Role of Echocardiographic Aortic Propagation Velocity in Predicting Obstructive Coronary Artery Disease – A Prospective Observational Study

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ABSTRACT

Objectives: The aim of this study was to assess the relationship between APV and CAD and to compare AS and AD in patients with and without CAD.

Material and Methods: A total of 100 subjects presenting to Government General Hospital, Guntur, with chest pain and undergoing coronary angiogram were selected for the study. Patients were divided into two groups, the study group comprises patients with >50% stenosis in at least one of the coronary artery on coronary angiogram, and control group comprises patients with normal coronaries on angiography. Two-dimensional echocardiography (Philips Affinity 70) was performed with the recording of data. AS and AD were calculated and APV was determined.

Result: In the present study, it was observed that there was a statistically significant increased incidence of deranged lipid profile, diabetes, hypertension, alcohol consumption, and a positive family history of CAD in the study group. Mean APV, mean AD, and mean AS was significantly low in the study group as compared to the control group ($P < 0.001$).

Conclusion: APV, AS, and AD can be used as surrogate markers to predict the presence of significant CAD and, hence, can be safely recommended as a simple, economical, and non-invasive means to screen CAD.

Keywords: Aortic propagation velocity, Aortic strain, Aortic distensibility, Coronaryartery disease

ABSTRACT IMAGE

ROLE OF ECHOCARDIOGRAPHIC AORTIC PROPAGATION VELOCITY IN PREDICTING OBSTRUCTIVE CORONARY ARTERY DISEASE – A PROSPECTIVE OBSERVATIONAL STUDY

100 Subjects
(Undergoing Coronary Angiogram)
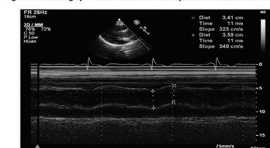
Aortic Propagation Velocity, Aortic Strain and Aortic Distensibility was measured

CONCLUSIONS

Our study found significant correlations between aortic stiffness parameters and coronary artery disease. APV,AS and AD can be used as surrogate marker to predict the presence of significant CAD and hence can be safely recommended as a simple, economical and non-invasive means to screen CAD. Aortic propagation velocity emerged as a promising prognostic marker, highlighting its potential for cardiovascular risk assessment and management.
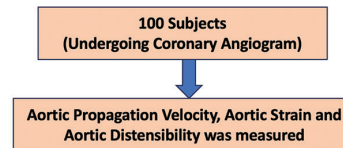
Figure : Echocardiographic determination of aortic systolic and diastolic diameters

Figure : Echocardiographic determination of Aortic propagation velocity

Keywords: APV: Aortic propagation velocity, AS: Aortic strain, AD: Aortic distensibility, CAD: Coronary artery disease

INTRODUCTION

Atherosclerosis presents a multifaceted pathology characterized by the accumulation of lipids, macrophages, and platelets within arterial walls, culminating in the narrowing of blood vessels. Its ramifications extend throughout the arterial system, impacting various anatomical regions.[1]

Coronary artery disease (CAD), a prominent manifestation of atherosclerosis in the coronary arteries, has been observed to exhibit an inverse association with certain biomechanical attributes of the aorta, such as strain and distensibility.[2]

Aortic distensibility (AD) serves as a pivotal indicator of arterial compliance, reflecting the aorta's capacity to expand and contract in response to fluctuations in blood pressure. Progressive atherosclerosis is paralleled by a reduction in AD.[2,3]

Likewise, aortic strain (AS), gauging the relative change in the length or diameter of the aorta during each cardiac cycle, correlates with arterial compliance. Elevated AS has been linked to an increased vulnerability to atherosclerosis and CAD.[2,3]

In addition to these conventional parameters, aortic propagation velocity (APV) emerges as an innovative marker of arterial stiffness. APV assesses the velocity of pressure wave propagation along the aorta, complementing conventional methods for evaluating aortic stiffness.

Prior investigations have explored diverse parameters, including AS, AD, augmentation index, and pulse pressure, to evaluate aortic stiffness and its interplay with CAD.[3]

Our study endeavors to probe aortic stiffness using the novel parameter APV and elucidate its correlation with conventional parameters such as AS and AD. By shedding light on these associations, we aim to contribute to a comprehensive understanding of atherosclerosis and its cardiovascular implications.

MATERIAL AND METHODS

This is an observational and prospective study conducted at the Department of Cardiology, Government General Hospital (GGH), Guntur, Andhra Pradesh, India. A total of 100 subjects presenting to GGH-Guntur with chest pain and undergoing coronary angiogram were selected for study during the period of June 2021–November 2022.

Inclusion criteria

Patients who were subjected to coronary angiogram for the purpose of the following issues were included:
1. Patients with definite angina with/without positive treadmill test
2. Patients with probable angina and with positive treadmill test
3. As a part of pre-operative cardiac risk stratification for non-cardiac surgery
4. As a part of evaluation before electrophysiological study and radiofrequency ablation.

Exclusion criteria

The following criteria were excluded from the study:
1. Patients with acute coronary syndrome
2. Patient with moderate or severe valvular stenosis or regurgitation
3. Patients with any cardiomyopathy
4. Patients with arrhythmias
5. Patients with congenital heart disease
6. Patients with symptomatic heart failure.

Data collection methods

Patients were divided into two groups, the study group comprises patients with >50% stenosis in at least one of the coronary artery on coronary angiogram and the control group comprises of patients with normal coronaries on angiography.

After obtaining informed consent detailed history and medical examination were done, and blood pressure and anthropometric measurements such as height and weight were recorded.

An 8 h fasting sample was drawn and the following parameters were analyzed random blood sugar (RBS), blood urea, creatinine, total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, very LDL, and triglycerides. Two-dimensional echocardiography (2D-Echo) (Philips affinity 70) [Figures 1 and 2] and coronary angiogram were performed with recording of data. AS and distensibility were calculated and APV was determined.

Statistical analysis

All data were evaluated by the Statistical Package for the Social Sciences (SPSS) (SPSS for Windows, version 15.0, Chicago, IL, USA). Parametric data were expressed as mean standard deviation (SD) and qualitative data as numbers and percentages. Differences between groups were assessed by the Chi-square for normally distributed quantitative variables. The data obtained were analyzed using SPSS version 17.0. Continuous variables were expressed as mean ± SD values. *P*-value (<0.05) was used to evaluate statistical significance.

Ethical considerations

Electrocardiography (ECG) and 2D-Echo are non-invasive tests. Coronary angiogram is an invasive study. The study protocol was approved by the Ethics Committee. Written informed

consent was taken from all the patients after a discussion of the study process with them. After taking proper consent, patients underwent ECG and 2D-Echo and all the patients received appropriate treatment according to the guidelines.

RESULTS

In the present study, it was observed that the mean age in the study group was 56.8 ± 8.21 years compared to a control group where in mean age was 51.08 ± 8.31 years. There was no statistically significant difference in the mean age between the two groups ($P = 0.12$).

In the present study, it was observed that there was no statistically significant difference in the distribution of patients based on gender in either groups $P = 0.38$. In the control group, 31 (62%) were male, whereas, in the study group, 36 (72%) were male.

In the present study, it was observed that body mass index, serum creatinine, total cholesterol, LDL cholesterol, and triglycerides were significantly higher in the study group compared to controls $P < 0.05$. HDL cholesterol levels in the study group were significantly lower when compared to controls $P < 0.05$ [Table 1].
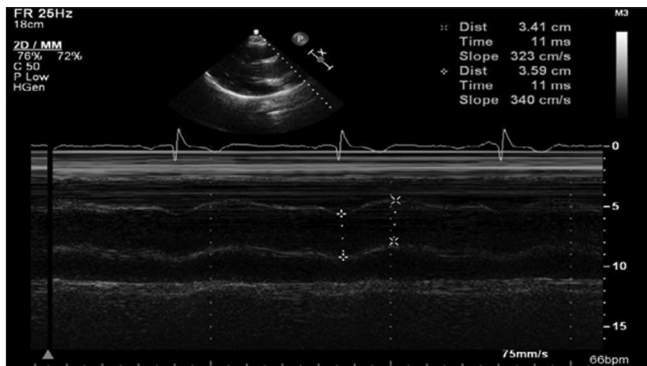

Figure 1: Echocardiographic determination of aortic systolic and diastolic diameters.
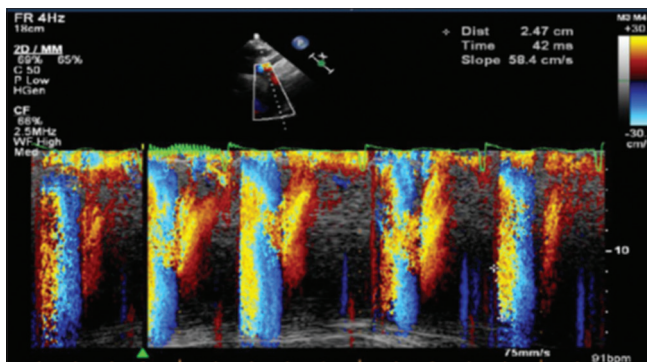

Figure 2: Echocardiographic determination of aortic propagation velocity.

In the present study, it is observed that there is a statistically significant higher occurrence of diabetes, hypertension, and alcohol consumption in the study group compared to controls ($P < 001$). In the present study, it was observed that there was a higher occurrence of smoking and family history of CAD in the study group compared to controls but the increase was not statistically significant [Table 2].

In the present study, it was observed that there was no statistically significant difference in the mean ejection fraction between the two groups ($P = 0.4$).

In the present study, it was observed that there is no statistically significant mean difference in aortic diastolic diameter ($P = 0.08$) and aortic systolic dimension between the two groups P (0.32). However, it was observed that APV, AS, and AD were significantly low in the study group compared to the control group [Table 3].

DISCUSSION

Our study demonstrated a noteworthy association between APV and CAD, revealing a statistically significant correlation with both AS and AD. APV exhibited a robust correlation with the extent of CAD, whereas AS and AD displayed stronger associations with risk factors such as aging and hypertension.

We observed a significantly lower mean AS in the study group compared to the control group ($P < 0.01$). In the control group, AS measured 32.75 ± 4.67%, while in the study group, it was 26.50 ± 5.58%. Similar findings have been reported in the previous studies by Ghaderi *et al.* and Sen *et al.*[2,4]

Bakirci *et al.* did a study in 2022 to find the association between APV and CAD in patients with stable angina pectoris (SAP). Two hundred and fourteen patients were included in this study. They found that decreased APV correlates with the severity of atherosclerotic CAD in SAP patients.[5]

Similarly, mean AD was significantly lower in the study group compared to the control group ($P < 0.01$). AD measured 1.49 ± 0.26 in the control group and 1.23 ± 0.30 in the study group. Lower AD was observed in patients with hypertension, diabetes, smoking, and alcoholism, suggesting that vascular responsiveness to these risk factors contributes to increased stiffness and reduced distensibility. This is consistent with findings from studies by Ghaderi *et al.* and Sen *et al.*[2,4]

Moreover, mean APV was significantly lower in the study group compared to the control group ($P < 0.05$). APV measured 65.68 ± 9.37 in the control group and 52.14 ± 13.8 in the study group, with $P < 0.001$. Patients with significantly lower APV were more likely to have double and triple vessel disease. Similar results have been reported in studies by Gunes *et al.*,[6] Sen *et al.*,[4] Chetty *et al.*,[7] and Ghaderi *et al.*[2]

Table 1: Mean and SD of baseline parameters between groups.

Parameters	Control group	Study group	*P*-value
	Mean±SD	Mean±SD	
BMI	24.20±1.59	24.64±1.18	0.026
Sr. Creatinine	0.93±0.23	1.05±0.25	0.008
Total cholesterol	169.72±11.75	176.44±13.69	<0.009
LDL	87.82±8.1	92.08±9.38	<0.02
HDL	40.48±2.98	39.12±3.17	<0.01
Triglycerides	138.5±9.04	144.22±8.5	<0.001

BMI: Body mass index, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, SD: Standard deviation, Sr: Serum

Table 2: Distribution of patients based on presence of risk factor diabetes.

	Controls (%)	Study group (%)	*P*-value
Diabetes	8 (16)	33 (66)	<0.001
Hypertension	10 (20)	40 (80)	<0.001
Alcohol	10 (20)	22 (44)	<0.005
Smoking	9 (18)	13 (26)	0.33
Family history of CAD	2 (4)	5 (10)	0.24

CAD: Coronary artery disease

Table 3: Comparison of aortic parameters between groups.

Parameters	Control group	Study group	*P*-value
	Mean±SD	Mean±SD	
Aorta diastolic diameter	2.16±0.15	2.22±0.19	0.08
Aorta systolic diameter (cm)	2.70±0.28	2.73±0.31	0.6
Aorta strain (%)	32.75±4.67	26.5±5.58	<0.001
Aorta dispensability (cm2/dyn)	1.49±0.26	1.23±0.30	<0.001
Aorta propagation velocity (cm/s)	65.68±9.37	52.14±13.8	<0.001

SD: Standard deviation

APV emerges as a straightforward and convenient echocardiographic parameter applicable in routine clinical practice. Its optimal clinical utility lies in non-invasive cardiovascular risk stratification and patient management, aiding in the selection of high-risk individuals. Our study demonstrated a significant reduction in APV among patients with significant CAD compared to those with insignificant disease.

However, several limitations warrant consideration. First, our study involved a relatively small sample size, necessitating further investigation with larger cohorts to validate our findings. In addition, being a single-center study, the generalization of results may be limited.

CONCLUSION

Our study found significant correlations between aortic stiffness parameters and CAD. APV, AS, and AD can be used as surrogate markers to predict the presence of significant CAD and, hence, can be safely recommended as a simple, economical, and non-invasive means to screen CAD. APV emerged as a promising prognostic marker, highlighting its potential for cardiovascular risk assessment and management.

Ethical approval

This study was approved by the Institutional Ethical Committee approval no GMC/IEC/179/2021.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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