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An Observational Study on Echocardiographic Assessment of Left Ventricular Function Using Simpson's and Global Longitudinal Strain Methods in Pre and Post Operative Coronary Bypassing Grafting Patient

Sabarivasan R[*1], Dr. Durgadevi[2]

[*1]Sabarivasan R, Assistant Professor, Department of Cardiovascular technology, School of Allied health Sciences, Malla Reddy University, Telangana.

[2]Dr. Durgadevi, Cardiologist, Sooriya hospital , Chennai , Tamilnadu

Corresponding Author

Sabarivasan R

Assistant Professor, Malla Reddy University, Telangana.

Email ID: sabva29@gmail.com

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ABSTRACT

Background: Coronary artery disease is a major cardiac disorder among the current population. The main risk factors for coronary artery disease are diabetes mellitus, systemic hypertension, dyslipidemia, hypothyroidism, stress, alcohol consumption, and smoking affect the coronary arteries, which supply blood to the heart, making them stiff and rigid, resulting in loss of their flexibility. The free radicals from the risk factors cause damage to the Intimal layer of blood vessels, which leads to a series of inflammatory reactions, causing plaque formation(1).

The plaque formation leads to decreased blood flow to the coronaries and causes ischemia to cardiac myocytes. It may progress to anaerobic metabolism of the myocyte that leads to cardiac myocyte injury, also known as Myocardial infarction(1).

In patients affected by Myocardial infarction, the left ventricular function will be depressed as a result of the infarction. In echocardiography, various methods are used to assess the left ventricular function. Simpson's and Global longitudinal strain were the most sensitive methods used to determine LV function(2).

Objective: The aim of the study is to assess the Left ventricular function in patients undergoing bypass grafting by Simpson and GLS methods, and to conclude which of these two methods might be the most accurate to assess the LV function.

Patients And Methods: A prospective observational study was done in 30 patients who presented to the cardiac OPD/Casualty with a clinical presentation of acute coronary syndrome, underwent coronary angiogram, and were further advised to undergo Coronary artery bypass grafting. In those patients, pre- and post-operative echocardiogram was done in order to evaluate LV function using GLS and Simpson's method.

Conclusion: The main use of bypass grafting in patients with coronary artery disease is to improve their LV Function. The purpose of this study is to promote that the current new echocardiography imaging techniques that enhance the accurate assessment of increased performance in LV Function in post bypass patients. In this contest, there are various number of methods which were derived to assess the LV Function. But in clinical aspect, the Simpson's and Global longitudinal strain methods provides the accurate assessment of LV systolic function. In behalf of comparing both merits and demerits of Simpson's and Global longitudinal strain methods, the LV Function assessed using the GLS is more reliable than the Simpson's method(3).

Keywords: *Coronary artery, LV systolic function, Simpson's method, Global longitudinal strain, Bypass grafting.*

1. INTRODUCTION

1.1. CORONARY ARTERY ANATOMY:

The major territories of coronary arteries are Right coronary artery, left coronary artery. RCA arises from Right coronary sinus and LCA arises from Left coronary sinus. The left coronary artery bifurcates into left anterior descending artery and circumflex artery or else bifurcates into Ramus Intermediacy LAD and LCX. The RCA runs into the right atrioventricular groove and reaches the right border of the heart and descends into PDA in posterior interventricular

groove. The LCA runs into the left atrioventricular groove as LCX, also in interventricular groove as LAD

1.2. CORONARY ARTERY PHYSIOLOGY:

In left ventricle the coronary blood flow reaches the subendocardial region during the phase of diastole whereas in right ventricle the coronary blood flow reaches the subendocardial region during both systole and diastole

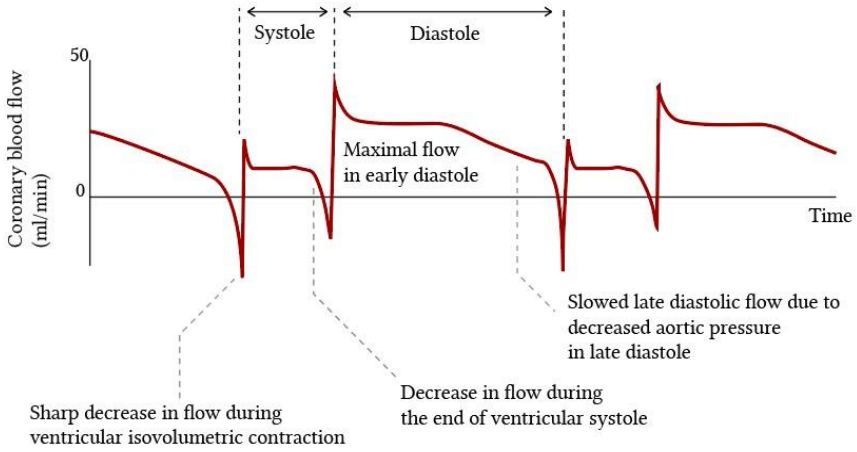


FIG 1.2.1. REPRSENTS CORONARY ARTERY PHYSIOLOGY

1.3. CORONARY ARTERY PATHOLOGY:

The major disease of the coronary artery results due to atherosclerotic plaque formation. The modifiable risk factors are Diabetes mellitus, hypertension, dyslipidemia, Smoking, alcohol, obesity, and hypothyroidism. The non-modifiable risk factors are familial hypercholesterolemia, ethnicity, race, and sex. The pathophysiology of coronary artery disease is described as follows:

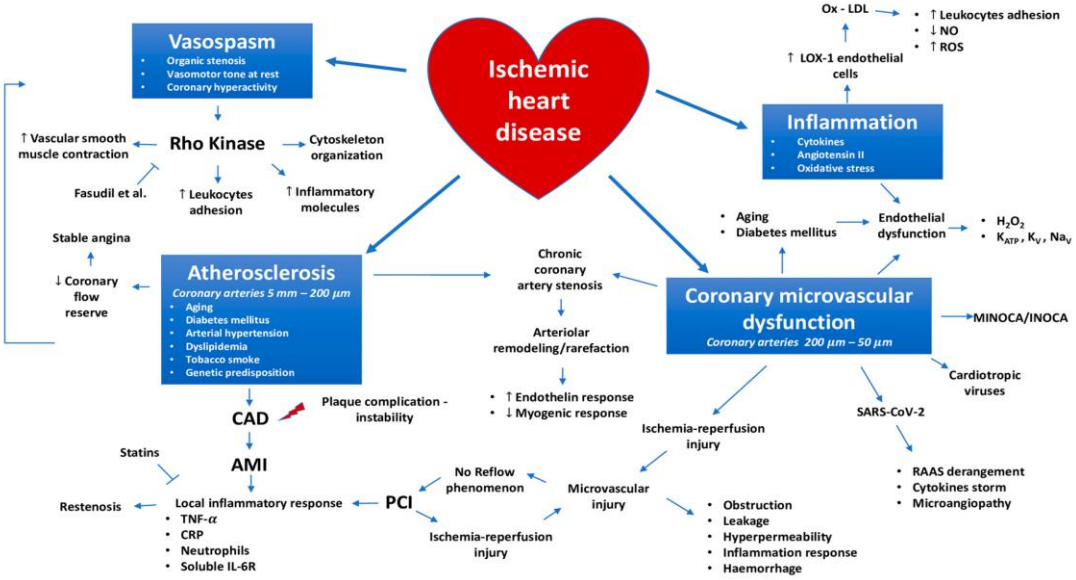


FIG 1.3.1. REPRESENTS CORONARY ARTERY PATHOPHYSIOLOGY

1.4. THE CLINICAL PRESENTATION:

Acute coronary syndrome is subdivided into unstable angina (occurs due to rupture of vulnerable plaque), NSTEMI (it is also known as non-trans mural myocardial infarction), STEMI (is also known as Trans mural myocardial infarction)(7).The clinical features of acute coronary syndrome is described as follows:

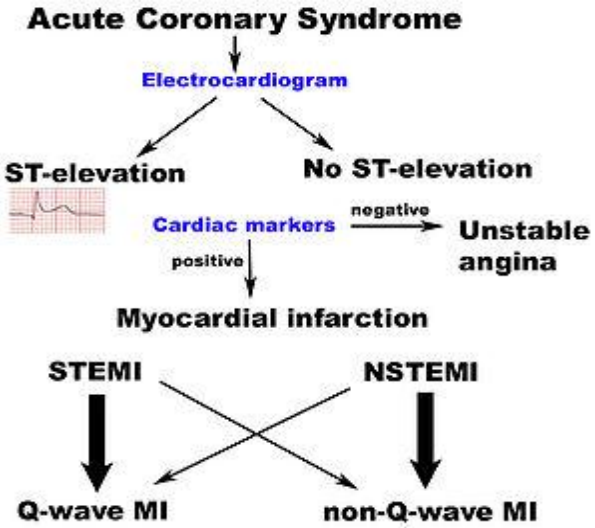


FIG 1.4.1. REPRESENTS FEATURES OF ACUTE CORONARY SYNDROME

1.5. THE CORONARY ANGIOGRAM:

It is the gold standard method to diagnosis the coronary artery disease using contrast agents .The occluded coronaries termed as single vessel disease, double vessels disease, triple vessels disease based on the number of vessels occluded .

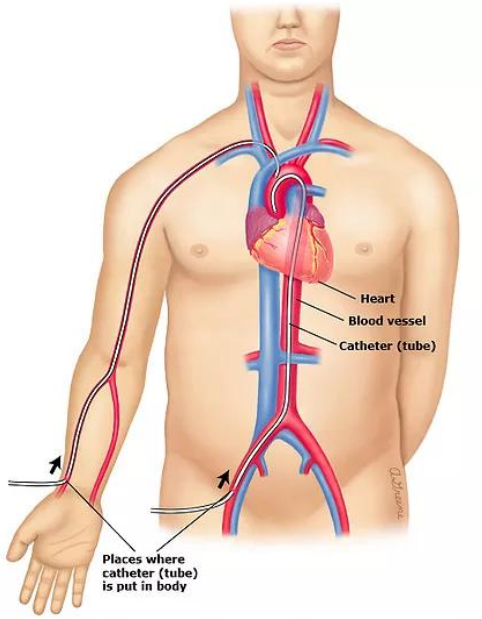
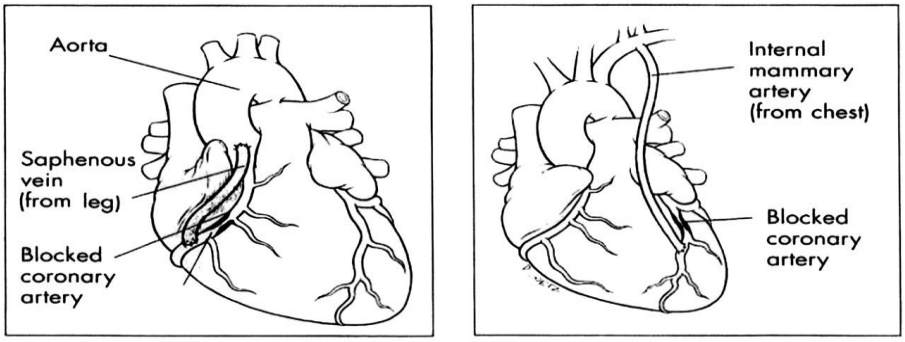


FIG 1.5.1. REPRSENTS PATHWAY OF CORONARY ANGIOGRAM

1.6. THE CORONARY ARTERY BYPASS GRAFTING:

In coronary artery bypass grafting the graft is placed from aorta to the distally occluded vessel. The most commonly preferred graft are saphenous grafts, left internal mammary artery



Coronary bypass using the saphenous vein or radial artery

Coronary bypass using the internal mammary artery

FIG 1.6.1. REPRESENTS THE PROCEDURE OF CORONARY BYPASS GRAFTING

3.3 SUBJECT SELECTION:

- Between the months of February 2023 to August 2023, a total of 30 consecutive patients were a known case of Type-2 Diabetes mellitus, Systemic hypertension, Dyslipidemia, hypothyroidism, and a history of CAD presented with clinical presentation of acute coronary syndrome. All these patients underwent Coronary angiogram and follow-ups to the respective departments were prospectively reviewed in Chettinad Superspeciality Hospital, Kelambakkam.

3.3.1 Inclusion criteria:

- ✓ Diabetes mellitus.
- ✓ Systemic hypertension
- ✓ Dyslipidemia
- ✓ Hypothyroidism
- ✓ Patient with history of CAD

3.3.2 Exclusion criteria:

- ✓ Arrhythmia
- ✓ Pregnancy.
- ✓ Psychiatry patients

- **Subjects are taken based on the Inclusion and Exclusion criteria.**

3.4 STUDY PROCEDURE:

By using 2-dimensional conventional echocardiography in Philips 50C affinity machine, by using the standard echocardiography images PLAX, PSAX, A4C, A2C and Subcostal windows.

2. SIMPSON METHOD:

The most common method for determining ventricular volume is the SIMPSON or RULE OF DISC. This technique requires recording an apical 4 chamber or 2 chamber view from which endocardial borders is outlined. Mathematically, the ventricle is divided into series of disks of equal height(4)

INDIVIDUAL DISC AREA = DISC AREA X HEIGHT OF DISC

DISC AREA = πr^2

DISC HEIGHT = TOTAL LENGTH OF LV DIVIDED BY NO. OF DISC

VENTRICULAR VOLUME = SUM OF THE VOLUME OF DISC

LVEF = LVEDV – LVESV / LVEDV X 100%, LVEF = STROKE VOLUME / LVEDV(5).

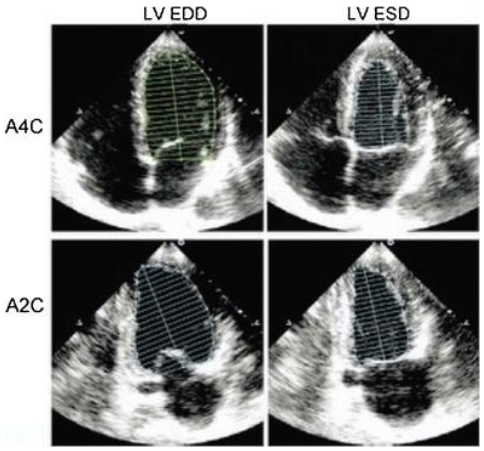


FIG 3.1. REPRESENTS LV FUNCTION BY SIMPSON'S METHOD

3. FOR ACCURATE VOLUME DETERMINATION:

- The transducer must be at true apex
- The ultrasound beam must be through Centre of LV
- To ensure, that transducer is at true apex, note that normal apex is thinnest area of LV .In clinical practice, apical 2 chamber view is often imaged tangentially and the volume derived from this view may underestimate the true LV volume(5) .

NOTE: While tracing the endocardia borders, the trabeculations and papillary muscle are excluded because it may lead to underestimation of LV volume

4. GLOBAL LONGITUDINAL STRAIN:

The newer method of Doppler tissue imaging and speckle tracking for calculation of strain or strain rate. Non-invasive evaluation of left ventricular (LV) systolic function by echocardiography remains one of the most pivotal measures in clinical cardiology. Although conventionally quantified by means of LV ejection fraction (LVEF), it has become evident that this parameter is subject to a number of limitations. LVEF can be normal in the presence of impaired LV systolic function, since it does not reflect intrinsic myocardial contractility(6).

In addition, LVEF is highly load-dependent and suffers from significant intra observer and interobserver variability. Assessment of myocardial strain can potentially overcome many of the limitations of LVEF in assessing LV systolic function(3).

Speckle tracking echocardiography permits assessment of myocardial strain in three spatial directions (longitudinal, radial, and circumferential) independent of the angle of insonation of ultrasound beam. Longitudinal strain is probably the most frequent type of strain used to characterize the LV systolic function in clinical practice. This review article focuses on the practical aspects of measuring LV global longitudinal strain (GLS), reviews the clinical implications of impaired LV GLS strain and provides a glimpse into the future clinical applications of this technology(6).

Assessment of LV GLS

The LV myocardium consists of two helical, opposing layers of myocardial fibers (endocardia/right-handed and pericardial/left-handed) surrounding a circumferential, mid-ventricular layer. When these layers contract, the myocardium shortens in the longitudinal and circumferential directions and thickens in the radial direction. The introduction of speckle tracking echocardiography has allowed for a more comprehensive analysis of LV systolic function when compared with LVEF by assessing myocardial deformation(7).

5. RESULTS

TABLE 5.1 REPRESENTS PATIENT DEMOGRAPHY

SEX	NO OF PATIENTS	PERCENTAGE (%)
MALE	17	57
FEMALE	13	43

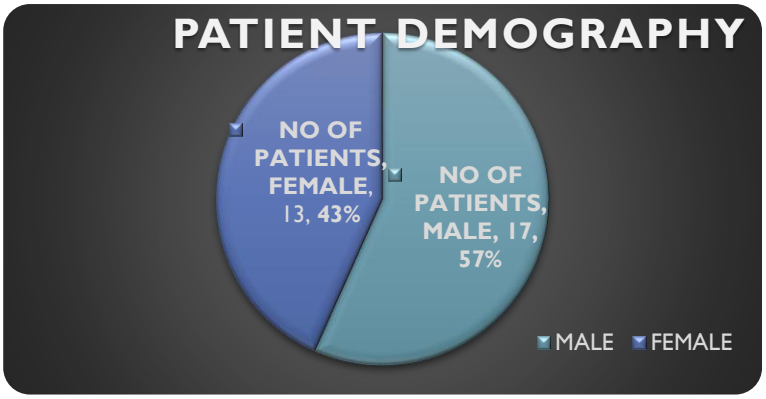


FIGURE 5.1 REPRESENTS PATIENT DEMOGRAPHY

TABLE 5.2 REPRESENTS PATIENTS AGE DISTRIBUTION

AGE	NO OF PATIENTS	PERCENTAGE (%)
30-40	5	17
40-50	7	23
50-60	12	40
>60	6	20

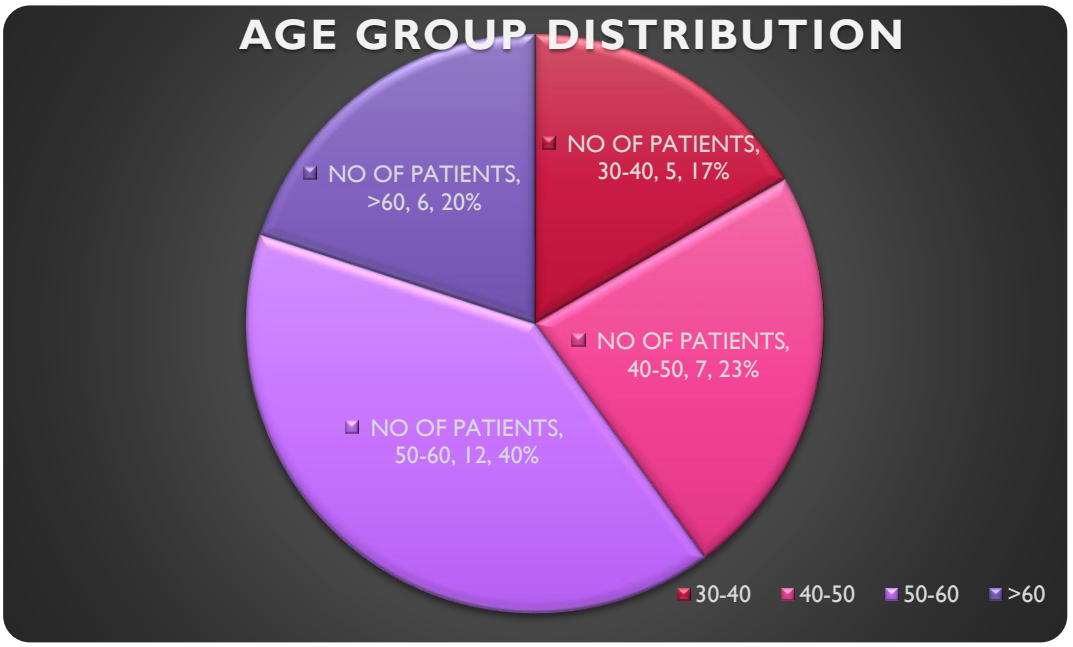


FIGURE 5.2 REPRESENTS PATIENT AGE DISTRIBUTION

TABLE 5.3 REPRESENTS PATIENT CO-MORBIDITIES

CO-MORBIDITIES	NO OF PATIENTS	PERCENTAGE (%)
DM	8	33
HTN	6	20

DLP	4	13
HYPOTHYROIDISM	2	7
H/O CAD	10	27

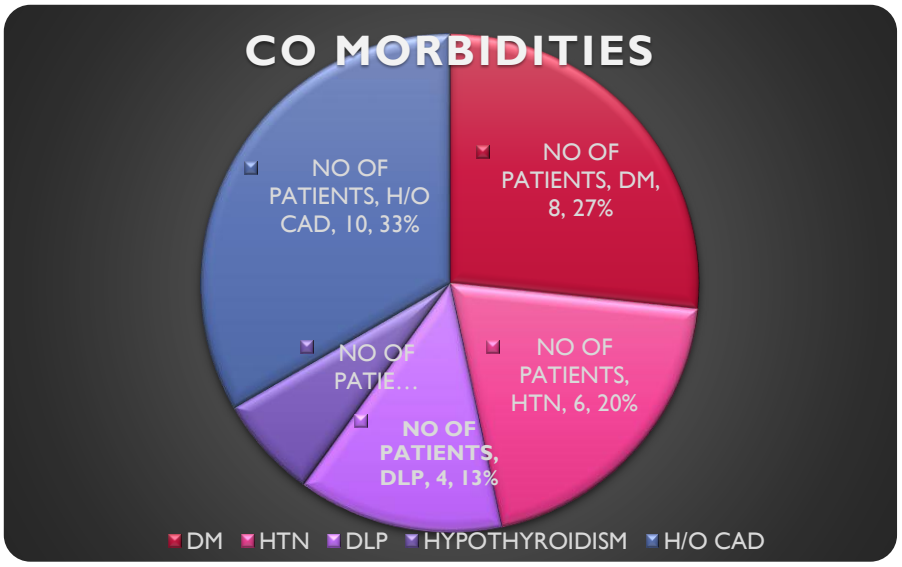


FIGURE 5.3 REPRESENTS PATIENTS CO-MORBIDITIES

TABLE 5.4 REPRESENTS PATIENT CAG FINDINGS

CAG FINDINGS	NO OF PATIENTS	PERCENTAGE (%)
TVD	11	36
DVD WITH >90% STENOSIS	7	23
LMCA STENOSIS	12	40

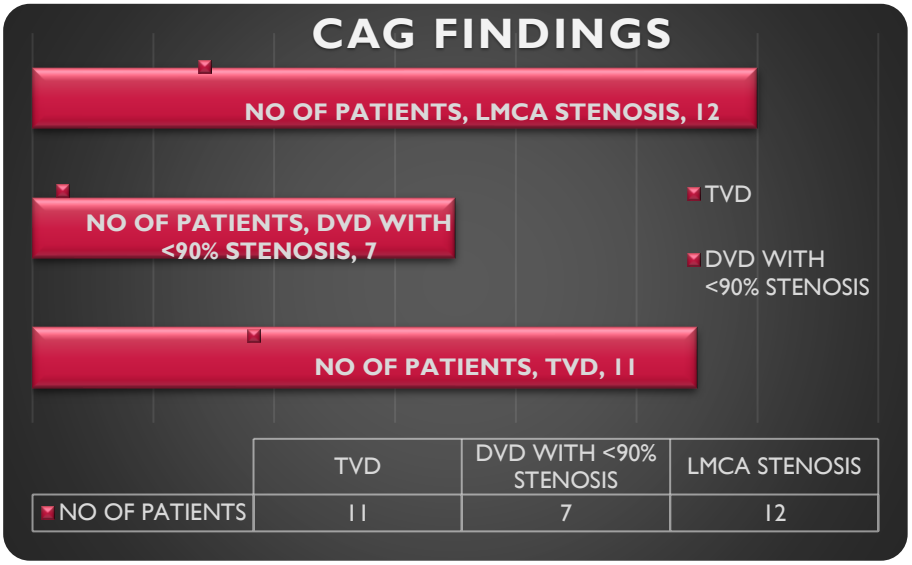


FIGURE 5.4 REPRESENTS PATIENT CAG FINDINGS

TABLE 5.5 REPRESENTS PATIENT CLINICAL DETAILS

CLINICAL DETAILS	NO: OF PATIENTS	PERCENTAGE (%)
STEMI	9	30
NSTEMI	11	36
USA	10	33

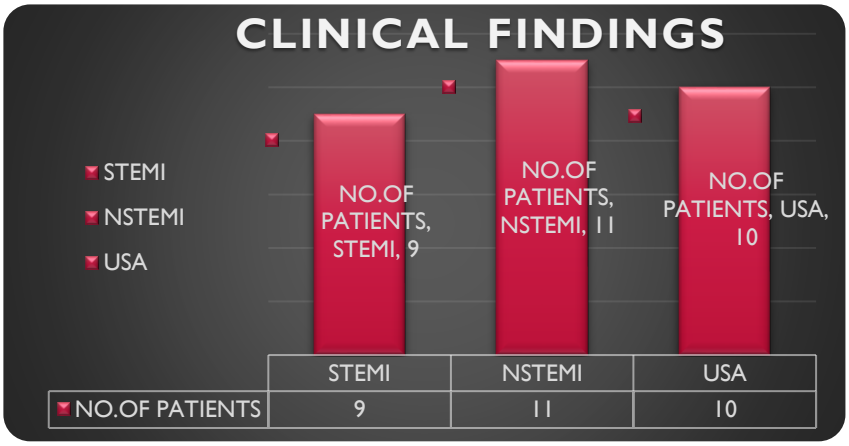


FIGURE 5.5 REPRESENTS PATIENT CLINICAL DETAILS

TABLE 5.6 REPRESENTS SIMPSON'S PARAMETERS

PARAMETERS	PRE CABG	POST CABG
EDV	80 ± 12	110± 15
ESV	30± 14	60± 17
EF	35±7	48±8

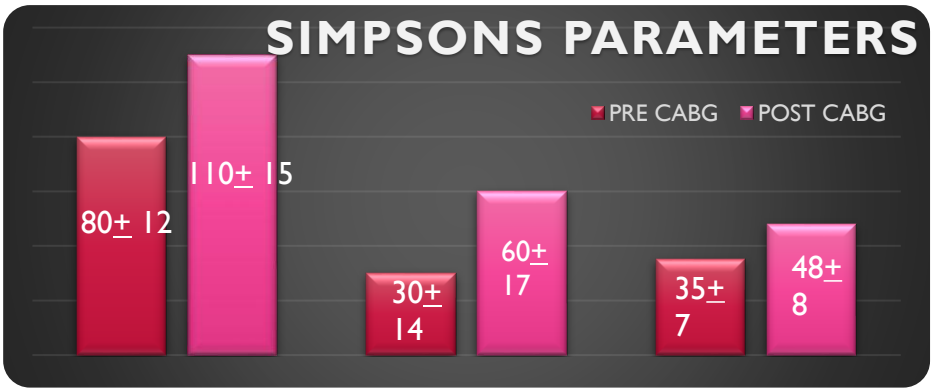


FIGURE 5.6 REPRESENTS SIMPSON'S PARAMETERS

TABLE 5.7 REPRESENTS GLS PARAMETERS

PARAMETER	PRE CABG	POST CABG
EDV	70±15	130±12

ESV	40±8	75±12
EF	30±8	55±8

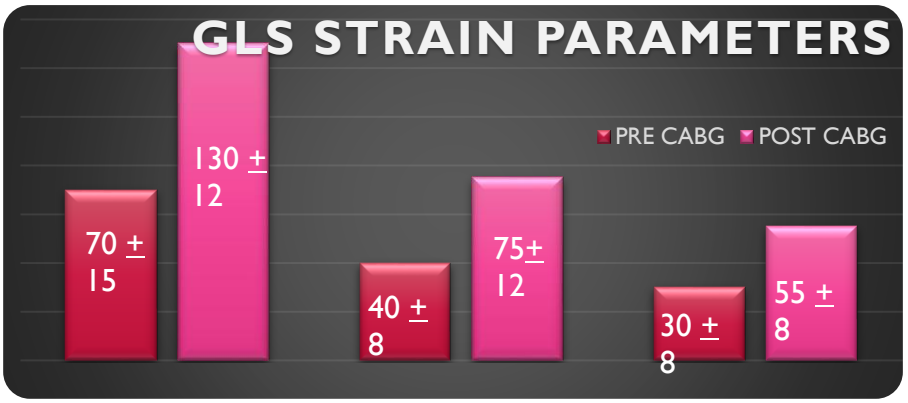


FIGURE 5.7 REPRESENTS GLS PARAMETERS

6. DISCUSSION

In this study, 30 patients were included in which 17 patients were male (57%) and 13 patients were female (43%) who were a known case of Type 2 Diabetes mellitus, Systemic hypertension, Dyslipidiemia, hypothyroidism and history of CAD presented with clinical presentation of acute coronary syndrome in Chettinad Super Speciality Hospital were included.

In 30 patients, 17% patients were within the age group of 30 – 40 years, 23% patients were within the age group of 40 – 50 years, and 40% patients were within the age group of 50-60 and 20% of patients above 60 years.

In 30 patients, 8 patients had a known comorbidity of Type II Diabetes Mellitus (27%), 6 patients had Systemic hypertension (20%), 4 patients had Dyslipidaemia (13%), 2 patients had Hypothyroidism (7%) and 10 patients had a history of CAD (33%).

Coronary angiogram of these patients revealed Triple vessels disease in 9 patients (36%), double vessel disease with more than 90 percent stenosis among 7 patients (23%) and left main coronary artery stenosis among 12 patients (40%).

In 30 patients, 9 patients had clinical features of STEMI (30%), 11 patients had clinical features of NSTEMI (36%) and 10 patients had clinical features of USA (33%).

The Echocardiographic assessment of left ventricular function among 30 patients using biplane Simpson's method has been carried out. The respective parameters are EDV, ESV, EF are calculated using biplane Simpson's method in which EDV accounts (80±12) in PRE-CABG and (110±15) in POST–CABG, ESV accounts (30±14) in PRE-CABG and 60±17 in POST-CABG, EF accounts (35±7) in PRE-CABG and (48±8) in POST-CABG patients.

The Echocardiographic assessment of left ventricular function among 30 patients using Global

Longitudinal strain has been carried out. The respective parameters are EDV, ESV, EF are calculated using global longitudinal strain in which EDV accounts (70±15) in pre-CABG and (130±12) post-CABG, ESV accounts (4 0±8) in pre-CABG and (75±12) in post-CABG, EF by strain accounts (30±8) in pre-CABG and (55±8) in post-CABG patients.

7. CONCLUSION

The main use of bypass grafting in patients with coronary artery disease is to improve their ventricular function. The purpose of this study is to assess the usefulness of the new echocardiography imaging technique of global longitudinal strain in the accurate assessment of LV Function in post-bypass surgery patients. The Simpson's and Global longitudinal strain methods provide accurate assessment of LV systolic function. Both Simpson's and GLS methods showed a significant improvement of LV function postoperatively. The magnitude of improvement is greater in GLS compared to Simpson's method. Hence GLS method is a reliable parameter to assess LV function(3).

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