to atherosclerosis and its complications. Hence its early detection and management with easily accessible and noninvasive methods are valuable. Aortic velocity propagation (AVP) through color M-mode of the proximal descending aorta determines aortic stiffness, reflecting atherosclerosis. The aim of this study was to find the utility of AVP in predicting coronary artery disease (CAD) burden assessed through SYNTAX (SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery) score and compared with carotid intima-media thickness (CIMT), which is an established surrogate marker of atherosclerosis.**

Methods: **In this cross-sectional comparative study, we measured AVP by color M-mode and CIMT by using Philips QLAB-IMT software in 100 patients, who underwent conventional coronary angiogram (CAG) between May 2013 and November 2014. Coronary artery disease is considered significant if >50% diameter stenosis is present in any epicardial coronary artery and insignificant if otherwise.**

Results: **Initially, to know the normal range we measured AVP and CIMT in 50 patients without any major risk factors for CAD but CAG was not done. Aortic velocity propagation ranged from 46 cm/s to 76 cm/s (mean = 58.62 þ 6.46 cm/s), CIMT ranged from 0.50 mm to 0.64 mm (mean = 0.55 þ 0.03 mm). Among 100 patients who underwent CAG we found 69% had significant CAD, 13% had insignificant CAD, and 18% had normal coronaries. Those with significant CAD had significantly lower AVP (41.65 þ 4.94 cm/s) [F (2,97) = 44.05, $p < 0.0001$] and significantly higher CIMT (0.86 þ 0.11 mm) [F (2,97) =35.78, $p < 0.0001$]. AVP had significant strong negative correlation with CIMT ($r = -0.836$, $p < 0.0001$, $n = 100$) and SYNTAX score ($r = -0.803$, $p < 0.0001$, $n = 69$), while CIMT was positively correlated with SYNTAX score significantly ($r = 0.828$, $p < 0.0001$, $n = 69$).**

Conclusions: **AVP and CIMT can predict CAD burden in a robust way. AVP may emerge as an exquisite bedside tool to predict atherosclerotic burden and guide in implementing preventive therapy for cardiovascular disease.**

Keywords: Aortic stiffness, Atherosclerosis, Intima-media thickness, Propagation velocity

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Introduction

The prevention of atherosclerosis and its complications is a major goal of cardiovascular health care. Currently, identifying patients who are at high risk for cardiovascular disease (CVD) prior to its development and disease prevention has taken a higher priority. Atherosclerosis involves a combination of fatty degeneration (atherosis) and vessel stiffening (sclerosis) of the arterial wall. Sclerotic changes have attracted less attention than atherosis because of the greater difficulty entailed in its assessment. Standard evaluation by histopathology and serial angiography is a sensitive method to determine atheromatous but not sclerotic changes. Atherosclerosis increases thickness and stiffness of the arterial wall and therefore it leads to increased arterial resistance. Increased arterial resistance results in decreased flow propagation velocity within the arterial lumen [1]. The color M-mode-derived aortic velocity propagation (AVP) of descending thoracic aorta by measuring arterial stiffness has been shown to be inversely correlated with coronary artery disease (CAD) [1,2], while other methods to assess arterial stiffness such as pulse wave velocity, aortic distensibility, and aortic strain are difficult to apply in practice. Also, a recent study found AVP was on par with pulse wave velocity and aortic distensibility in assessing arterial stiffness, with added advantage of ease and reproducibility in clinical practice.

Carotid intima-media thickness (CIMT) is increasingly used as a surrogate marker for atherosclerosis. The American Heart Association Writing Group 3, National Cholesterol Education Program Adult Treatment Panel III, the American Society of Echocardiography, Screening of Heart Attack Prevention and Education guideline, and European Society of Hypertension recommend measuring CIMT for redefining CVD risk assessment in patients with subclinical atherosclerosis [3]. Carotid intima-media thickness and brachial artery flow-mediated dilatation have been shown to be correlated with coronary atherosclerosis [4,5].

This study was done to find the utility of AVP in predicting CAD burden and compare with CIMT, which is an established surrogate marker of atherosclerosis.

Abbreviations

CVD	cardiovascular disease
AVP	aortic velocity propagation
CAD	coronary artery disease
SYNTAX	Score SYNergy between PCI with TAXus and cardiac surgery Score
CIMT	carotid intima-media thickness
CAG	coronary angiogram
NCEP-ATPIII	National Cholesterol Education Program Adult Treatment Panel III
SHAPE	Screening of Heart Attack Prevention and Education
TC	total cholesterol
TG	Triglycerides (TG)
HDL	high density lipoprotein
DT	deceleration time
IVRT	isovolumetric relaxation time
ANOVA	Analysis of Variance
ROC curve	receiver operating characteristic curve
SPSS	Statistical Package for Social Sciences
SVD	single vessel disease
DVD	double vessel disease
TVD	triple vessel disease

Methods

This was a cross-sectional comparative study in which 100 patients who required conventional coronary angiogram were included. Patients with severe valvular heart disease, aneurysm of the aorta, renal failure (serum creatinine >2 mg/dL), atrial fibrillation, frequent premature beats, left bundle branch block on electrocardiography, or poor echocardiographic image quality were excluded.

A baseline examination was performed, which included detailed medical history taking, physical examination, laboratory testing, and assessment of CVD status. The blood sample was taken after 12 hours of overnight fasting. Baseline biochemistry included serum lipid profile, fasting blood sugar, creatinine, urea, and liver function tests to rule out any other systemic illness or a secondary cause of dyslipidemia.

Total cholesterol, triglycerides, and high-density lipoprotein–cholesterol were analyzed using enzymatic methods, while low-density lipoprotein–cholesterol was computed from the Friedewald formula [6].

Informed consent was obtained from all individual participants included in the study. This study was approved by the hospital ethics committee.

Transthoracic echocardiographic examination

Two-dimensional transthoracic echocardiographic examination was performed at rest with S5-1 transducer using a commercially available echocardiographic machine (iE 33; Philips, Eindhoven, The Netherlands), according to established standards. Left ventricular diameters and the left atrial systolic diameter determined

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