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# UTILISATION OF TISSUE DOPPLER AND SPECKLE TRACKING TO PREDICT CORONARY ARTERY DISEASE BURDEN IN STABLE ANGINA PATIENTS

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**Abstract**

**Background:**

Echocardiographic diastolic abnormalities may be clinically used to assess ischemic burden in patients with stable angina. This could provide an awareness of the burden of coronary artery disease (CAD) before angiography is performed to help in early intervention of suspected ischemic lesions. The objective of the study is to assess whether 2D transthoracic echocardiography (TTE)-derived tissue Doppler imaging parameters and speckle tracking echocardiography can predict the severity of CAD in comparison with the cardiac catheterization-derived SYNTAX score. Early identification of high-grade ischemia or early myocardial dysfunction based on echocardiographic diastolic abnormalities rather than overt systolic dysfunction would be advantageous. This could provide the clinician with an awareness of the burden of CAD before angiography is performed to allow for early intervention on suspected ischemic lesions.

**Methods** Total of 100 patients were studied after explaining the purpose of the study, procedure in detail and after obtaining their consent in written format. Data collection is by clinical history, examination, echocardiography and coronary angiogram. Statistical analysis was performed with the use of SPSS software. Comparison was done by Chi-square test. We calculated sensitivity, negative predictive value, specificity, positive predictive value and accuracy.

**Results**: A total of 100 patients with stable angina were studied. 80% had syntax score 33 and more among patients with E/e' more than 15. Syntax score was less than 33 in 66% of the patients with E/e' less than 15. GPLSS was more than -17 in 82% of patients with syntax score above 33. Meanwhile 68% of the patients had syntax score less than 33 among patients with GPLSS less than -17. Sensitivity (82 vs 80) and accuracy rate (75 vs 73) is higher for GLPSS compared to E/E' in predicting coronary artery disease burden**.**

**Conclusion:** The results of our study suggest that both tissue doppler and GLPSS aids in the detection of patients with increased SYNTAX score on coronary angiogram. Although the normal EF, echocardiographic parameters was impaired in proportion to the severity of CAD in patients with stable CAD. We demonstrated that patients with a higher CAD burden based on the SYNTAX score had a higher E/E' ratio and GPLSS. It could help risk stratify patients prior to invasive intervention.

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**Keywords**

SYNTAX score, stable angina, speckle tracking, tissue doppler

**INTRODUCTION:**

Coronary artery disease (CAD) is one among the leading cause of death worldwide. Coronary angiography is the preferred investigation for the invasive assessment of obstructive CAD. Coronary angiography sometimes may end up with complications. Major complications like death, myocardial infarction (MI), or major embolization have been estimated to occur in less than 2% of cases.[1] Complications are higher approaching 4% when percutaneous coronary intervention (PCI) is performed[2]. Renal dysfunction is an important complication of coronary angiogram which occurs in around 5% of the patients.

The SYNTAX (Synergy between PCI with TAXUS and Cardiac Surgery) score is frequently used to assess the complexity and burden of CAD. The SYNTAX score is an anatomically based risk calculation. It is used predict prognosis and response to revascularization strategies. High scores have the worst prognosis for revascularization with PCI in comparison to coronary artery bypass graft surgery (CABG). In SYNTAX scoring system points are assigned to each lesion which have >50% diameter stenosis in vessels >1.5mm diameter. The SYNTAX angiographic tool thus assists in deciding optimal revascularization strategies for patients with complex coronary artery disease.[3,4]

In ischemic heart disease (IHD), diastolic dysfunction occurs before systolic dysfunction[5]. Echocardiography remains the most commonly used imaging tool for the non-invasive determination of diastolic dysfunction in clinical practice. In combination with conventional diastolic parameters including E velocity, A velocity, E/A ratio, deceleration time (DT), and isovolumetric relaxation time (IVRT), tissue Doppler imaging (TDI) gives added benefit in evaluation of diastolic function using transthoracic echocardiography (TTE).

Tissue Doppler imaging (TDI) measures velocities of myocardial tissue. Routinely longitudinal velocities of medial and lateral mitral annulus and lateral tricuspid annulus are recorded in apical four chamber view. Commonly measured waves include isovolumic contraction wave, systolic wave, isovolumic relaxation wave, early diastolic wave, and late diastolic wave. TDI is useful in detection of subclinical systolic dysfunction and early diastolic dysfunction. Normally, during systole, the base of the ventricles moves toward the apex and gets back during diastole. The apex is relatively stationary. Thus, annuli move toward transducer (apex) in systole and move away from transducer during diastole. Movement toward apex (systole) is recorded above the baseline, and movement away from apex (diastole) is recorded below baseline.[6,7]

Diastole: Early diastolic filling wave (E')- Magnitude of E' is closely related to myocardial relaxation. In the failing ventricle, E' is much less dependent on filling pressure than E wave velocity of transmitral flow. Therefore, when left ventricular (LV) filling pressure becomes elevated due to impaired relaxation. Magnitude of E wave increases but that of E' decreases and results in increase in E/E' ratio. Hence E/E' ratio is used as marker of elevated LV filling pressure. With increasing diastolic dysfunction (restrictive pathology), magnitude of E' wave progressively declines.

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Late diastolic wave during atrial contraction (Aa or a')- Myocardial lengthening due to filling during atrial contraction produces a negative wave (Aa) during late diastole. Magnitude of Aa depends on the amount of ventricular filling during atrial contraction. In impaired relaxation, early ventricular filling (E') is diminished. It is compensated by increased filling during atrial contraction. Amplitude of Aa wave is, therefore, increased. Amplitude of Aa wave is also dependent on force of atrial contraction. It decreases with increasing atrial failure and is absent in atrial fibrillation. Exercise E/E' correlates with exercise LV filling pressure and is helpful in identifying latent diastolic dysfunction.

Strain is the degree of myocardial shortening in percent. Strain is a dimensionless quantity of myocardial deformation. Positive strain denotes relaxation and negative strain denotes contraction. Longitudinal strain helps in detection of subclinical left ventricular dysfunction. Strain can be computed during every point and time of the cardiac cycle. The best parameter for systolic function however is the peak systolic strain. One can measure strain in individual segments by averaging all segments of the entire ventricle. This value is called global peak systolic strain (GPSS). Usually this is done for longitudinal strain from all apical views. Therefore it is also called global longitudinal peak systolic strain (GLPSS). The so-called Langrangian strain (ε) is mathematically defined as the change of myocardial fibre length during stress at end-systole compared to its original length in a relaxed state at end-diastole.

Two-dimensional strain echocardiography may be able to detect early changes in cardiac function caused by ischaemia and predict the extent of coronary lesions[8]. Longitudinal mechanics mainly noted in the ischemia-vulnerable subendocardium, and abnormalities of myocardial deformation in the longitudinal axis are observed in the development of many pathophysiologic states, including CAD and myocardial infarction[9,10].

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**METHODOLOGY:**

This study is a descriptive study on patients with stable angina. Stable angina patients underwent coronary angiogram and echocardiography. The aim of the study is to assess whether transthoracic echocardiography (TTE) parameters can predict the severity of CAD compared with the cardiac catheterization-derived SYNTAX score in stable angina patients. All patients older than 18 years who presented with stable angina and coronary angiogram showing LMCA or three vessel disease were included. A total of 100 patients were studied after explaining the purpose of the study, procedure in detail and after obtaining their consent in written format. The patient information was kept confidential. Exclusion criteria includes previous coronary artery bypass surgery (CABG) as the SYNTAX score cannot be applied in this patient population, patients with myocardial disease and valvular heart disease, patients with systolic left ventricular dysfunction.

SYNTAX Score: coronary angiograms of patients with stable angina were viewed, and an online calculator was used to determine the SYNTAX score (www.syntaxscore.com)[13]. Left and right coronary artery dominance were determined. Each coronary lesion in a vessel with a diameter greater than 1.5 mm were scored if there was greater than 50% luminal obstruction. Patients were categorized as having a low SYNTAX score (≤32), or high score (≥33).

ECHOCARDIOGRAPHY: GE Vivid E9 machine was used. Standard TTE with a multifrequency transducer and TDI capability were performed in all patients. LV ejection

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fraction (LVEF) was measured using modified simpson method. Diastolic function was evaluated using pulsed-wave Doppler obtained at the level of the mitral valve and tissue doppler, assessing:

E/E' ratio

E/E' ratio ≥ 15 was considered abnormal.

SPECKLE TRACKING: GLPSS (global longitudinal peak systolic strain were obtained from the apical four-chamber, three chamber and two-chamber views, after manually tracing the endocardium and epicardium of the left ventricle, beginning from the annulus of the mitral valve for all the three views. GPLSS more than -17 was considered abnormal in our study.

**Statistical analysis**

Statistical analysis was performed with the use of SPSS software. Comparison was done by Chi-square test. We calculated sensitivity, negative predictive value, specificity, positive predictive value and accuracy.

**RESULTS:**

A total of 100 cases were studied and minimum age was 41 and maximum age was 71. There was a predominance of males as compared to females amounting to 68% and 32% of the total cases respectively. Comorbidities the patients presented with were diabetes mellitus (53%) and hypertension (45%).

**Chart 1**

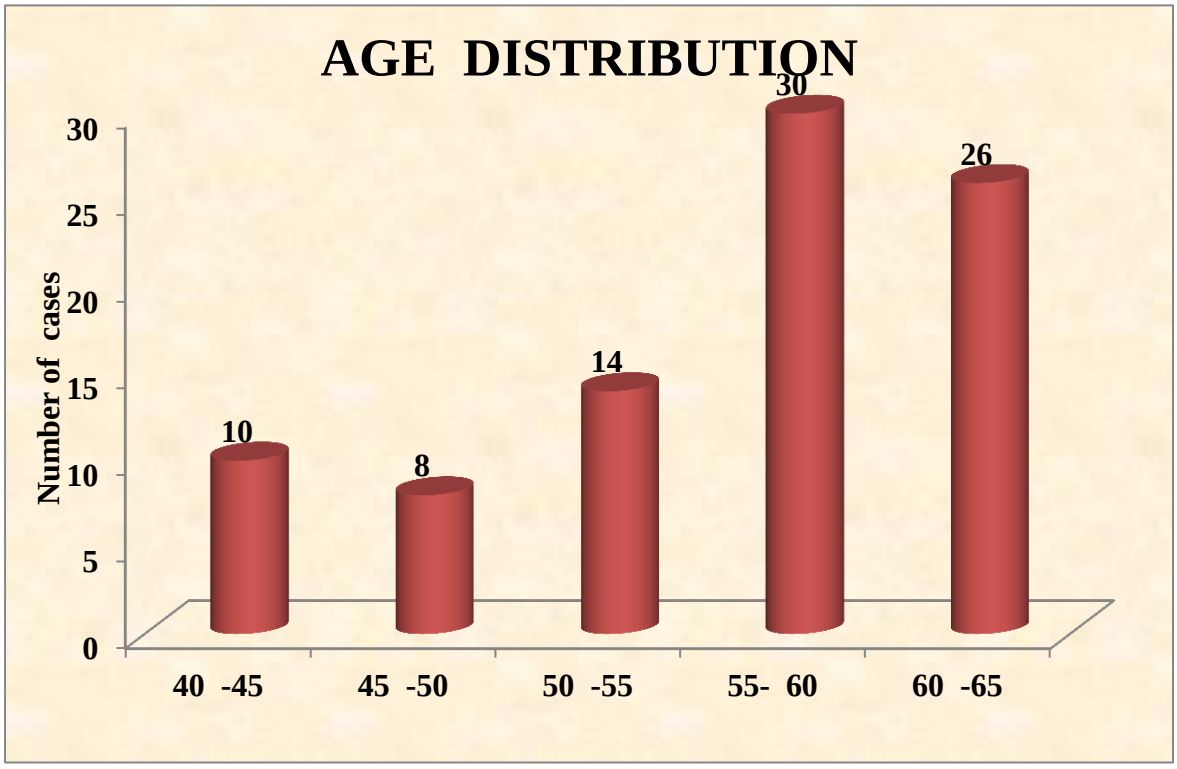

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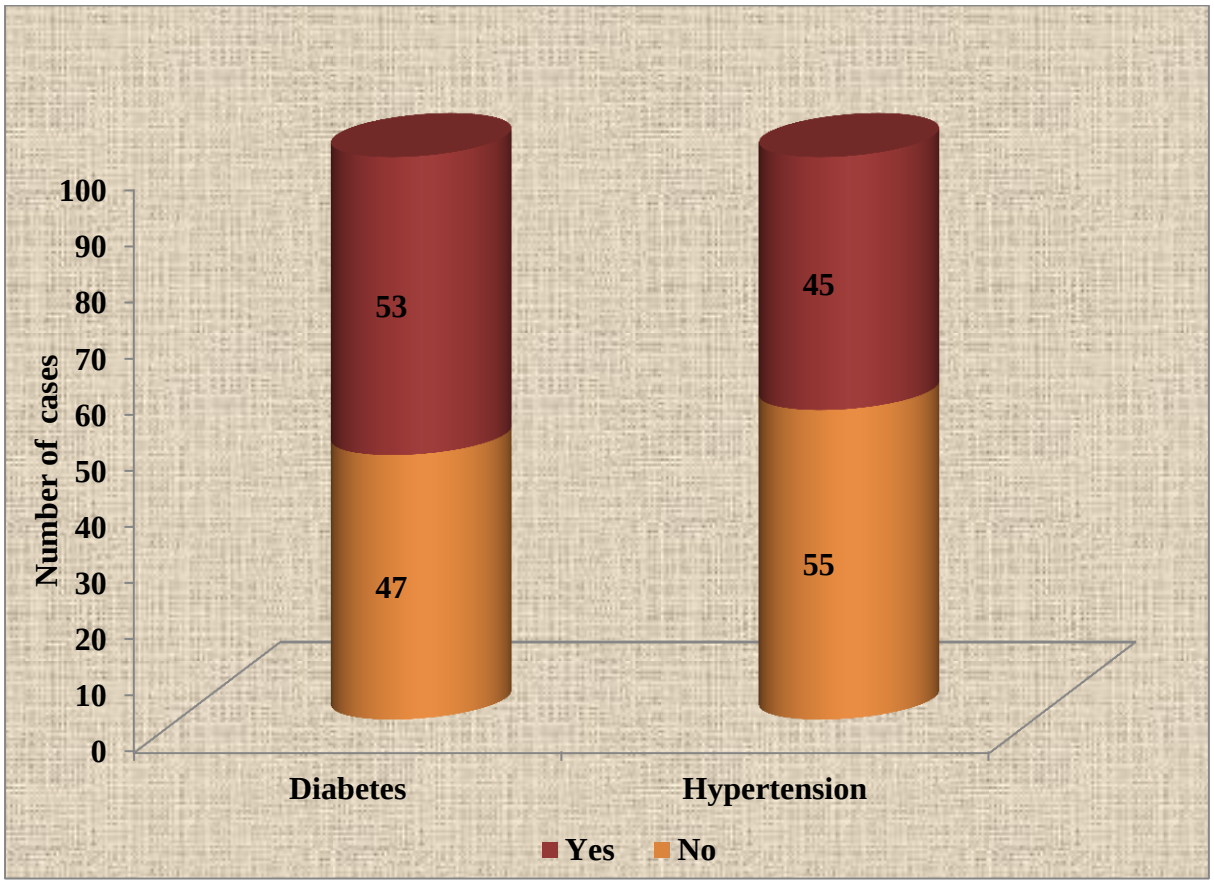
**Chart 2**




**E/E' and Syntax Score**

80% had syntax score more than 33 among patients with E/e' more than 15. Syntax score was less than 33 in 66% of the patients with E/e' less than 15.

**Table 1**

| | | | Syntax score | | Total |
|---|---|---|---|---|---|
| | | | ≥33 | <33 | |
| E/e' | ≥15 | Count | 40 | 17 | 57 |
| | | % | 80.0% | 34.0% | 57.0% |
| | <15 | Count | 10 | 33 | 43 |
| | | % | 20.0% | 66.0% | 43.0% |
| Total | | Count | 50 | 50 | 100 |
| | | % | 100.0% | 100.0% | 100.0% |

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**Sensitivity =80% Specificity = 66% Positive predictive value= 70.2% Negative predictive value=76.7% Accuracy rate=73%**

**GPLSS and Syntax Score**

GPLSS was more than -17 in 82% of patients with syntax score above 33. Meanwhile 68% of the patients had syntax score less than 33 among patients with GPLSS less than -17.

**Table 2**

| | | | Syntax score | | Total |
|---|---|---|---|---|---|
| | | | ≥33 | <33 | |
| gplss | >-17 | Count | 41 | 16 | 57 |
| | | % | 82.0% | 32.0% | 57.0% |
| | <-17 | Count | 9 | 34 | 43 |
| | | % | 18.0% | 68.0% | 43.0% |
| Total | | Count | 50 | 50 | 100 |
| | | % | 100.0% | 100.0% | 100.0% |

**a. Sensitivity =82% Specificity = 68% Positive predictive value= 71.9% Negative predictive value=79% Accuracy rate=75%**

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**Mean value of E/E' and Syntax Score**

**Table 3**

| | N | Mean E/E' | SD | p |
|---|---|---|---|---|
| **Syntax Score<33** | **38** | **13.64** | **2.54** | **<0.0001** |
| **Syntax Score≥33** | **62** | **17.52** | **3.59** | **<0.0001** |

**Mean GPLSS and Syntax Score**

**Table 4**

| | N | Mean GPLSS | SD | P |
|---|---|---|---|---|
| **Syntax Score<33** | **38** | **-18.47** | **1.88** | **<0.0001** |
| **Syntax Score≥33** | **62** | **-15.74** | **2.07** | **<0.0001** |

**DISCUSSION:**

The prevalence of coronary artery disease (CAD) continues to rise worldwide associated with increasing patient morbidity and mortality. In the early phase of ischemic heart disease (IHD), diastolic dysfunction can be detected noninvasively by TTE prior to the development of overt systolic dysfunction. Left ventricular wall motion at rest can be normal, even in patients with severe CAD. Therefore, it would be useful if another resting parameter could help in the discrimination of patients with severe CAD from those with less severe or no CAD. So, the clinical studies have shown that SS is a widely accepted.

A total of 100 patients fulfilled the inclusion criteria and were included in the study and analysed. Males constituted 68% of the total patients. Age group varied over a wide range

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with mean age being 57.8yrs and most of the cases (56%) were in the range of 55-65yrs of age. 53% of the patients were diabetic and 45% were hypertensive.

Coronary angiogram was done in all patients and 13% had LMCA disease and 50% had SYNTAX score ≥33. Study demonstrated that patients with a higher SYNTAX score (≥33) have higher E/E' and higher GLPSS. Comparing E/E' and GLPSS sensitivity was slightly better for GLPSS (82% vs 80%). Moreover specificity (68% vs 66%), positive predictive value (71.9% vs 70.2%) and accuracy rate (75% vs 73%) was better for GLPSS.'

Several studies studied correlation between coronary disease burden and echocardiographic parameters like E/A and deceleration time. Tissue Doppler Imaging parameters like S' or E' have been used to assess diastolic function and compared with syntax score. There are no enough studies which have compared E/E' with syntax score. This study showed that patients with higher E/E' had higher coronary artery disease burden. In this study, it was found that GLPSS best predicts a high SS in patients with suspected CAD. Similar to study by A Vrettos et al in this study GLPSS aided in detection of patients with increased SYNTAX score on coronary angiogram[15]

S. Mustafa et al demonstrated that Two-dimensional speckle tracking echocardiography has good sensitivity and specificity to predict the presence, extent and severity of CAD[16]. In this study E/E' and GPLSS was compared and GPLSS fared slightly better in terms of specificity, sensitivity, accuracy rate and positive predictive value.

**CONCLUSIONS:**

The results of our study suggest that both tissue doppler and GLPSS aids in the detection of patients with increased SYNTAX score on coronary angiogram. Although the normal EF, echocardiographic parameters was impaired in proportion to the severity of CAD in patients with stable CAD.

We demonstrated that patients with a higher CAD burden based on the SYNTAX score had a higher E/E' ratio and GPLSS. It could help risk stratify patients prior to invasive intervention.

**LIMITATIONS**

1. Our control group consists of a small number of patients.
2. Some of the baseline characteristics of the study population are known to affect GLPSS values like age, hypertension and diabetes mellitus.
3. Lack of healthy control group prevents to compare the results.
4. Cardiac MRI was not performed to look for myocardial fibrosis, which could explain altered echocardiographic values in some of the patients

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