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PREDICTING THE ANGIOGRAPHIC SEVERITY OF CAD BY 2D SPECKLE TRACKING ECHOCARDIOGRAPHY IN PATIENTS WITH NON ST SEGMENT ELEVATION MYOCARDIAL INFARCTION

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ABSTRACT

Objectives:

In our study, we aimed to investigate the correlation between reduction in global longitudinal strain value and severity of coronary artery disease in Non-ST-Elevation Myocardial Infarction (NSTEMI) patients.

Materials and Methods:

Patients admitted with NSTEMI were underwent 2D echocardiography to evaluate LV global longitudinal .strain and coronary angiography to evaluate severity of CAD. Data analysis was done to investigate the correlation between global longitudinal strain and severity of CAD

Results:

In the present study we were able to demonstrate the correlation between reduction in global longitudinal strain value and severity of coronary artery disease in Non-ST-Elevation Myocardial Infarction (NSTEMI) patients. As the number of coronary arteries involved increases LVGLS reduces.

Conclusions:

2D echocardiographic Global longitudinal strain can be used in initial diagnostic workup for early identification and revascularization of NSTEMI patients with severe CAD.

Keywords: NSTEMI; Global longitudinal strain; Coronary Angiogram, Gensini score

1. INTRODUCTION

ST-segment-Elevation Myocardial Infarction (STEMI) and non ST-elevation acute coronary syndrome (NSTE-ACS) share the same pathology, complications, and risk factors.[1] Goals of non-invasive testing in patients with suspected NSTE-ACS include (1) determining the presence or absence of coronary artery disease; (2) establishing CAD as the cause of the elevated cardiac troponin in patients with other possible explanation; (3) evaluating the extent of residual

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ischemia after medical therapy has been initiated thus guiding further therapy; (4) localizing the ischemia before a planned PCI in patient with multivessel disease; (5) assessment of left ventricular function [2] Although conventional echocardiography is considered to be reliable for ventricular wall motion analysis and assessment of regional myocardial function, there is high inter-observer and intra-observer variability and allows only limited evaluation of radial displacement and deformation, without the possibility of assessing myocardial shortening and twisting.[3] In addition, poor temporal resolution of the human eye creates limitations for the accurate visual assessment of the longitudinal myocardial motion in full detail.[4]

Myocardial strain by speckle-tracking echocardiography is a technique based on widely available two-dimensional grey scale echocardiography, enabling the accurate evaluation of global and regional myocardial function, and it has been shown to be sensitive to abnormalities caused by ischemia and necrosis.[5]

Myocardial strain is three dimensional. The heart shortens and lengthens in the longitudinal direction and circumferential direction. On the contrary it thickens and thins in the radial direction. So, strain can be longitudinal, radial and circumferential. Longitudinal strain is the most sensitive and reproducible of the various strain measurements, so it is the only strain we record.[6]. So, in this study we chose global longitudinal strain (GLS) to record.

Global Longitudinal Strain (GLS) assessed using automated speckle tracking echocardiography (STE) is an emerging technique for detecting and quantifying subtle disturbances in LV systolic function. GLS reflects the longitudinal contraction of the myocardium and its accuracy has been validated against tagged magnetic resonance imaging.[7]

Strain echocardiography can be performed bedside at low cost and has been demonstrated to identify high-risk patients with non–ST-segment elevation acute coronary syndrome (NSTE-ACS) setting [8]

Patients with suspected NSTE-ACS are a more heterogeneous group. Coronary occlusion and/or significant stenosis may or may not be present, and coronary angiography and revascularization therapy might not be necessary. Therefore, a better selection of patients with real need for coronary angiography and revascularization therapy could reduce both complication rates and healthcare costs associated with this procedure.

Approximately 85% patients with a clinical diagnosis of NSTE-ACS have significant coronary obstruction (i.e.,>50% stenosis of the luminal diameter) in at least one major coronary artery. The remaining 15% have no evidence of significant coronary obstruction on angiography.[9]

There are several ways of quantification of CAD severity. In daily clinical practice, number of stenosed vessel or vessel scoring is most commonly used. In this way, CAD is divided into Left Main disease, Single Vessel Disease (SVD), Double Vessel Disease (DVD) and Triple Vessel Disease (TVD). Along the advent of coronary angiography multiple scoring systems have been devised for the quantification of CAD burden. These scores quantify CAD severity more objectively and accurately. Previous study demonstrated that regardless of the degree of heterogeneity among systems, scores are highly and consistently correlated with each other. Among them Gensini score had strongest correlation with IVUS assessed intracoronary plaque

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burden (ρ= .90) ($p < 0.001$).[10]. In the present study we have compared this 2D speckled myocardial strain to Gensini score for angiographic severity of CAD in NSTEMI patient in tertiary care hospital in south India. Study result can be applied in management of patients with non ST-segment elevation myocardial infarction (NSTEMI) and stratifying the patients requiring early interventions to improve the outcome in Indian population

2. MATERIALS AND METHOD

Study design: Cross sectional study

Study Period: March 2022 to Jan 2023

Study Setting: Dept. of Cardiology, Govt. medical college Alappuzha

Sample Size:

Based on the previous studies 250 patients admitted with Non-ST-Elevation Myocardial Infarction (NSTEMI) in Govt. medical college Alappuzha were enrolled in the study. Those who were not willing to continue in this study were excluded

Sampling method:

Participants were consecutively assigned to the study after obtaining consent.

Study Population:

Patients with non‑ST elevation myocardial infarction (NSTEMI) admitted in Govt. medical college Alappuzha.

STUDY METHOD

Patients who satisfied the inclusion and exclusion criteria enrolled into this study. Demographic details and baseline characteristics of the patient population documented meticulously. Relevant medical history, salient clinical examination findings, laboratory investigations including cardiac biomarkers, ECG and echocardiogram findings were noted. Details of medication prescribed were also collected.

2D Speckle tracking echocardiography performed using Vivid E9 GE Healthcare Echocardiography machine with 3.5MHz Transducer of all selected NSTEMI patients. Global longitudinal strain calculated by acquiring standard apical long axis, 4 chamber, 2chamber views and processed using GE user interface

Coronary angiogram assessed for all coronary lesions in two orthogonal planes. Lesion locations assessed and percent diameter of stenosis measured for each coronary lesion. Significant coronary artery disease was defined by presence of 70% or more stenosis in any major coronary artery and 50% or more stenosis in left main coronary artery.[11] Gensini Score calculated using pre-designed standard format of all patients.

STATISTICAL ANALYSIS:

Data was processed and analysed using computer software SPSS (Statistical Package for Social Sciences) (SPSS Inc, Chicago, IL, USA). Continuous data presented as mean ± SD and categorical data as frequency and percentage. Data presented on continuous scale was compared between groups using Student's t-Test and among groups using one way ANOVA test. Correlation between GLS and Gensini score was analysed by Spearman's Rank Correlation Coefficient Test. Binary logistic regression analysis was done to adjust for confounding variables

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(age, diabetes mellitus, hypertension and GLS). Level of significance is set at 5% and p-value <0.05 was considered as significant

3. RESULTS

In the present study 250 patients were selected amongst the patients admitted with NSTEMI in our hospital during the study period. Study conducted to correlate the global longitudinal strain (GLS) by 2D strain echocardiography and angiographic severity in CAD patients with NSTEMI.

	Age (years)	58.59 (±9.3)
Gender		
	Male	164 (66)
	Female	86 (34)
Risk factors		
	DM	106 (42.4)
	Hypertension	156 (62.4)
	Dyslipidemia	72 (28.8)
	Overweight	10 (4)
	F/H CAD	12 (4.8)
	Smoking	41 (16.4)
Medication		
	Aspirin	227 (90.8)
	Clopidogrel	215 (86)
	Statin	226 (90.4)
	Beta blocker	213 (85.2)
	ACEI/ ARB	208 (83.2)
ECG		
	Normal	74
	ST depression	160
	Negative T waves	23
Doppler echocardiogram		
	LVEF	65.78(±8)
	LVGLS strain	-15(±1.9)
Coronary angiogram		
	No significant lesions	20
	One-vessel disease	61
	Two-vessel disease	90
	Three-vessel disease	79

Table 1: Baseline characteristics

Gender distribution

In the admitted patients 66% patients were male and 34% patients were female. Female population comprising almost half of the male population

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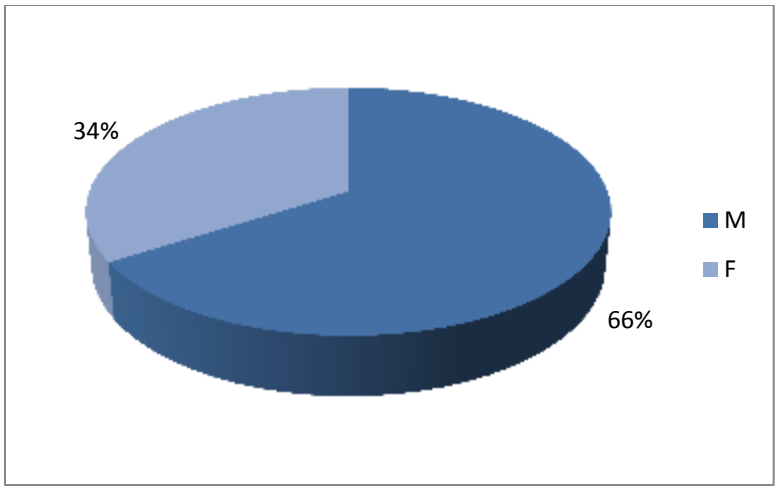

Figure 1: Showing Gender distribution in study population

Age Distribution

Age-wise 36.4% patients were in 51-60 yrs. age group, 33.6% in 61-70 yrs. 16.8% from 41-50 yrs. 2.8% from 30-40 yrs. and 10.4% from more than 70 yrs. age group

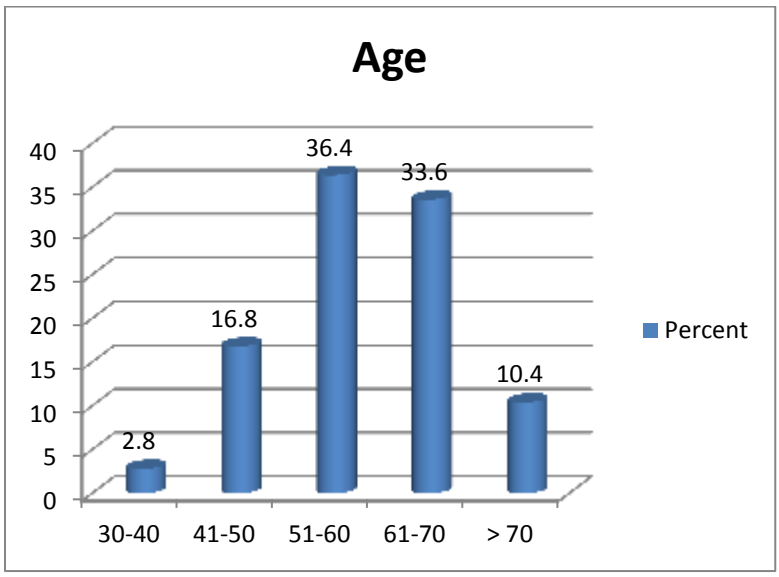

Figure 2: Showing Age distribution in study population

Associated comorbidities

Among the study population 62.4% patients were having hypertension, 42.4% were diabetic, and 28.8% were dyslipidemic. 4.8% patients were having family history of CAD and 4% were overweight. 16.4% were smokers.

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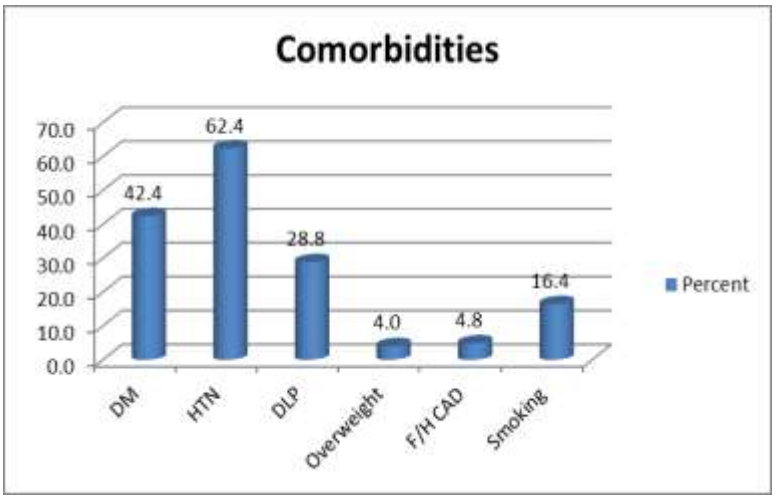

Figure 3: Showing percentage of comorbidities in study population

Presenting chief complaints

In study population 74% patients presented with chest pain,. 17.6% patients presented with breathlessness and chest pain, 6.8% with breathlessness and rest presented with symptoms like exertional angina or dyspnea

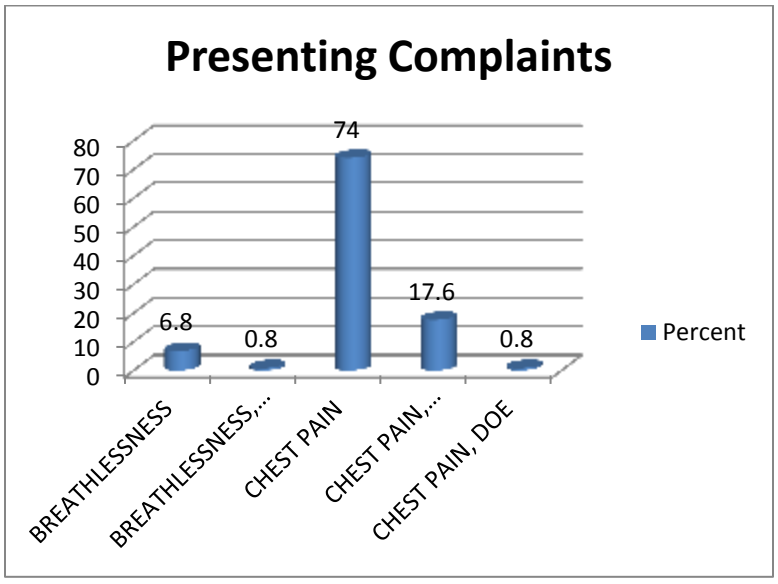

Figure 4: Showing percentage of various presenting complaints in study population

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Left ventricular ejection fraction (LVEF)

29 % patients having LVEF between 50-60%, 39% having between 61-70%, 30% patients were having between 71-80% and around 1% patients having LVEF more than 80%

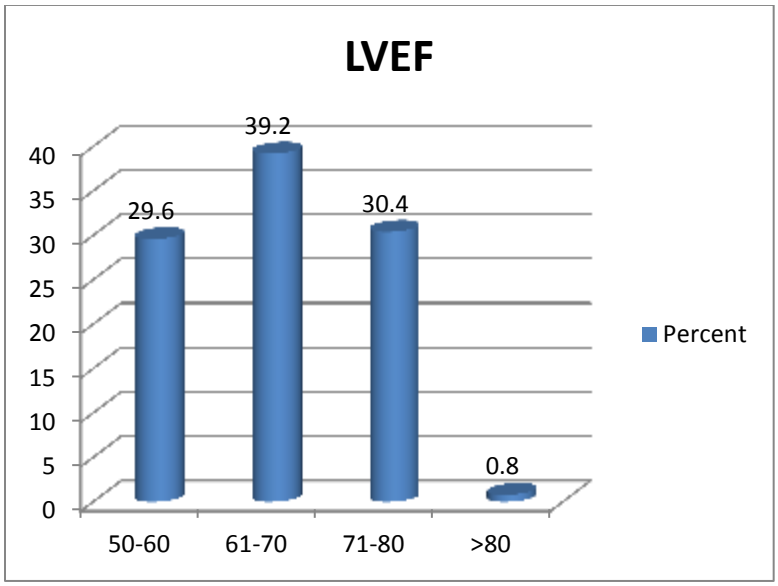

Figure 5: Showing proportion of Left ventricular ejection fraction (LVEF) in study population

Significant CAD

Out of 250 patients 92% patients were having significant CAD and remaining 8% were having non-significant CAD

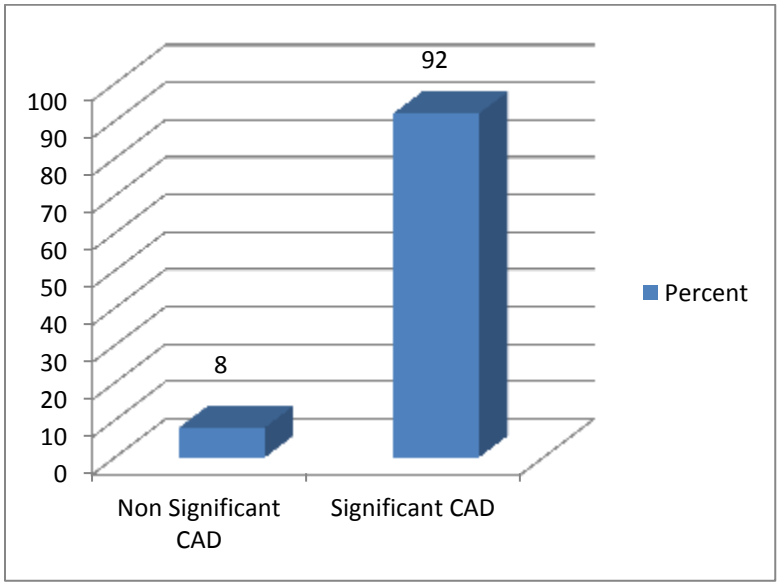

Figure 6: Showing percentage of patients having significant coronary artery disease in study population

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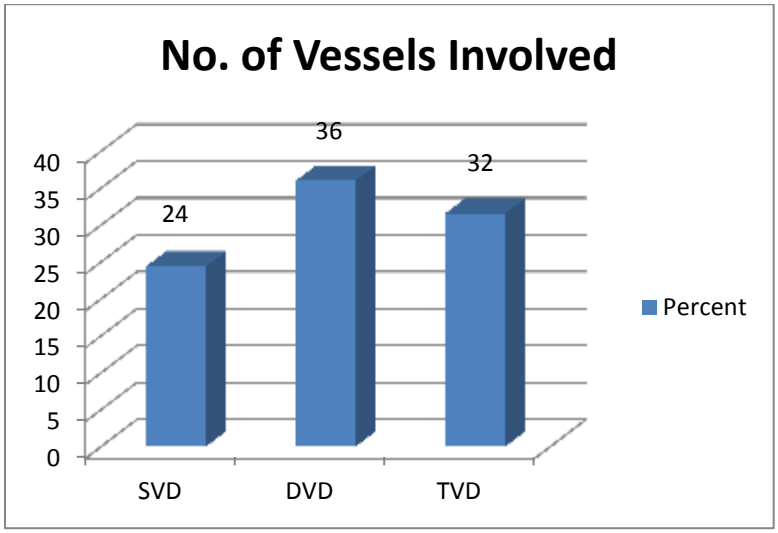
Number of coronary arteries Involved

24% patients were having single vessel disease, 36% were having double vessel disease and 32% were having triple vessel disease



SVD: Single vessel disease, DVD: Double vessel disease, TVD: Triple vessel disease

Figure 7: Showing percentage of patients having single, double or three coronary arteries involved in study population

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Comparison of global longitudinal strain (GLS) between patients with and without significant CAD

Group Statistics					
		N	Mean	Std. Deviation	Std. Error Mean
GLS(%)	Significant CAD	230	-14.9	2.2	0.1
	Non-Significant CAD	20	-22.6	2.9	0.6

Table 2: Showing means of 2D echocardiographic GLS of patients having significant or non-significant coronary artery disease in study population

SUMMARY				
Groups	Count	Sum	Average	Variance
Non significant cad	20	-451.8	-22.59	8.216737
Significant cad	230	-3426.7	-14.898	5.033404

ANOVA					
Source of Variation	Sum of squares	df	Mean Square	F	Sig
Between Groups	1088.473	1	1088.473	206.2562	0.0000
Within Groups	1308.768	248	5.277289		
Total	2397.241	249			

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Table.3: Showing Analysis of Variance (ANOVA) of GLS and patients having significant or non-significant coronary artery disease

Correlation of GLS and number of vessels involved

GLS(%)			
No. of Vessels Involved	Mean	N	Std. Deviation
No significant vessel involved	-22.59	20	2.866485102
SVD	-16.34918033	61	2.120819256
DVD	-15.07333333	90	1.679339089
TVD	-13.57974684	79	2.158072487

SUMMARY				
Groups	Count	Sum	Average	Variance
1_Vessel	61	-997.3	-16.3492	4.497874
2_Vessel	90	-1356.6	-15.0733	2.82018
3_Vessel	79	-1072.8	-13.5797	4.657277

ANOVA					
Source of Variation	Sum of sqaures	df	Mean Sqare	F	Sig.
Between Groups	268.5136	2	134.2568	34.47013	0.000
Within Groups	884.1361	227	3.894872		
Total	1152.65	229			

Table.4: Showing Analysis of Variance (ANOVA) of GLS and number of vessels involved in study population

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Spearman's rank correlation coefficient test between GLS and Gensini score shows that the two variables bear a linear inverse relationship ($\rho = 0.742$, $p < 0.001$). This means that Gensini score increases while GLS value decreases

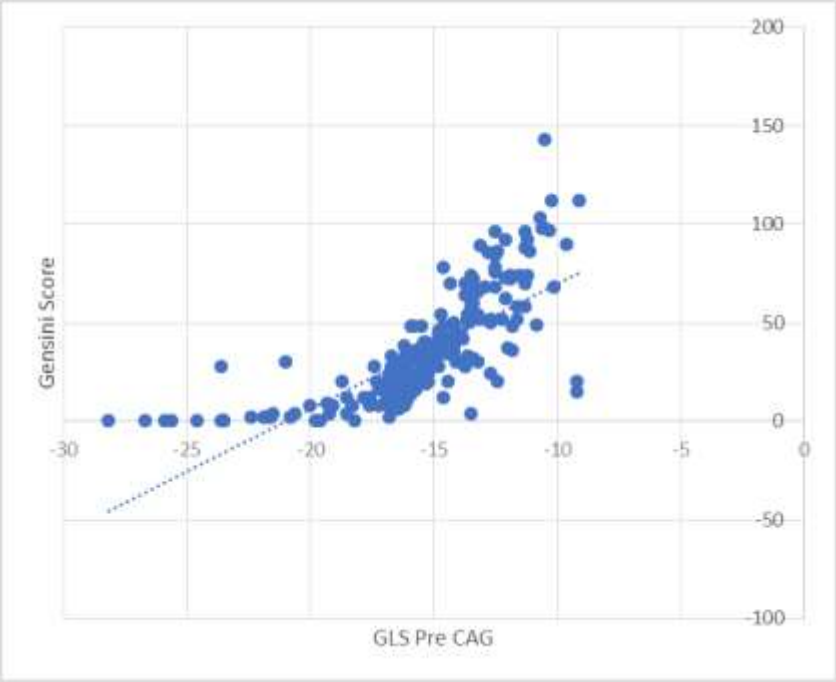

Figure 8: Showing scatter diagram depicting inverse linear correlation between GLS and Gensini score in study population

4. DISCUSSION

In the present study 250 patients were selected amongst the patients admitted with NSTEMI in our hospital during the study period. Study conducted to correlate the global longitudinal strain (GLS) by 2D strain echocardiography and angiographic severity in CAD patients with NSTEMI.

Study findings showed that, between the admitted patients 66% patients were male and 34% patients were female (Figure.1).

Among the study population 36.4% patients were in 51-60 yrs. age group, 33.6% in 61-70 yrs. 16.8% from 41-50 yrs. 2.8% from 30-40 yrs. and 10.4% from more than 70 yrs. age group (Figure.2).

Patients were associated with multiple comorbidities. 62.4% patients were having hypertension, 42.4% were diabetic, and 28.8% were dyslipidemic. 4.8% patients were having family history of CAD and 4% were overweight. 16.4% were smokers (Figure.3).

Mostly patients of NSTEMI presented with chief complaint of chest pain either central, left sided, right sided or bilateral and constituted 74% study population. 17.6% patients presented with breathlessness and chest pain, 6.8% with breathlessness and rest presented with symptoms like exertional angina or dyspnea (Figure.4).

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All patients presented with non ST elevation myocardial infarction were prescribed guideline directed medical therapy according to recent ACC/ESC guidelines including antiplatelet like Aspirin, Clopidogrel then statins, beta blockers, ACE inhibitors and Angiotensin receptor blockers. Patients were given other symptomatic treatment according to their clinical condition. At times drug dosages were modified or discontinued for some time due to the adverse drug reactions Patients were followed up for study duration and were meticulously monitored for drug compliance 94% patients adhered to the treatment and 6% patients had defaulted treatment.

Transthoracic 2D echocardiography study done in all patients and primarily regional wall motion abnormality and left ventricular ejection fraction were assessed. 39.2% patients found to have LVEF between 61-70 percent, 30.4% patients were having between 71-80 percent another 29.6% patients were having between 50-60 percent and rest 0.8% were having LVEF of more than 80 percent (Figure.5).

According to study protocol significant coronary artery disease was defined by presence of 70% or more stenosis in any major coronary artery and 50% or more stenosis in left main coronary artery. Angiographic severity was established using the Gensini score.

In the present study 92% patients found to have significant CAD and 8% were having non-significant CAD (Figure.6). All patients were subjected to coronary angiography (CAG). CAG results showed 24.4% were having single vessel disease (SVD), 36% were having double vessel disease (DVD) and 31.6% patients were having triple vessel disease (TVD) (Figure.7).

Data analysis using ANOVA showed significant difference ($p = 0.000$) in the global longitudinal strain (GLS) between patients with significant and non-significant CAD. Patients having significant CAD had lower GLS value compared to patients having non-significant CAD (Table 2; Table 3).

The present study showed statistically significant correlation between number of coronary arteries involved and global longitudinal strain (GLS) by data analysis using ANOVA (p value 0.000) in consistent with the previous studies. As severity of coronary artery disease increases the GLS value decreases (Table 4)

Spearman's rank correlation coefficient test between Gensini score which is calculated by coronary angiogram and GLS shows that the two variables bear a linear inverse relationship ($\rho = 0.742$, $p < 0.001$). This means that Gensini score increases while GLS value decreases. Linear inverse correlation between GLS and Gensini score in study population is depicted by scatter diagram. (Figure. 8)

Multivariate regression analysis showed none of the associated comorbidities found to have significant association with the severity of CAD.

In a study conducted by Miguel Angel Tibaldi and et.al [12] shown that LVGLS is novel diagnostic method which can be included along with ECG and cardiac biomarkers for initial diagnostic work up. Magdy Mohamad Abdelsamie and et.al concluded that 2D GLS and territorial longitudinal strain (TLS) can be considered as a part of routine echocardiography in evaluation of NSTEMI patients, and it is a promising, easy to perform, quick imaging and noninvasive method for early detection of the presence of coronary artery occlusion to identify

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patients who may benefit from early reperfusion [13]. In a study by Md. Al Amin and et. al they have shown that myocardial strain assessed by global longitudinal strain correlates with severity of coronary artery disease [14].

Mghaieth Zghal F, Boudiche and et al have concluded that in NSTEMI patients, GLS detected severe CAD and poor myocardial function and also TLS can be used to predict the culprit vessel and its occlusion. They have also demonstrated that GLS improvement at midterm was predicted by baseline systolic LV function parameters and myocardial revascularization [15]. In a study by Andrea Igoren Guaricci and et al predicted that coronary-specific quantification of myocardial deformation by strain echocardiography allows an accurate identification of the culprit vessel in NSTE-ACS patients and TLS along with routine wall motion score index can be used for better assessment of clinical status in this subset of patients [16].

5. CONCLUSION

- In the present study we were able to demonstrate the correlation between reduction in global longitudinal strain value and severity of coronary artery disease in Non-ST-Elevation Myocardial Infarction (NSTEMI) patients. As the number of coronary arteries involved increases LVGLS reduces.
- As 2D Echocardiography is the fundamental tool in assessment of CAD, strain echocardiography can be useful along with visual wall motion abnormalities in the assessment of ischemic heart disease.
- It's been a noninvasive, easy to perform and quick method to predict coronary artery disease in NSTEMI patients.
- Cardiac biomarkers increase after 2-3 hours of tissue hypo perfusion but myocardial contractile dysfunction sets in immediately after ischemia. So strain parameters can detect ischemia earlier than cardiac biomarkers. Hence it can help in early identification of NSTEMI patients with CAD and can differentiate patients having severe CAD for their early coronary revascularization.
- So it can be used for initial diagnostic workup of NSTEMI patients and to priorities the management strategies.

6. LIMITATIONS

- It is a single center study so findings cannot be generalized and even long term prognosis could not be assessed
- Major limitation of using strain echocardiography is lack of standard criteria and cut off values.
- Conventional way of denoting negative values for strain parameters can create confusion while data analysis
- It has limitations of conventional 2D echocardiography like observer variability, dependence on loading conditions of the heart and image quality.
- LVGLS cannot be used in patients with previous history of CAD and preexisting wall motion abnormalities hence those patients were excluded from the study

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- Currently longitudinal strain being more sensitive than radial and circumferential strain as shown by present cardiac imaging modalities, effects of ischemia on other strain patterns not been evaluated.

Tables

Figures

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Figure.8: Showing scatter diagram depicting inverse linear correlation between GLS and Gensini score in study population	**20**

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