

**EFFECTS OF SEVOFLURANE VERSUS PROPOFOL ON MITRAL ANNULAR  
DISPLACEMENT EVALUATED USING SPECKLE TRACKING.**

**Dr. SUDA NAVEEN KUMAR**

DM CARDIOTHORACIC AND VASCULAR ANESTHESIOLOGY

THESIS

2021- 2023



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES  
AND TECHNOLOGY, THIRUVANANTHAPURAM.**

An Institution of National Importance

Established by an Act of the Indian Parliament.

(Act No.52 of 1980)

Department of Science and Technology,

Government of India.

[www.sctimst.ac.in](http://www.sctimst.ac.in).

**EFFECT OF SEVOFLURANE VERSUS PROPOFOL ON MITRAL ANNULAR  
DISPLACEMENT EVALUATED USING SPECKLE TRACKING.**

A THESIS SUBMITTED BY

**Dr. SUDA NAVEEN KUMAR**



TO

**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL  
SCIENCES AND TECHNOLOGY, THIRUVANANTHAPURAM.**

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF

**DM CARDIOTHORACIC AND VASCULAR ANAESTHESIOLOGY.**

YEAR 2021 TO 2023.



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM  
Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

P  
a  
g  
e  
|  
1

DECLARATION BY THE STUDENT

I, Dr Suda Naveen Kumar, hereby certify that I had personally carried out the work depicted in the thesis titled, "Effects of Sevoflurane versus Propofol on mitral annular displacement, evaluated by speckle tracking".

No part of this thesis has been submitted for the award of any other degree or diploma prior to this date.

Date: 31-08-2023

Signature

Dr. Suda Naveen Kumar,  
Senior resident,  
Division of Cardiothoracic and  
Vascular Anaesthesiology,  
Department of Anaesthesiology,  
SCTIMST, Thiruvananthapuram.



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM  
Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

CERTIFICATE BY THE RESEARCH GUIDE

Name of the guide: **Dr. Shrinivas V Gadhinglajkar.**

Department: Department of Anesthesiology.

Division: Division of Cardiothoracic and Vascular Anaesthesia.

This is to certify that Dr. Suda Naveen Kumar, Senior resident in the division of Cardiothoracic and Vascular Anesthesiology, of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

The thesis entitled "Effects of Sevoflurane versus Propofol on mitral annular displacement, evaluated by speckle tracking" was carried out under my direct supervision. No part of the thesis was submitted for the award of the degree or diploma prior to this date.

Clearance was obtained from the Institutional ethics committee for carrying out the study.

Date: 4-9-2023

Signature

**Dr. SHRINIVAS GADHINGLAJKAR**  
Professor (Senior Grade) and Head of Department  
Department of Anaesthesiology  
Sree Chitra Tirunal Institute for  
Medical Sciences and Technology  
Thiruvananthapuram, Kerala, India

Dr. Shrinivas V Gadhinglajkar,  
Professor Senior Grade and HOD,  
Department of Anaesthesiology,  
SCTIMST, Thiruvananthapuram.



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM  
Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

CERTIFICATE BY THE RESEARCH CO-GUIDE

Name of the guide: **Dr. PRASANTA KUMAR DASH**

Department: Department of Anaesthesiology.

Division: Division of Cardiothoracic and Vascular Anaesthesia.

This is to certify that Dr. Suda Naveen Kumar, Senior resident in the division of Cardiothoracic and Vascular Anaesthesiology, of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

The thesis entitled "Effects of Sevoflurane versus Propofol on mitral annular displacement, evaluated by speckle tracking" was carried out under my direct supervision. No part of the thesis was submitted for the award of the degree or diploma prior to this date. Clearance was obtained from the Institutional ethics committee for carrying out the study.

Date: 29-08-2023

Signature

Dr. Prasanta Kumar Dash,  
Professor Senior Grade,  
Department of Anaesthesiology,  
SCTIMST, Thiruvananthapuram.



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
तिरुवनन्तपुरम - ६९५०९९, केरल, इंडिया

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM  
Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grams : Chitramel, Phone : +91-471-2442152, Fax : +91-471-2590726/2446433, E-mail : act@sectest.ac.in, Website : www.actimst.ac.in

**CERTIFICATE BY THE RESEARCH CO-GUIDE**

Name of the guide: Dr. SUBIN SUKESAN

Department: Department of Anaesthesiology,

Division: Division of Cardiothoracic and Vascular Anaesthesia,

This is to certify that Dr. Suda Naveen Kumar, Senior resident in the division of Cardiothoracic and Vascular Anaesthesiology, of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

The thesis entitled "Effects of Sevoflurane versus Propofol on mitral annular displacement, evaluated by speckle tracking" was carried out under my direct supervision. No part of the thesis was submitted for the award of the degree or diploma prior to this date. Clearance was obtained from the Institutional ethics committee for carrying out the study.

Date: 28<sup>th</sup> August 2023

Signature

Dr. Subin Sukesan,

Additional Professor,

Department of Anaesthesiology,

SCTIMST, Thiruvananthapuram.



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया  
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM  
Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grana : Chitranet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@scimst.ac.in, Website : www.scimst.ac.in

CERTIFICATE BY THE RESEARCH CO-GUIDE

Name of the guide: **Dr. VIVEK V PILLAI**

Department: Department of Cardiovascular and thoracic surgery.

This is to certify that Dr. Suda Naveen Kumar, Senior resident in the division of Cardiothoracic and Vascular Anaesthesiology, of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

The thesis entitled "Effects of Sevoflurane versus Propofol on mitral annular displacement, evaluated by speckle tracking" was carried out under my direct supervision. No part of the thesis was submitted for the award of the degree or diploma prior to this date.

Clearance was obtained from the Institutional ethics committee for carrying out the study.

Date: 28-08-2023

Signature

Dr. Vivek V Pillai,  
Professor and HOD,  
Department of CVTS,  
SCTIMST, Thiruvananthapuram.



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया  
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM  
Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grana : Chitranat, Phone : +91-471-2443152, Fax : +91-471-2550728/2446433, E-mail : scl@actimst.ac.in, Website : www.actimst.ac.in

CERTIFICATE BY THE RESEARCH CO-GUIDE

Name of the guide: Dr. VARGHESE T PANICKER.

Department: Department of Cardiovascular and thoracic surgery.

This is to certify that Dr. Sada Navam Kumar, Senior resident in the division of Cardiothoracic and Vascular Anaesthesiology, of this Institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

The thesis entitled "Effects of Sevoflurane versus Propofol on mitral annular displacement, evaluated by speckle tracking" was carried out under my direct supervision. No part of the thesis was submitted for the award of the degree or diploma prior to this date.

Clearance was obtained from the Institutional ethics committee for carrying out the study.

Date: 28-8-2023

Signature

Dr. Varghese T Panicker,

Professor,

Department of CVTS,

SCTIMST, Thiruvananthapuram.

## ACKNOWLEDGMENTS

I take this opportunity to express my sincere gratitude to Dr Shrinivas V Gadhinglajkar, Professor Senior grade and HOD of Department of Anaesthesiology, SCTIMST, my guide for this study, for his expert guidance, constant review, kind help and keen interest at each step of the study.

I am thankful to Dr. Prasanta Kumar Dash, Dr. Subin Sukesan, Dr. Vivek Pillai and Dr. Varghese T Panicker, who were co-guides in this study, for their valuable input and help for the study.

I am thankful to Dr. Rupa Sreedhar, Dr. Thomas Koshy, Dr. Suneel PR, Dr. Unnikrishnan KP, Dr. Saravana Babu and Dr. Don P Jose of Department of Anaesthesiology, nursing staff in cardiac surgical ICU, and my colleagues for their valuable input and assistance to the study. I am extremely grateful to my friends for their overwhelming support and constant encouragement.

I take this opportunity to also thank Dr Santosh Kumar B, registrar of SCTIMST and his academic section team for all help rendered during thesis preparation.

This would not have been possible without the love and constant support of Dr. Pramitha, Kris Joel, Charis Maria and my parents.

I am greatly indebted to all my patients and their primary caregivers who participated in this study, without whose cooperation this study would not have been possible.

Above all, I thank the almighty GOD, for HIS mercy and grace in my life.

30<sup>th</sup> August, 2023.

Dr Suda Naveen Kumar.

# CONTENTS

1) DECLARATION BY THE STUDENT ..... iii

2) CERTIFICATE BY THE RESEARCH GUIDE.....iv

3) ACKNOWLEDGEMENTS ..... ix

4) TABLE OF CONTENTS ..... x

5) LIST OF FIGURES ..... xi

6) LIST OF TABLES ..... xi

7) LIST OF ABBREVIATIONS..... xii

8) SYNOPSIS..... xv

SL.NO	TOPIC	PAGE NUMBER
1	Introduction	1 – 3
2	Aims and Objectives	4
3	Review of literature	5 – 10
4	Materials and Methods	11 – 14
5	Results	15 – 27
6	Discussion	28 – 33
7	Conclusion	34
8	Bibliography	35 – 42
9	Institute ethics committee approval	43-44
10	Consent forms	45 – 49
11	Study proforma	52 – 53
13	Master charts	54 – 71
14	Plagiarism check	72

## LIST OF FIGURES

Figure number	Figure Caption	Page number
1	TMAD measurements in mid-esophageal four-chamber view.	3
2	TMAD measurements in mid-esophageal two-chamber view.	3
3	Consort diagram showing patient selection.	15
4	Gender distribution among the study groups.	4
5	Intra-observer Bland-Altman plots of TMAD % and GLS%.	24
6	Inter-observer Bland-Altman plots of TMAD % and GLS%.	25
7	Scatter plot showing correlation between TMAD 4C and MAPSE (average) between the study groups in Post-CPB period.	25
8	Scatter plot showing correlation between TMAD 4C and LVEF % between the study groups in Post-CPB period.	26
9	Scatter plot showing correlation between TMAD 4C and average tissue doppler velocity of mitral annulus between the study groups in Post-CPB period.	26
10	Scatter plot showing correlation between TMAD 4C and GLS % between the study groups in Post-CPB period.	27

## LIST OF TABLES

Table no	Table caption	Page No
1	Demographic parameters between the study groups	14
2	Comorbidities among the two study groups	17
3	Comparison of mean of hemodynamic parameters in the Pre-CPB and Post-CPB period between study groups (n=44)	17
4	Comparison of CPB time and ACC time between the groups.	18
5	Comparison of post-CPB values of selected variables	18
6	Comparison of 2DE and STE parameters in the Pre-CPB and post-CPB period in Sevoflurane group (n =44)	19
7	Comparison of 2DE and STE parameters in the Pre-CPB and post CPB period in Propofol group (n =44).	20
8	Comparison of 2DE and STE parameters in the Pre-CPB period between the study groups (n=44)	21
9	Comparison of 2DE and STE parameters in the Post-CPB period between the study groups (n=44)	22
10	Pearson correlation of Midpoint TMAD 4C Post-CPB with other methods of assessment of LV systolic function.	23
11	Pearson correlation coefficient ranges and inference.	24
12	Time taken for calculating TMAD and GLS using Q-lab software.	25
13	Intra-observer and inter-observer variability between Percentage TMAD in 4C and GLS %	25

## LIST OF ABBREVIATIONS

Sl. No	Abbreviation	Expansion
1	LV	Left ventricle
2	EF	Ejection Fraction
3	CABG	Coronary Artery Bypass Grafting
4	TEE	Trans Esophageal Echocardiography
5	MAPSE	Mitral Annular Systolic Plane Excursion
6	GLS	Global Longitudinal Strain
7	TDI	Tissue Doppler Imaging
8	TMAD	Tissue Mitral Annular Displacement
9	SPSS	Statistical Package for the Social Sciences
10	CPB	Cardio-Pulmonary Bypass
11	2DE	2Dimensional Echocardiography
12	WMSI	Wall Motion Severity index
13	STE	Speckle Tracking Echocardiography
14	BNP	B natriuretic Peptide
15	TTE	Transthoracic Echocardiography
16	MAV	Mitral Annular Velocity
17	CAD	Coronary Artery Disease
18	ME	Mid-esophageal
19	TG	Trans-gastric
20	ROI	Region of Interest
21	CMR	Cardiovascular magnetic resonance
22	RCT	Randomized controlled trials

## LIST OF ABBREVIATIONS

Sl. No	Abbreviation	Expansion
23	IEC	Institutional Ethics Committee
24	MAP	Mean Arterial Pressure
25	SBP	Systolic Blood pressure
26	DBP	Diastolic Blood Pressure
27	HR	Heart rate
28	CVP	Central venous pressure
29	BIS	Bi-spectral index
30	LVOT	Left ventricular outflow tract
31	CI	Cardiac index
32	CMQ	Cardiac motion Quantification
33	MAC	Minimum alveolar concentration
34	ACC	Aortic cross clamp
35	4C, 2C, 3C	Four-chamber, Two-chamber, Three-chamber

## INTRODUCTION

Left ventricular (LV) systolic function predicts for perioperative morbidity and mortality in patients undergoing coronary artery bypass grafting (CABG) <sup>1,2</sup>. Transoesophageal echocardiography (TEE) is a valuable tool for assessing intraoperatively LV systolic function. Various echocardiographic parameters have been used to define the LV function: such as fractional shortening, fractional area change, ejection fraction (EF) and wall thickening. For evaluation of regional and global myocardial function reliable and reproducible parameters are required which guides the perioperative physician in stratifying perioperative risk and management<sup>3</sup>. Unfortunately, the parameters mention above has several limitations in evaluating the LV myocardial function. These limitations include necessity for geometric assumptions, dependence on preload and afterload, less reproducibility and alteration with hemodynamic changes and translational motion<sup>4,5</sup>.

Wall motion severity index (WMSI) is often used to predict outcomes after the CABG<sup>6</sup>. However, it is limited by necessity for expertise, failure to distinguish grades of hypokinesia and inability to pick up subtle abnormalities <sup>7</sup>. Wall motion of the endocardium denotes changes in the radial mechanics of heart, ignoring the longitudinal myocardial function which may be altered in the initial stage of myocardial ischemia. In addition, the LVEF may not be reduced unless many myocardial segments are involved in ischemic injury. An area of normally contracting myocardium surrounding the infarcted area may appear akinetic due to tethering effect, which may overestimate the infarct size by the method of WMSI<sup>8</sup>. Similarly, the LVEF may not be sensitive to detect the early changes in myocardial dysfunction<sup>9</sup>.

Tissue doppler imaging (TDI) uses doppler principles to quantify the higher amplitude, lower velocity signals of myocardial tissue motion<sup>10</sup>. Systolic myocardial velocity at the lateral annulus measures longitudinal systolic function and correlates well with LV ejection fraction measurements. The assessment of myocardial deformation by doppler or speckle tracking techniques are considered more sensitive and consistent parameters for detecting subclinical dysfunction of myocardium, having a well – defined normal range <sup>11</sup>. The myocardial velocity and strain quantification performed using doppler based techniques using transthoracic echocardiography have been advocated for the quantification of myocardial function<sup>12</sup>. However, the doppler interrogation is limited by angle dependency and noise artifacts in the operation suite.

The 2D speckle tracking echocardiography (STE), a relatively newer technique introduced in clinical practice measures the tissue deformation and provide accurate and objective information pertaining to regional and global myocardial function in real time and improves the diagnostic accuracy due to decrease variability in the subjective interpretation. Published reports describe identification of subclinical LV dysfunction in ischemic heart disease using global longitudinal strain (GLS) derived from STE<sup>13</sup>. The GLS has been shown to have many advantages over WMSI due to less interobserver variability. Similarly, the GLS is more sensitive in detecting wall motion abnormalities than WMSI during dobutamine stress echocardiography in ischemic heart disease<sup>14</sup>. The subendocardial area of the left ventricle, which is frequently used for quantification of longitudinal strain is at the risk of developing ischemia in CABG patients that may derange the GLS segmental strain<sup>15</sup>.

The mitral annular plane systolic excursion (MAPSE) is often considered a surrogate marker for LVEF. Studies has shown that reduced MAPSE correlates with LV systolic dysfunction after heart failure, myocardial infarction, shock and atrial fibrillation. Ejection fraction may be derived from MAPSE using following formula in adult males, which has been validated by published study<sup>16</sup> ( $LVEF = 4.8 \times MAPSE \text{ (mm)} + 5.8$ ). Willeheiner et al<sup>17</sup> in their study have shown that the patient mortality was 36% when MAPSE was less than 6.4mm, compared to insignificant mortality when MAPSE value exceeded 10mm. In patients with normal or preserved LVEF, MAPSE showed good correlation with longitudinal strain at rest as per study done by Wenzelburger et al<sup>18</sup>. MAPSE also had significant correlation serum beta natriuretic peptide<sup>19</sup> (BNP) levels and could predict long-term survival in patients with heart failure.

Tissue mitral annular displacement (TMAD) is a new parameter introduced on recent echocardiographic platforms for the evaluation of longitudinal systolic function. Characteristically, the STE-TMAD measurement has an edge over other methods of longitudinal functional evaluation that it is not affected by endocardial definition and dropout artifacts of myocardium. In a study published Dai asada et al<sup>20</sup>, the authors reported a significant correlation between LVEF and TMAD ( $r = 0.71, p < 0.01$ ) and GLS and TMAD ( $r = - 0.77, p < 0.01$ ). Their results suggested that TMAD was useful in assessing LVEF and longitudinal function with insignificant influence of changes in heart rate and body surface area. Majority of the studies evaluating the TMAD were performed using transthoracic echocardiography (TTE) and studies based on intraoperative TEE are lacking.

We prospectively compared the TMAD measurements with other parameters of LV systolic function that is MAPSE, TDI- based mitral annular velocity, LVEF and GLS. We compared these parameters with two anaesthetic regimens incorporating sevoflurane or propofol.

Figure 1: TMAD measurements in mid-esophageal four-chamber view.

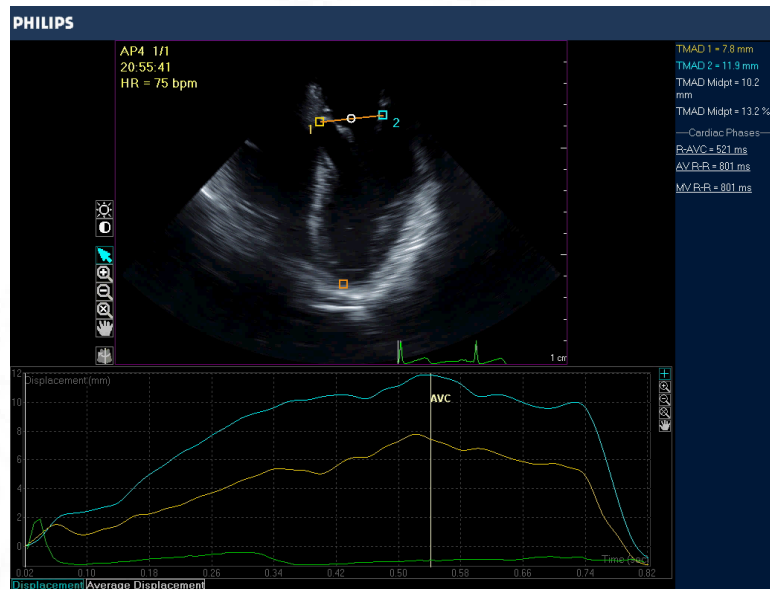


Figure 1 shows mid-esophageal four-Chamber loop opened in Q-lab using CMQ software displaying TMAD acoustic markers and measurements.

Figure 2 TMAD measurements in mid-esophageal two-chamber view.

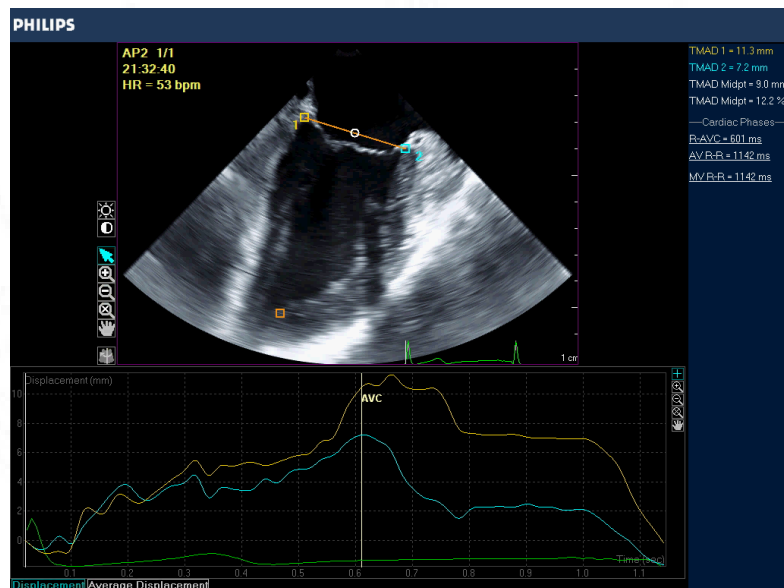


Figure 2 Shows mid-esophageal Two-chamber loop opened in Q-lab using CMQ software displaying TMAD acoustic markers and measurements.

## AIMS AND OBJECTIVES

**Hypothesis:** We hypothesize that

**Null Hypothesis:**

1. There is no difference in M-mode MAPSE, mitral annular velocity (MAV) with TDI, GLS and TMAD before and after CABG in patients.
2. There is no difference in the effects of sevoflurane and propofol anaesthesia in MAPSE, MAV with TDI and TMAD before and after CABG in patients
3. There is no difference between GLS and M-mode MAPSE, MAV with TDI and TMAD, before and after CABG.

**Alternate hypothesis:**

1. MAPSE, MAV with TDI and TMAD are different before and after CABG in patients.
2. There are different effects of sevoflurane and propofol anaesthesia on MAPSE, MAV with TDI and TMAD and before and after CABG
3. GLS, MAPSE, MAV with TDI and TMAD are different before and after CABG

**Primary objectives:**

1. To compare effects of sevoflurane and propofol anesthesia on changes in MAPSE, MAV with TDI, GLS and TMAD in CABG patients.
2. To compare differences between GLS, MAPSE, MAV with TDI and TMAD in CABG patients.

**Secondary objectives:**

To ascertain intra-observer and inter-observer variability between TMAD and GLS.

# REVIEW OF LITERATURE

## **Methods for evaluating intraoperative LV systolic function and their limitations**

In CABG patients intraoperative TEE helps to monitor LV function for detection of acute ischemia manifesting as new regional wall motion abnormality. Patients with LV systolic dysfunction has poor prognosis, so needs early identification.<sup>21</sup> Different methods to assess LV systolic function like WMSI, fractional shortening, fractional area change, LVEF by 2DE or doppler parameters of cardiac structures guide clinicians to decide on various treatment modalities. Out of which LVEF is simple and very good predictor of mortality associated with LV systolic dysfunction<sup>22</sup>. But its use is limited due to many LV geometric assumptions to be made, difficulty to get correct endocardial borders and load dependence. Visual assessment of LV systolic function and WMSI though popular among clinicians, is dependent on operators experience with interobserver variability and not a sensitive predictor of subclinical myocardial dysfunction. Other methods like stroke volume, cardiac output, fractional area change also depends on load and has interobserver variability. Advanced 3D echocardiography systems<sup>23</sup>, with post processing capability, performed by highly trained clinicians is superior to 2DE in assessing LV systolic function.

## **Necessity for accurate estimation of LV systolic function**

More than 6,00,000 patients undergo CABG annually throughout the world<sup>24</sup>. Intraoperative TEE assessment of LV systolic function by WMSI, LVEF, cardiac output may fail to identify early stages of dysfunction. Studies proved WMSI as a poor predictor<sup>25</sup> of major adverse cardiac events and hospital admissions in coronary artery disease (CAD) patients, while GLS is a strong predictor. Cardiovascular risk assessment by GLS is more accurate than LVEF. Newer method of speckle tracking – based TMAD seems to be more simple and reliable method of assessing LV systolic function<sup>26</sup>.

**MAPSE** (mitral annular plane systolic excursion):

MAPSE obtained using M mode echocardiography is a reliable method in assessing LV systolic function. Patients with myocardial infarction, heart failure and cardiogenic shock with LV systolic dysfunction showed reduced MAPSE. As shown in Willenheimer et al<sup>17</sup> study MAPSE <6.4mm is associated with increased one - year mortality (36%) compared to MAPSE > 10mm. Nithin et al found 43.8% incidence of hospital admission and mortality in post myocardial infarction patients with MAPSE <8mm. In a 10 -year follow-up study on patients with heart failure, serum beta natriuretic peptide levels<sup>19</sup> and MAPSE showed very good association. TTE studies<sup>27</sup> in patients with normal LV morphology and motion showed, 90% sensitivity and 87% specificity of preserved LVEF >55% when MAPSE value of >10 mm and 98% sensitivity and 82% specificity with decreased LVEF of <50% when MAPSE was <8mm. Global LV longitudinal function assessed by MAPSE is simple and similar to tissue doppler velocity and speckle tracking of mitral annulus in patients with heart failure with normal or preserved LV ejection fraction. In adult males with LV dysfunction, as per a recent study, LV EF can be calculated by the following formula<sup>16</sup>:  
$$\text{LVEF} = 4.8 \times \text{MAPSE (mm)} + 5.8.$$

### **Myocardial deformation and strain imaging**

In left ventricular myocardium, the myocardial fibres are arranged in layers which forms a leftward and rightward, subepicardial and subendocardial helix respectively. This arrangement of fibres<sup>28</sup> imparts longitudinal motion (mitral annulus moving to apex), radial motion (epicardium towards endocardium) and circumferential motion (tangential to epicardium) during systole and diastole. This myocardial arrangement causes systolic shortening in longitudinal plane, thinning in circumferential and thickening in radial plane with inverse changes during diastole. Visualisation of heart from apex reveals clockwise rotation at the base and counter clockwise rotation at the apex of the LV during systole. Conventional 2D-TEE imaging falls short to delineate the 3D complex motion of the heart. Function of middle layer of the myocardium alone is displayed on 2D-TEE imaging, which can be assessed as endocardial excursion inwardly in mid-esophageal (ME) views and thickening in trans-gastric (TG) views. The effective myocardial contraction during

SCTIMST, Thiruvananthapuram.

systole is contributed significantly by radial thickening (40%) and longitudinal shortening (14%). The first impact of acute ischemic event<sup>29</sup> deteriorates longitudinal motion of the subendocardial layer of myocardium. However, ascertaining the longitudinal motion (ME views) and circumferential motion (TG views) may be difficult on 2DE. The assessment of myocardial deformation by STE overcomes most of these limitations.

### **Speckle tracking echocardiography (STE)**

By tracking of the denoted “speckles” the STE ascertains myocardial movement and deformation in echocardiographic images. The bright and dark pixels in standard B-mode images, which are known as “fingerprints” are consistently assigned to small regions of the myocardium. The inhomogeneous design of myocardial tissue produces peculiar constructive and destructive interference patterns of the speckles continuously in the cardiac cycle which can be tracked by the ultrasound signals<sup>30</sup>. Various parameters such as displacement, velocity, strain and strain rate within the predetermined myocardial segments are extracted by the software algorithm. Dependence on insonation angle of ultrasound beam, a major limitation of tissue doppler imaging, can be overcome by the STE strain quantification, which focuses on speckle displacement within the region of interest with respect to previous frames during the cardiac cycle. Therefore, the STE strain quantification remains independent of angle of insonation unlike the tissue doppler imaging. As the STE can measure deformation in two planes, it can perform strain quantification simultaneously in longitudinal and transverse planes at long axis views and radial and circumferential planes at short axis views. Tethering or translation artifacts are rarely encountered during STE strain quantification. Due to the tethering effect the ischemic myocardial segments contiguous with segments having normal contraction may also appear to have displacement and velocity. On the contrary the regional strain and strain rate

value is zero in the tethered segment in the absence of deformation<sup>31</sup>. Thus, lack of strain and SR in the tethered segments may discern between the active contraction and passive motion. Therefore, the STE may be considered the reference method for the measurement of myocardial strain as it is a robust parameter of myocardial deformation with permissible intra-observer variability and inter-observer variability.

### **Limitations of STE strain quantification**

Acquiring good echocardiographic images which determines the speckle tracking of endocardial borders correctly, limits strain quantification by STE. The accuracy of strain measurement is decreased due to inadequate tracking secondary due to complex 3D out of plane motion of the heart, acoustic shadowing and reverberation artifacts<sup>32</sup>. Operator based settings such as position of speckles at the region of interest (ROI) and defining endocardial borders also limits STE strain quantification. Though there are many limitations<sup>33</sup>, intraoperative myocardial function assessed by STE seems simple, easily reproducible and angle independent method of estimating strain.

### **Comparison of GLS with gold standard CMR method**

The gold standard method of evaluating cardiac chambers volumes and function is by Cardiovascular magnetic resonance (CMR) imaging. In a study done by Brown et al (40) reported that GLS is effective in measuring global LV function and has good correlation with LVEF measured on CMR than that of 2DE among patients with wall motion abnormalities. The global and regional LV strain as quantified with CMR has better reproducibility as reported in a study done by Aurish et al<sup>34</sup>.

### **Tissue Mitral Annular Displacement (TMAD):**

TMAD is a newer parameter introduced on recent echocardiographic platforms for the evaluation of longitudinal systolic function. Characteristically, the STE-TMAD measurement has an edge over other methods of longitudinal functional evaluation that it is not affected by endocardial definition and dropout artifacts of myocardium. Dai asada et al<sup>20</sup>, reported a significant correlation between LVEF and TMAD ( $r = 0.71$ ,  $p < 0.01$ ) and GLS and TMAD ( $r = -0.77$ ,  $p < 0.01$ ). This study shown that TMAD can

be useful in evaluating longitudinal systolic function of LV with no significant changes with heart rate and body surface area. In a study done in patients with non-ST elevation myocardial infarction by Poorzard et al<sup>35</sup>, reported that TMAD measurements correlates with the mortality in patients with occlusion of coronary arteries. Another retrospective study done by Song et al<sup>26</sup> in patients with sepsis induced cardiomyopathy, TMAD mid value of <9.75mm showed significant correlation with higher in-hospital and 28-day mortality. Majority of the studies evaluating the TMAD<sup>36</sup> were performed using TTE36 and studies based on intraoperative TEE are lacking.

### **Effect of Volatile anaesthetic agents or Propofol on myocardial protection**

Two standard induction regimens used commonly in CABG patients are based on sevoflurane or propofol. Many studies comparing the myocardial protection between these two regimens<sup>37-40</sup> had variable results. Sevoflurane based regimen seems to have better myocardial protection in CABG patients due to its anaesthetic preconditioning effects. In a study done by De Hert et al<sup>37</sup> compared the cardioprotective effects of sevoflurane with propofol in cardiac surgery showed decrease rise of myocardial injury biomarkers in first 36 postoperative hours in sevoflurane group. In the same study postoperative myocardial function was found better in elderly patients undergoing cardiac surgery with sevoflurane and desflurane based regimen than propofol based regimen. On the contrary, post operative troponin levels in patients undergoing CABG, isoflurane based<sup>38</sup> regimen did not had any benefit compare to propofol regimen with use of opioids in both groups. A multicentric randomized trial done by Landoni et al<sup>39</sup> in cardiac surgery patients concluded no significant difference in duration of ICU stay or mortality between sevoflurane and propofol group. Sevoflurane based regimen did not decrease the incidence of myocardial ischemia in patients undergoing major noncardiac surgery compared to propofol based regimen as reported by Lurati et al<sup>40</sup>.

Meta-analysis done by Feng li et al<sup>41</sup> in 15 randomized controlled trials (RCT), found sevoflurane-based anaesthesia had more cardioprotective effects than propofol based anaesthesia in patients undergoing cardiac surgery. A meta- analysis done among cardiac surgery patients by Yao el at<sup>42</sup> showed volatile based regimens were superior to propofol based regimens in reducing mortality and giving better myocardial protection. Another meta-analysis done by Beverstock et al<sup>43</sup> found no significant difference in

mortality, 24 hour cardiac biomarker levels postoperatively and time to tracheal extubation between sevoflurane and propofol groups.

### **Effect of Sevoflurane and Propofol on 2D STE derived strain values**

Intraoperative studies comparing sevoflurane and propofol regimens on 2D STE derived strain values are limited. Chennakeshavullu et al<sup>44</sup> found no significant difference in sevoflurane and propofol groups in CABG patients on 2D STE derived GLS values. As per study done by Coleman et al<sup>45</sup> propofol based anaesthesia did not reduce systolic function as measured by GLS in elective endoscopic surgeries.

MAPSE is a routinely used parameter in the assessment of longitudinal function of LV, whereas speckle tracking TMAD is a relatively new parameter that ascertains LV longitudinal function. We compared both parameters with speckle tracking -guided GLS, which is an established parameter for LV longitudinal function assessment and treated as a reference parameter in our study. Both propofol and sevoflurane have different effects on LV longitudinal function. Hence, we compared MAPSE and TMAD with GLS when patients received two different anaesthetic regimens. TMAD may be an easy and reliable way to assess mitral annular movements than M-MODE MAPSE. There are several limitations of MAPSE such as interobserver variations. Studies published in international literature on this topic are very few. There are no published studies comparing MAPSE and TMAD in the intraoperative setting from India and also from our institute.

## MATERIALS AND METHODS

Approval from institutional ethics committee (IEC) was taken prior to the starting of the study. IEC approval number was SCT / IEC/ 1890 / May -2022. Our study was also registered with Clinical Trials Registry – India (CTRI) with number CTRI / 2023/ 02/ 049598 on 09/02/2023. Informed consent was obtained from all patients regarding the conduct of study. All patients were thoroughly examined during pre-anaesthetic evaluation and educated regarding study protocol.

This prospective randomised study was conducted in adult elective CABG surgical patients. Comparison was made between Group S (Sevoflurane group) and Group P (Propofol group) with 44 patients in each group. Study was done in a tertiary referral centre, a university level hospital, annually performing more than 1500 cardiac operations. Adult patients in sinus rhythm coming for elective CABG under cardio pulmonary bypass (CPB), between age group of 18 to 70 years, were included in this study. Patients with other associated complex anomalies, more than mild valvular heart diseases, with severe mitral annular calcification and those with contraindication to TEE probe placement were excluded from the study. Patient with poor 2D & 3D image quality and those coming for emergency and redo surgeries were also excluded from the study. Randomization was done by computer generated numbered, sealed, opaque envelope to assign patients to one of the following group: Sevoflurane group and Propofol group.

Patients was selected on previous day during our pre-anaesthetic check-up and educated on the study in the presence of a witness. The witness could counter question the patient whether he/she really understood the proposed study, of which he/she was a part. Patients undergoing adult elective cardiac surgery were consecutively recruited and randomized into two groups (Group S: Sevoflurane group or Group P: Propofol group). Patients were advised to continue all medications except oral hypoglycaemic drugs, insulin, angiotensin - converting enzyme inhibitors and angiotensin - receptor blockers. Angiotensin-converting enzyme inhibitors and Angiotensin - receptor blockers were stopped 48hours prior to surgery. Insulin and oral hypoglycaemic drugs were stopped on the morning of surgery. Oral diazepam 5-10 mg was administered for sedation the night before the day of surgery.

The induction of general anaesthesia in the Sevoflurane group (S-Group) was with fentanyl (5-10 mcg/kg), midazolam (0.1 mg/kg), pancuronium (0.1 mg/kg) and sleep dose of propofol (0.5 to 1mg/kg). Anaesthesia was maintained with sevoflurane with 0.5 to 1 minimum

alveolar concentration (MAC) throughout the procedure, including CPB, and was guided using bi-spectral index (BIS) values which was maintained between the range of 40 - 50. During CPB, sevoflurane was administered in the oxygenator circuit through a calibrated vaporizer. Fentanyl was administered to avoid changes of MAP within 20% from baseline but not less than 65 mm Hg. Patients in propofol group (P-Group) received TIVA throughout the surgery. Propofol (1-2 mg/kg), fentanyl (5-10 mcg/kg), midazolam (0.1 mg/kg) and pancuronium (0.1 mg /kg) was used for anaesthesia induction. General anaesthesia was maintained with propofol infusion (50-100µg/kg/min) throughout the procedure including CPB. Intermittent fentanyl boluses (to a total dose of 20mcg/kg/min) were administered to avoid changes of MAP within 20% from baseline but not less than 65mmHg. BIS was maintained in the range of 40- 50. No volatile anaesthetic was administered at any time during the procedure.

In both groups during pre-CPB period, any hypertension or hypotension was treated with nitro-glycerine infusion or phenylephrine boluses, respectively to a target MAP of >65mmHg. Patients requiring repeated boluses of phenylephrine were treated with noradrenaline infusion (0.05 - 0.1 mcg/kg/min). All patients were mechanically ventilated with volume control ventilation mode. Intraoperative continuous monitoring in both groups included 5-lead electrocardiography with ST analysis, heart rate, invasive blood pressure, pulse oximetry, body temperature, respiratory gas monitoring, central venous pressure and BIS. All patients underwent coronary artery bypass grafting with CPB using heart lung machines with a roller pump for non-pulsatile perfusion and membrane oxygenators with a flow appropriate for the core temperature. Electromechanical quiescence was achieved using intermittent antegrade cold blood cardioplegia.

At CPB weaning, if MAP < 65 mm Hg and TEE guided left ventricular outflow tract (LVOT) cardiac index (CI) >2L/min/m<sup>2</sup>, phenylephrine boluses of 1 - 2 mcg/kg were given. If desired targets were not achieved, despite repeated boluses, norepinephrine was added (starting dose of 0.05mcg/kg/min). Inotropes were administered only if contractility was found reduced on echocardiography. At the end of the surgical procedure, patients were transferred to the intensive care unit, where they were kept sedated with a continuous infusion of 20 mcg/kg of morphine. When hemodynamically stable and rewarmed, the patients were weaned from the ventilator and trachea was extubated. The study data was manually entered in the study chart as documented in annexure.

## **Echocardiographic protocols**

After anaesthesia induction Real time 3dimensional trans-oesophageal echocardiography (RT-3D-TEE) probe was inserted and heart was inspected using 3D echocardiography system IE33, Philips Medical Systems, Andover, MA, USA. Data was acquired from mid-esophageal four-chamber view, two-chamber view, three-chamber view focussed on LV and aortic valve. Mitral annular movement both in lateral and septal area was evaluated using M mode to measure MAPSE and tissue doppler imaging to measure mitral annular velocity. All images were acquired with 2D frame rate more than 50 frames / sec after optimizing gain and compression as describe by the European guidelines 2015 for speckle tracking. For tissue doppler the frame was narrowed to acquire frame rate >120. During MAPSE and tissue doppler measurements the movement of the mitral valve annulus was maintained as much parallel as possible to ultrasound beam (<15 degree). For MAPSE measurement the values were averaged between septal and annular motions and they were compared with the long axis length of the LV in diastole, acquired in two-chamber view. MAPSE was also measured in deep trans-gastric long axis view and higher value measured between ME and TG views was considered. LVEF was measured using modified Simpson's method in X - plane mode.

During measurement for TMAD the ME four-chamber loop and two-chamber loop were opened using Q-Lab (Version 7.0, Philips Medical systems, USA) and through cardiac motion quantification (CMQ) inbuilt software. In four-chamber view, at the origin of mitral valve leaflets, the acoustic markers were selected manually in the region of interest (ROI) at the septal and lateral parts and in two-chamber view at the anterior and inferior parts. The third ROI was placed at the apex of the LV. The movement of mitral annulus towards apex was automatically tracked by software and measurements were calculated as the average of base to apex displacement of both annulus in millimetre and the midpoint between the ROI. Midpoint displacement with respect to LV length at end-diastole was measured as percentage TMAD. The mean of three cardiac cycles of three measurements was recorded for analysis.

The GLS was measured after opening four-chamber, three-chamber and two-chamber loops in CMQ. The endocardial borders were adjusted manually as required. GLS value and bull's eye representation was displayed by the system. Offline analysis was performed from the acquired data. All echocardiographic images were transferred from the ultrasound system to a portable hard disc by the principle or coinvestigator in Diacom format. Patient details, date

of study performed and institute details were kept confidential before transferring to the hard disc.

This prospective randomized trial consisted of Group S: Sevoflurane anaesthesia group and Group P: Propofol anaesthesia group having 44 patients each. The sample size was calculated assuming with 80% power and based on an expected sample correlation of 0.70 and hypothesized correlation of 0.50 between the two methods of assessing LV systolic function. To conclude statistical significance at 5% level, the sample size of 88 was required. To assess the difference between the two treatment groups it is decided to take 44 in each group.

To compare the difference between the two anaesthesia regimens quantitative variables were summarised with mean and standard deviation. Categorical variables were expressed as frequency and percentage. Statistical comparisons were attempted using Chi-square test or Fisher's exact test for categorical variables and t-tests for continuous variables. Association between continuous variables were assessed by Pearson correlation. P value less than 0.05 was considered statistically significant. Data analysis was performed using SPSS version 21.0. Our study results obtained were shown as tables and graphs.

## RESULTS

In our study out of 104 patients eligible, we included 88 patients, randomised by computer generated sequencing into two groups Group S (Sevoflurane group) and Group P (Propofol group) with 44 in each group. 16 patients were excluded from study in which ten patient images could not be analysed, two patients had atrial fibrillation post-CPB and four patients needed pacing post- CPB.

Figure 3: Consort diagram showing patient selection.

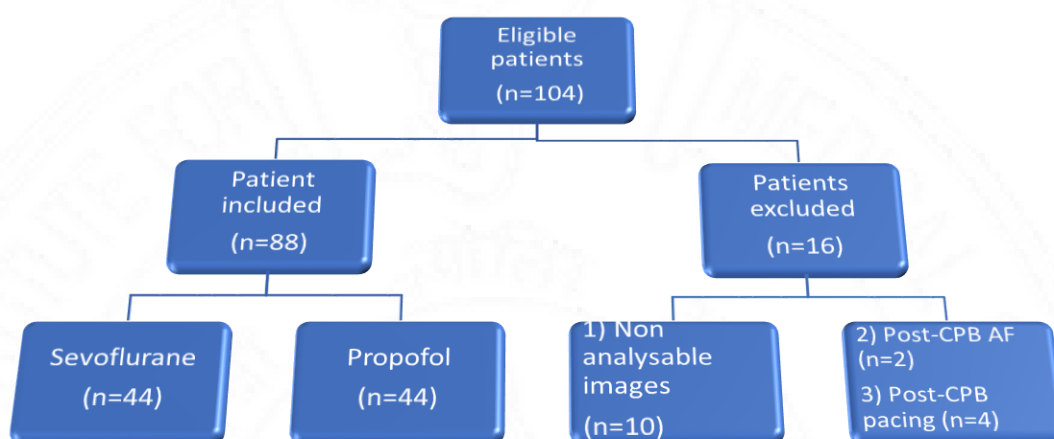


Figure 3 shows consort diagram explaining patient selection. Total patients eligible were 104. 16 patients were excluded from study in which images could not be analysed 10 patients: 2 patients had atrial fibrillation in the post-CPB period and 4 of them need pacing in the post-CPB. 88 patients included in the study were distributed equally (44 each) between sevoflurane and propofol groups.

The mean  $\pm$  SD of percentage TMAD (%) in four-chamber view in pre-CPB and post-CPB period was  $11.4 \pm 1.8$  and  $11.3 \pm 1.4$  in sevoflurane group and  $11.7 \pm 1.8$  and  $12 \pm 1.7$  in propofol group. The mean  $\pm$  SD of average MAPSE (mm) in four-chamber view in pre-CPB and post CPB period was  $11.4 \pm 1.6$  and  $11.5 \pm 1.6$  in sevoflurane group and  $11.5 \pm 2.1$  and  $14 \pm 1.8$  in propofol group. The mean  $\pm$  SD of average mitral annular velocity by TDI (m2) in pr-CPB and post-CPB period was  $7.8 \pm 1.2$  and  $8.6 \pm 1.3$  in sevoflurane group and  $8.0 \pm 1.0$  and  $8.2 \pm 1.2$  in propofol group. The mean  $\pm$  SD of GLS % in four-chamber view in pre-CPB and post-CPB period was  $-13.6 \pm 5.2$  and  $-15.0 \pm 4.0$  in sevoflurane group and  $-12.4 \pm 6.8$  and  $-13.4 \pm 5.5$  in propofol group.

Table 1: Demographic parameters between the study groups.

Demographic parameter	Study group (Mean ± SD)		p value
	Sevoflurane	Propofol	
Age (years)	61 ± 7.9	59.7 ± 7.2	0.416
BSA (m <sup>2</sup> )	1.7 ± 0.1	1.7 ± 0.1	0.766
Height (cm)	161.8 ± 4.4	161.8 ± 5.1	0.982
Weight (Kg)	69.7 ± 4.6	69.2 ± 6.2	0.655

Conclusion: Table 1 shows that there was no significant differences in the demographic or baseline characteristics between the two groups.

Abbreviation: Body Surface Area:-BSA.

Figure 4: Gender distribution among the study groups.

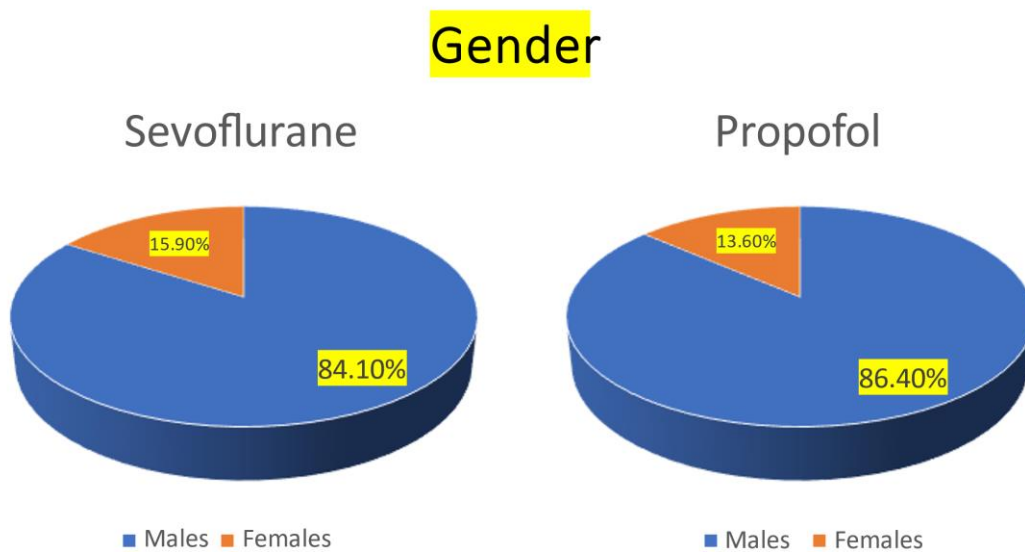


Figure 4 shows pie diagram of gender distribution between the study groups. Both groups had predominantly male patients as participants.

Table 2: Comorbidities among the two study groups

Sl. No	Comorbidity	Sevoflurane	Propofol	P value
1	Hypertension	77.3%	72.7%	0.622
2	Dyslipidemia	40.9%	25%	0.112
3	Diabetes mellitus	75%	59.1%	0.112
4	Cardiovascular accident	13.6%	2.3%	0.049*
5	Chronic Kidney disease	4.5%	0%	0.153
6	Hypothyroidism	7%	4.6%	0.295
7	Peripheral Occlusive vascular disease	6.8%	4.5%	0.645

Conclusion: Table 2 shows no significant difference in the comorbidities between the two groups except more incidence of cerebrovascular accident (CVA) in sevoflurane group.

\* Indicates p value of < 0.005.

Table 3: Comparison of mean of hemodynamic parameters in the Pre-CPB and Post-CPB period between study groups (n=44)

PARAMETER	Pre-CPB data		p value	Post-CPB		p value
	Sevoflurane	Propofol		Sevoflurane	Propofol	
HR (beats/min)	70.7 ± 10.2	66.1 ± 9.7	0.032	75.5 ± 9.7	75.0 ± 8.9	0.802
SBP (mmHg)	148.0 ± 28.5	156.5 ± 34.4	0.205	121.3 ± 10.5	122.1 ± 9.1	0.690
DBP (mmHg)	85.7 ± 14.2	86.4 ± 15.1	0.828	68.1 ± 9.1	68.9 ± 10.0	0.706
MBP (mmHg)	99.9 ± 19.5	106.3 ± 22.3	0.154	79.0 ± 8.2	80.0 ± 8.6	0.580
SpO2 %	98.6 ± 0.7	98.8 ± 1.0	0.144	98.6 ± 0.7	98.8 ± 1	0.144
CVP (mmHg)	7.9 ± 1.5	7.3 ± 1.5	0.071	6.5 ± 1.3	6.7 ± 1.9	0.558

**Conclusion:** Table 3 shows there was no significant difference in the mean of hemodynamic characteristics between the two groups during Pre-CPB and Post-CPB periods.

Table 4: Comparison of CPB time and ACC time between the groups.

Time in minutes	Sevoflurane	Propofol	P value
CPB	116.8 ± 13.3	118.2 ± 15	0.653
ACC	66.3 ± 11.3	67.1 ± 12.9	0.766

Conclusion: Table 4 shows that there was no significant difference in CPB time and ACC time between the groups.

CPB :-Cardiopulmonary bypass, ACC :- Aortic cross clamp.

Table 5: Comparison of Post-CPB values of selected variables.

Parameter	Sevoflurane	Propofol	P value
	Mean ± SD	Mean ± SD	
Heart Rate (beats/ min)	74.5 ± 12.1	74.9 ± 10.5	0.858
Systolic Blood Pressure (mmHg)	117.1 ± 11.6	120.0 ± 12.1	0.242
Diastolic Blood Pressure (mmHg)	63.7 ± 8.7	68.8 ± 8.3	0.006*
Mean arterial pressure (mmHg)	74.9 ± 8.1	78.5 ± 8.3	0.043*
Central Venous Pressure (mmHg)	6.6 ± 1.6	7.1 ± 2.4	0.246
Hemoglobin (gm / dl)	9.9 ± 0.7	9.7 ± 0.8	0.178
LVOT diameter (cm)	19.6 ± 1.3	19.6 ± 1.0	0.928
LVOT cross sectional area (cm <sup>2</sup> )	3. 2 ± 2.3	3.0 ± 0.4	0.566
LVOT VTI (cm)	18.7 ± 5.1	20.5 ± 5.0	0.099
LVOT stroke volume (ml)	60.0 ± 13.7	63.9 ± 8.2	0.107
LVOT cardiac output (l/min)	4.9 ± 1.3	4.7 ± 1.1	0.592
LVOT Cardiac Index (ml/m <sup>2</sup> )	2.8 ± 0.7	2.7 ± 0.6	0.686

Conclusion: Table 5 shows that there was no significant difference in immediate post-CPB values between the groups except that the mean and diastolic blood pressures were better in propofol group. CPB - cardiopulmonary bypass

Table 6: Comparison of 2DE and STE parameters in the Pre-CPB and Post-CPB period in Sevoflurane group ( $n = 44$ ).

PARAMETER		Sevoflurane group		<i>p</i> value
		Pre-CPB data	Post-CPB data	
LV EF %		60.3 ± 3.3	60.6 ± 3.0	0.563
MAPSE (mm)	Lateral	12 ± 2.1	12.0 ± 2.1	0.962
	Septal	11.1 ± 1.7	10.9 ± 1.6	0.443
	Average	11.4 ± 1.6	11.5 ± 1.6	0.969
Tissue doppler velocity (cm/s)	Lateral	8.2 ± 1.6	8.7 ± 1.7	0.222
	Septal	7.4 ± 1.1	8.5 ± 1.4	0.010*
	Average	7.8 ± 1.2	8.6 ± 1.3	0.012*
TMAD 4C (mm)	Lateral	9.0 ± 1.9	8.7 ± 1.5	0.365
	Septal	8.0 ± 2.2	8.4 ± 1.3	0.332
	Midpoint	8.0 ± 1.7	8.2 ± 1.2	0.425
	Percentage	11.4 ± 1.8	11.3 ± 1.4	0.664
TMAD 2C (mm)	Anterior	8.7 ± 2.0	9.0 ± 2.2	0.499
	Inferior	8.1 ± 2.2	8.7 ± 1.9	0.208
	Midpoint	8.5 ± 1.7	8.4 ± 1.6	0.786
	Percentage	11.5 ± 1.8	12 ± 1.3	0.157
GLS % 4C	Lateral	-12.3 ± 5.4	-13.5 ± 3.3	0.209
	Septal	-12.3 ± 6.9	-15.8 ± 4.3	0.002*
	Regional	-13.6 ± 5.2	-15 ± 4.0	0.135
GLS % 2C	Lateral	-12.2 ± 3.9	-13.3 ± 4.4	0.197
	Septal	-12.2 ± 6.4	-12.3 ± 5.5	0.906
	Regional	-12.3 ± 5.0	-13.0 ± 4.3	0.516
GLS % 3C	Lateral	-13.3 ± 5.4	-13.3 ± 4.3	0.800
	Septal	-12.6 ± 5.1	-13.2 ± 3.6	0.456
	Regional	-12.0 ± 3.6	-13.3 ± 3.3	0.109
Final GLS %		-14.0 ± 3.4	-14.9 ± 2.7	0.120

Conclusion: Table 6 shows that there is no significant difference in the 2D transoesophageal, doppler echocardiographic parameters and TMAD characteristics between the Pre-CPB and Post-CPB in sevoflurane group.

Except septal and average tissue doppler velocities and septal GLS % in 4C view were significant in post-CPB period.

Table 7: Comparison of 2DE and STE parameters in the Pre-CPB and Post-CPB period in Propofol group (n =44).

PARAMETER		PROPOFOL		p value
		Pre-CPB data	Post-CPB data	
LV EF %		59 ± 3.7	59.3 ± 3.6	0.372
MAPSE (mm)	Lateral	11.9 ± 2.4	11.8 ± 2.0	0.662
	Septal	10.9 ± 2.2	10.7 ± 2.1	0.250
	Average	11.5 ± 2.1	11.4 ± 1.8	0.600
Tissue doppler velocity (cm/s)	Lateral	8.4 ± 1.2	8.8 ± 1.4	0.012*
	Septal	7.6 ± 0.9	7.7 ± 1.3	0.719
	Average	8.0 ± 1.0	8.2 ± 1.2	0.099
TMAD 4C (mm)	Lateral	8.7 ± 1.6	8.6 ± 1.7	0.508
	Septal	8.4 ± 1.8	8.6 ± 1.9	0.115
	Midpoint	8.1 ± 1.6	8.4 ± 1.7	0.010*
	Percentage	11.7 ± 1.8	12.0 ± 1.7	0.003*
TMAD 2C (mm)	Anterior	9.0 ± 2.1	9.1 ± 2.1	0.233
	Inferior	9.3 ± 2.5	9.4 ± 2.5	0.156
	Midpoint	8.7 ± 2.0	9.0 ± 2.1	0.002*
	Percentage	12 ± 1.7	12.3 ± 1.6	0.010
GLS % 4C	Lateral	-13.3 ± 6.5	-13.5 ± 4.3	0.769
	Septal	-13.4 ± 8.7	-14.5 ± 5.1	0.272
	Regional	-12.4 ± 6.8	-13.4 ± 5.5	0.194
GLS % 2C	Lateral	-12.8 ± 5.2	-13.0 ± 6.2	0.856
	Septal	-12.9 ± 7.0	-10.5 ± 7.1	0.096
	Regional	-12.3 ± 3.6	-11.6 ± 5.2	0.469
GLS % 3C	Lateral	-12.9 ± 4.1	-13.0 ± 5.2	0.901
	Septal	-13.5 ± 4.0	-12.7 ± 4.6	0.325
	Regional	-11.4 ± 3.9	-12.7 ± 4.8	0.106
Final GLS %		-14.1 ± 3.4	-14.0 ± 3.1	0.885

Conclusion: Table 7 shows there was no significant difference in the 2D transoesophageal, doppler echocardiographic parameters and TMAD characteristics between the Pre-CPB and Post-CPB in Propofol group except percentage TMAD in 4C view and midpoint and percentage TMAD in 2C view were better in post-CPB period.

Table 8: Comparison of 2DE and STE parameters in the Pre-CPB period between the study groups (n=44).

PARAMETER		Study group		p value
		Sevoflurane	Propofol	
LV EF %		60.3 ± 3.3	59 ± 3.7	0.088
MAPSE (mm)	Lateral	12 ± 2.1	11.9 ± 2.4	0.859
	Septal	11.1 ± 1.7	10.9 ± 2.2	0.604
	Average	11.4 ± 1.6	11.5 ± 2.1	0.982
Tissue doppler velocity (cm/s)	Lateral	8.2 ± 1.6	8.4 ± 1.2	0.635
	Septal	7.4 ± 1.1	7.6 ± 0.9	0.369
	Average	7.8 ± 1.2	8.0 ± 1.0	0.470
TMAD 4C (mm)	Lateral	9.0 ± 1.9	8.7 ± 1.6	0.412
	Septal	8.0 ± 2.2	8.4 ± 1.8	0.313
	Midpoint	8.0 ± 1.7	8.1 ± 1.6	0.751
	Percentage	11.4 ± 1.8	11.7 ± 1.8	0.502
TMAD 2C (mm)	Anterior	8.7 ± 2.0	9.0 ± 2.1	0.432
	Inferior	8.1 ± 2.2	9.3 ± 2.5	0.022*
	Midpoint	8.5 ± 1.7	8.7 ± 2.0	0.631
	Percentage	11.5 ± 1.8	12 ± 1.7	0.188
GLS % 4C	Lateral	-12.3 ± 5.40	-13.3 ± 6.5	0.424
	Septal	-12.3 ± 6.9	-13.4 ± 8.7	0.507
	Regional	-13.6 ± 5.2	-12.4 ± 6.8	0.108
GLS % 2C	Lateral	-12.2 ± 3.9	-12.8 ± 5.2	0.582
	Septal	-12.2 ± 6.4	-12.9 ± 7.0	0.612
	Regional	-12.3 ± 5.0	-12.3 ± 3.6	0.980
GLS % 3C	Lateral	-13.0 ± 5.4	-12.9 ± 4.1	0.947
	Septal	-12.6 ± 5.1	-13.5 ± 4.0	0.323
	Regional	-12.0 ± 3.6	-11.4 ± 3.9	0.480
Final GLS %		-14.0 ± 3.4	-14.1 ± 3.4	0.802

Conclusion: Table 8 shows that there was no significant difference in the 2D transoesophageal, doppler echocardiographic parameters and TMAD characteristics in pre-CPB period between the two groups except septal TMAD in 2C view.

Table 9: Comparison of 2DE and STE parameters in the Post-CPB period between the study groups (n=44).

PARAMETER		Study group		p value
		Sevoflurane	Propofol	
LV EF %		60.6 ± 3.0	59.3 ± 3.6	0.077
MAPSE (mm)	Lateral	12.0 ± 2.1	11.8 ± 2.0	0.742
	Septal	10.9 ± 1.6	10.7 ± 2.1	0.746
	Average	11.5 ± 1.6	11.4 ± 1.8	0.832
Tissue doppler velocity (cm/s)	Lateral	8.7 ± 1.7	8.8 ± 1.4	0.771
	Septal	8.5 ± 1.4	7.7 ± 1.3	0.008*
	Average	8.6 ± 1.3	8.2 ± 1.2	0.219
TMAD 4C (mm)	Lateral	8.7 ± 1.5	8.6 ± 1.7	0.889
	Septal	8.4 ± 1.3	8.6 ± 1.9	0.614
	Midpoint	8.2 ± 1.2	8.4 ± 1.7	0.570
	Percentage	11.3 ± 1.4	12.0 ± 1.7	0.031
TMAD 2C (mm)	Anterior	9.0 ± 2.2	9.1 ± 2.1	0.790
	Inferior	8.7 ± 1.9	9.4 ± 2.5	0.152
	Midpoint	8.4 ± 1.6	9.0 ± 2.1	0.133
	Percentage	12 ± 1.3	12.3 ± 1.6	0.335
GLS % 4C	Lateral	-13.5 ± 3.3	-13.5 ± 4.3	1.000
	Septal	-15.8 ± 4.3	-14.5 ± 5.1	0.218
	Regional	-15 ± 4.0	-13.4 ± 5.5	0.108
GLS % 2C	Lateral	-13.3 ± 4.4	-13.0 ± 6.2	0.798
	Septal	-12.3 ± 5.5	-10.5 ± 7.1	0.190
	Regional	-13.0 ± 4.3	-11.6 ± 5.2	0.171
GLS % 3C	Lateral	-13.3 ± 4.3	-13.0 ± 5.2	0.823
	Septal	-13.2 ± 3.6	-12.7 ± 4.6	0.554
	Regional	-13.3 ± 3.3	-12.7 ± 4.8	0.505
Final GLS %		-14.9 ± 2.7	-14.0 ± 3.1	0.190

**Conclusion:** Table 9 shows that there is no significant difference in the 2D transoesophageal, doppler echocardiographic parameters and TMAD characteristics between the two groups in Post CPB except septal Tissue doppler velocities and percentage TMAD in 4C view.

Table 10: Pearson correlation of Midpoint TMAD 4C Post-CPB with other methods of assessment of LV systolic function.

Midpoint TMAD 4C Post-CPB		R value	P value
Sevoflurane	MAPSE average Post-CPB	0.879	<0.001
	Average TDV Post-CPB	0.803	<0.001
	LVEF % Post-CPB	0.527	<0.001
	Final GLS % Post-CPB	- 0.697	<0.001
Propofol	MAPSE average Post-CPB	0.775	<0.001
	Average TDV Post-CPB	0.561	<0.001
	LVEF % Post-CPB	0.572	<0.001
	Final GLS % Post-CPB	- 0.897	<0.001

Conclusion: Table 10 shows midpoint TMAD in four-chamber had strong positive correlation with average of MAPSE, average of tissue doppler velocity (TDV), and strong negative correlation with GLS % in both groups in post-CPB period. LVEF had moderate positive correlation in both groups.

Table 11: Pearson correlation coefficient ranges and inference.

Sl.No	Pearson correlation coefficient	Inference
1	-0.01 to 0.01	No correlation
2	-0.3 to -0.1	weak negative correlation
3	0.1 to 0.3	weak positive correlation
4	-0.6 to -0.3	moderate negative correlation
5	0.3 to 0.6	moderate positive correlation
6	> 0.6	strong positive correlation
7	< - 0.6	strong negative correlation

Pearson correlation coefficient ranges from -1 to +1

Table 12: Time taken for calculating TMAD and GLS using Q-lab with CMQ software.

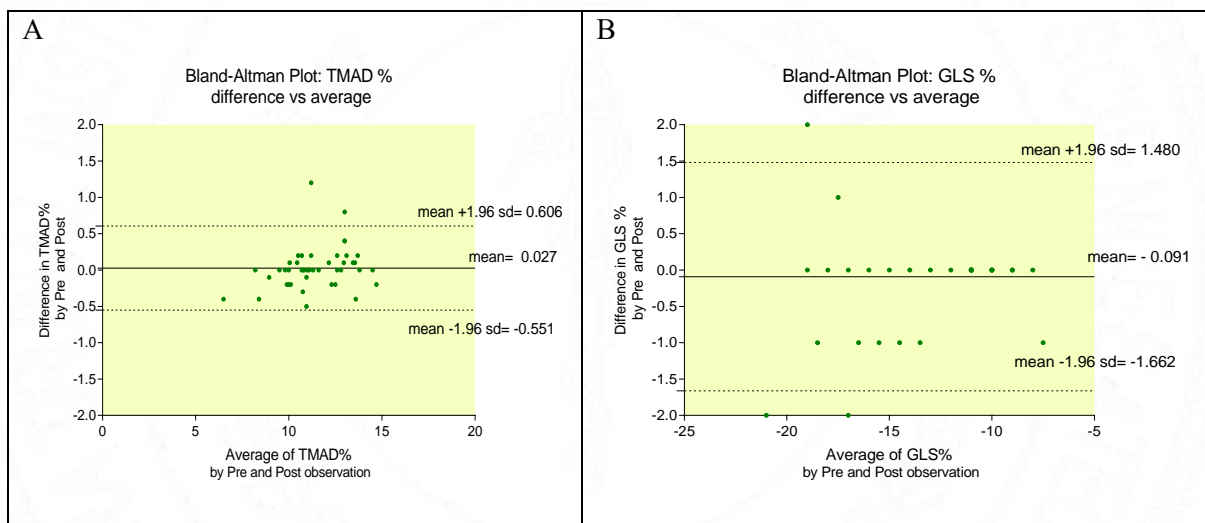
Sl.No	Parameter	Average time (Seconds)
1	TMAD	15.3
2	GLS	70.3

Table 13: Intra-observer and inter-observer variability between TMAD 4C percentage and GLS %

Sl. No	Parameter	Intra-observer variability	Inter-observer variability
1	Percentage TMAD %	0.9864*	0.9641*
2	GLS %	0.9713*	0.9652*

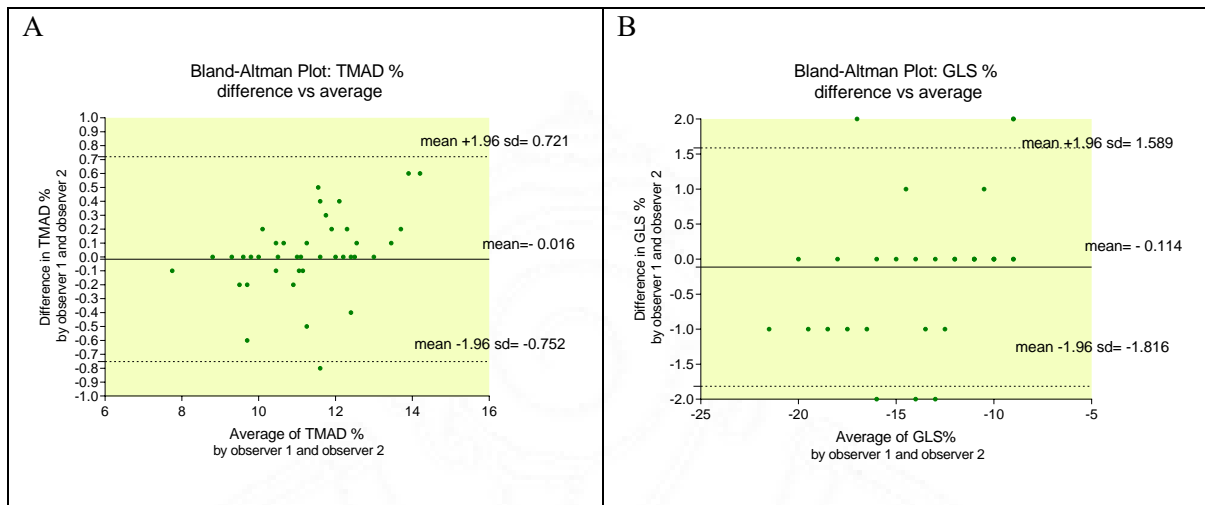
### Intra-observer and Inter-observer variability

Figure 5 : Intra-observer Bland-Altman plots of TMAD % and GLS%.



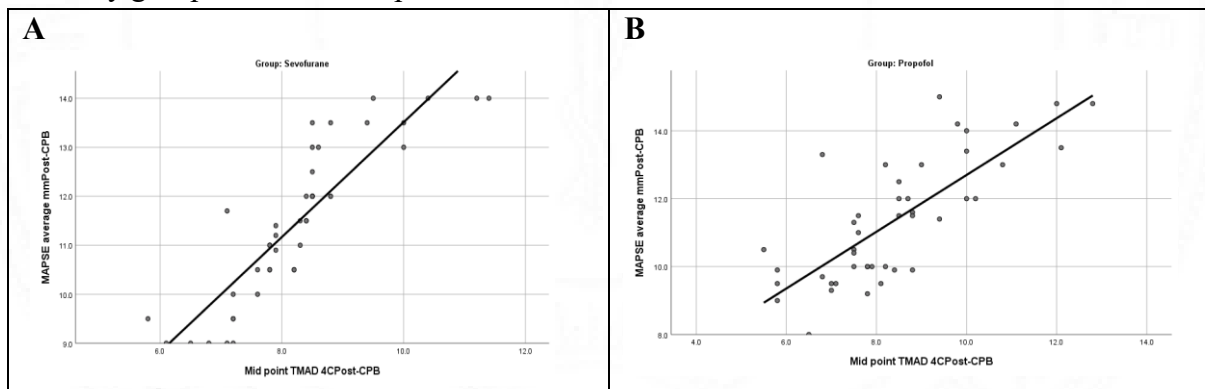
The Bland–Altman plots of intra-observer variability as shown in figure 5 comparing the difference of parameter (TMAD% and GLS%) with its average. This shows that the differences between the measurements observed were dispersed around the mean, with the majority staying within the limits of agreement (-0.551 to 0.606 in TMAD % and -1.662 to 1.480 in GLS%). The mean difference between the two measurements was found to be statistically significant, with a coefficient of variation of 0.9864 in %TMAD and 0.9713 in GLS %.

**Figure 6: Inter-observer Bland-Altman plots of TMAD % and GLS%.**



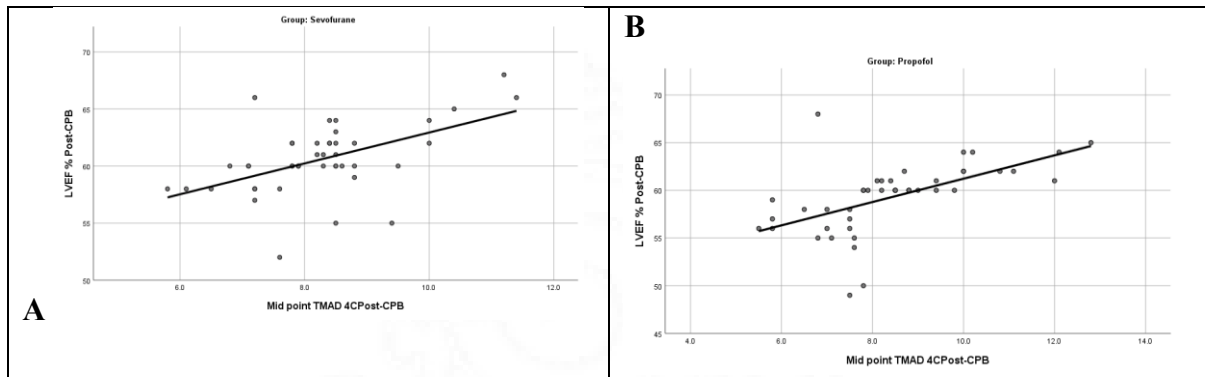
The Bland–Altman plots of inter-observer variability as shown in figure 6 comparing the difference of parameter (TMAD% and GLS%) with its average. This shows that the differences between the measurements observed were dispersed around the mean, with the majority staying within the limits of agreement (-0.752 to 0.721 in TMAD % and -1.868 to 1.589 in GLS%). The mean difference between the two measurements was found to be statistically significant, with a coefficient of variation of 0.9641 in %TMAD and 0.9652 in GLS %.

**Figure 7: Scatter plot showing correlation between TMAD 4C and MAPSE (average) between the study groups in Post-CPB period.**



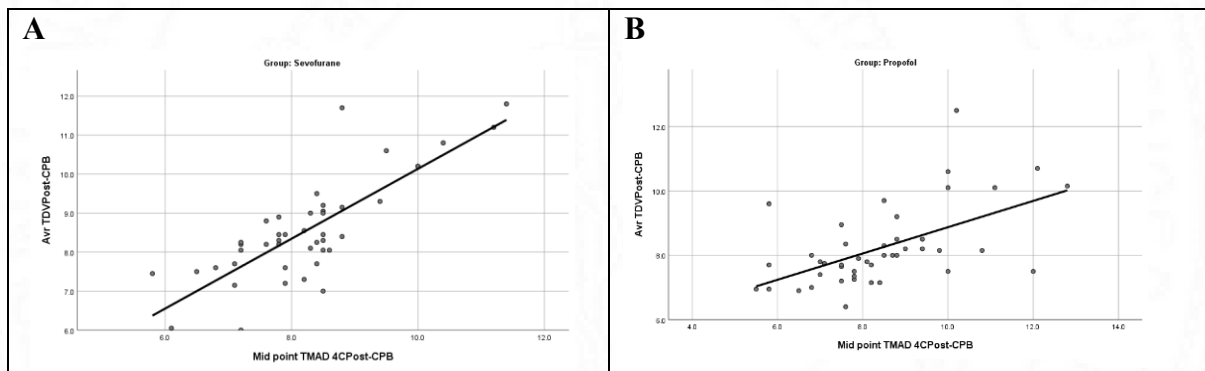
Scatter plot in figure 7 shows correlation between TMAD 4C and MAPSE (average) in post-CPB period. Upward direction of the trend line showing Positive correlation between the parameters in both the study groups.

Figure 8: Scatter plot showing correlation between TMAD 4C and LVEF % between the study groups in Post-CPB period.



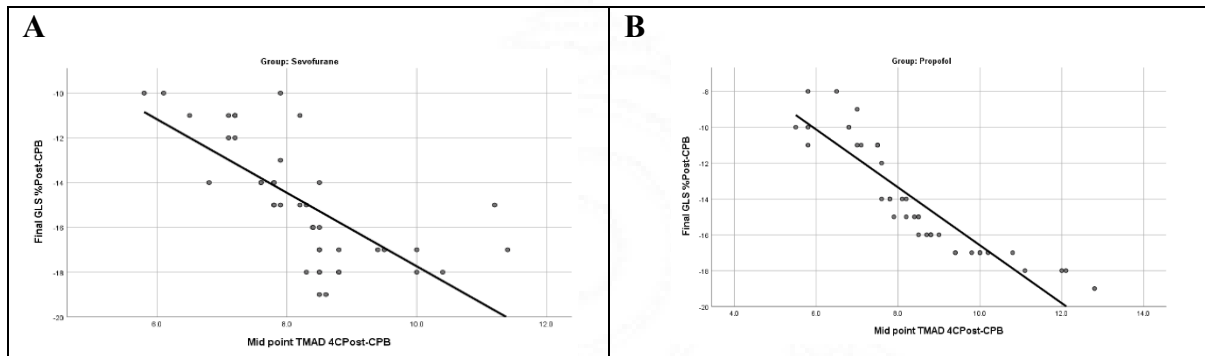
Scatter plot in figure 8 shows correlation between TMAD 4C and LVEF % in post-CPB period. Upward direction of the trend line showing Positive correlation between the parameters in both the study groups.

Figure 9: Scatter plot showing correlation between TMAD 4C and average tissue doppler velocity of mitral annulus between the study groups in Post-CPB period.



Scatter plot in figure 9 shows correlation between TMAD 4C and average tissue doppler velocity of mitral annulus in post-CPB period. Upward direction of the trend line showing Positive correlation between the parameters in both the study groups.

Figure 10: Scatter plot showing correlation between TMAD 4C and GLS % between the study groups in Post-CPB period.



Scatter plot in figure 10 showing correlation between TMAD 4C and GLS% in post-CPB period. Downward direction of the trend line showing Negative correlation between the parameters in both the study groups.

## Discussion

This prospective randomized study was done in patients undergoing CABG, where the effects of sevoflurane and propofol on MAPSE, MAV by TDI, GLS and TMAD were compared at equal anesthetic doses monitored by BIS. Throughout the surgery (including CPB) patients received either sevoflurane or propofol to maintain BIS value of 40 to 50. All adult patients with CAD having good LVEF > 55% and in sinus rhythm were included in our study. The following echocardiographic parameters MAPSE, LVEF, MAV by TDI, GLS and TMAD were compared between the groups and within the group in both pre-CPB and Post-CPB period. The baseline values for CVP, SBP and MAP were maintained within 20 % of the limits, as myocardial strain is affected by loading conditions. During CABG, LV systolic function can be influenced by many factors like patient age, BSA, extent of CAD, severity of LV dysfunction, number and quality of grafts, cardioplegia solution, duration of CPB and aortic cross clamp time. In our study there was no significant difference in the patient demographic characteristics or surgery and CPB related factors. In our study the cardioprotective effect of opioids was similar as the dosage of fentanyl given was same.

The use of conventional echocardiographic techniques for assessment of LV systolic function are LVEF, MAPSE, TDI of MAV and GLS have been well studied and published. TMAD, a new method, for assessing LV systolic function by TEE is not commonly used in intraoperative period. Commonly used WMSI has many limitations like operator dependent and highly subjective scoring. LVEF is affected only when significant number of myocardial fibers are dysfunctional. So, it may not predict early longitudinal LV systolic dysfunction. Hence strain quantification is more valuable in assessing different types of LV contractile forces.

At present, methods used for myocardial strain quantification are TDI of mitral annular velocity and GLS by STE. TDI strain cannot quantify the mid and apical segments of LV due to its angle dependency. STE strain assessment being angle independent gives strain value more accurately. STE can estimate deformation in two axes simultaneously and measure strain in longitudinal and transverse direction in long-axis views and radial and circumferential direction in short axis views. Hence it can be considered as a reference method for the evaluation of regional myocardial function, although it needs more time than other methods. TMAD a new method of assessing LV longitudinal function may be comparable, easier and faster than GLS.

## **Feasibility of GLS and TMAD in pre CPB and post CPB period**

The Feasibility of a method of assessment of LV systolic function was predicted by its easy in acquiring 2DE parameters, intra-observer and inter-observer variability and time taken for measurement. In our study out of 104 patients, strain quantification was feasible both in pre-CPB and post-CPB period in only 88 patients. The feasibility of TMAD was 100% and GLS was 84%. Ten patients in whom GLS was difficult to analyse due to poor tracking of the myocardium in more than 3 LV segments were excluded from the study. In our study we compared the time taken to analyse TMAD and GLS with Qlab software and found that average time for TMAD and GLS was 15 and 70 seconds respectively. Sujuki et al<sup>46</sup> could analyse TMAD% in 10 seconds and 15 seconds in another study<sup>47</sup>. Even though several studies<sup>48</sup> have reported 90% feasibility of segmental strain imaging during cardiac surgery, post-CPB period strain quantification can be influenced by use of inotropes and tissue edema.

## **Intra-observer and Inter-observer variability**

To evaluate the reproducibility of STE data, a random sample of 22 loops in each group were reassessed by same principal investigator after four weeks from the initial assessment which was considered as intra-observer variability. For inter-observer variability the same 22 samples of each group were assessed by another investigator who was blinded to the results of the principal investigator. Intraclass correlation coefficient was used to evaluate intra-observer and inter-observer agreement, which ranged from +1 (100% agreement) to -1 (100% disagreement). In our study intra-observer and inter-observer intraclass correlation for TMAD % was 0.986 and 0.964 and for GLS % was 0.971 and 0.965. There was very good intra-observer agreement between difference of TMAD % and average TMAD % with 95% limits of agreement -0.551 to -0.606 and for GLS% -1.66 to -1.48. There was very good inter-observer agreement between difference of TMAD % and average TMAD % with 95% limits of agreement -0.753 to -0.721 and for GLS% -1.816 to -1.589. Chiu et al<sup>47</sup> also showed that TMAD had low inter- and intra-observer variability with small biases and narrow limits of agreement (LOA) (bias of  $-0.01 \pm 1.32$  (95 % LOA was  $-2.60$  to  $2.58$ ) and  $-0.07 \pm 1.27$  (95 % LOA  $-2.55$  to  $2.41$ ) respectively.

### **Effect of sevoflurane and propofol on hemodynamics:**

In our study sevoflurane was administered in the concentration of 0.5-1.0 MAC whereas the propofol was given as infusion at a dose range of 50-100µg/kg/min to maintain BIS in the range of 40 to 50. Patients with poor LV systolic function are known to have profound hypotension with use of propofol. However, we expected minimal hemodynamic disturbances in both the groups as patients included in our study had good LV function. Use of large doses of fentanyl in propofol group can be associated with bradycardia but in our study we used moderate doses of fentanyl (5-10µg/kg) during induction. The average heart rate in pre-CPB and post-CPB period was comparable to baseline heart rate in both the groups. During CPB weaning time the MAP and DBP were better in propofol group with p value of 0.006 and 0.043 in our study. In a study done by Nishikawa et al<sup>49</sup> MAP was lower in both sevoflurane and propofol groups. But MAP values were similar to baseline values after the patients were weaned from CPB<sup>6</sup>. This can be attributed to the use of inotropes in both the groups. Hypotension incidence in our patients was minimal and managed with fluid replacement, adjustments of inhalational agents and injection of boluses of vasopressors in both the groups.

### **Effect of sevoflurane and propofol on conventional echocardiographic parameters**

Use of higher concentration of sevoflurane and propofol produces hemodynamic disturbances. Propofol infusion is known to cause arterio-venodilatation resulting in hypotension. Many studies have shown beneficial effects of sevoflurane in maintaining the myocardial function<sup>50,51</sup>. This variable effect on myocardial function by both agents can be reflected on conventional echocardiographic parameters. In our study there was no significant difference in the conventional echocardiographic parameters between the groups. Our findings are consistent with those published by Lindholm et al<sup>52</sup>. In another study they found that echocardiographically derived cardiac index was more and troponin level were less in sevoflurane group compared to propofol group after revascularization in patients operated for CABG<sup>53</sup>. These changes were attributed to the cardio-protective effects of sevoflurane<sup>54</sup> by reducing ischemia-induced metabolic changes in myocardium despite hypotension which were not seen with the propofol. In our study there was no significant difference in the conventional echocardiographic parameters between the groups except septal TMAD in two-chamber view in pre-CPB period and septal TDV and % TMAD in four-chamber view in post-CPB periods,

which did not have clinical relevance. We conclude that when sevoflurane and propofol based anaesthetic regimens were titrated to maintain BIS between 40 to 50 do not defer significantly in their effect on longitudinal function of myocardium.

### **MASPE for LV function assessment**

It is the amount of displacement of mitral annulus towards the LV apex measured by M-mode so helps in assessing longitudinal function of LV. The average normal value of MAPSE derived from previous studies<sup>26</sup> ranged between 12 and 15 and MAPSE <8 mm was associated with a depressed LV EF (50%) with a specificity of 82% and a sensitivity of 98%. In our study the mean  $\pm$  SD of average MAPSE (mm) in four-chamber view in pre-CPB and post-CPB periods was  $11.4 \pm 1.6$  and  $11.5 \pm 1.6$  in sevoflurane group and  $11.5 \pm 2.1$  and  $14 \pm 1.8$  in propofol group which was similar to above study. MAPSE<sup>27</sup> is less dependent on 2D image quality, easy reproducibility, with high temporal resolution and good correlation with LVEF. But it is angle and load dependent and not suitable for regional myocardial function evaluation

### **Tissue doppler imaging for LV function assessment**

Tissue Doppler imaging measure the mitral annular motion velocity using the principle of pulse wave doppler and its derivative the color flow doppler<sup>55</sup>. Signals from red blood cells which are high-velocity low-amplitude are eliminated to display only the low-velocity high-amplitude signals arising from myocardium. The advantages of TDI is similar to MAPSE like less dependent on 2D imaging, with high temporal resolution and good correlation with LVEF. But TDI is limited due to its angle dependency and its inability to differentiate the velocity generated by actual myocardial contraction and that of translational motion due to pull of normal myocardium contraction on akinetic myocardial segments. In our study there was no significant difference in the mean  $\pm$  SD of average mitral annular velocity by TDI (m2) in pre-CPB and post-CPB period. The mean and SD of TDI of MAV was  $7.8 \pm 1.2$  and  $8.6 \pm 1.3$  in sevoflurane group and  $8.0 \pm 1.0$  and  $8.2 \pm 1.2$  in propofol group.

### **BIPLANE SIMPSON'S METHOD for assessing LV function:**

LVEF by biplane Simons method<sup>55</sup> is the most commonly used method for assessing LV systolic function using 2DE. This method uses the principle of summation of twenty cylindrical discs of equal height. LV volumes are measured at end diastole and end systole in both the planes and used in the equation for calculating the EF. This method is limited in patients with poor image quality where endocardial border tracing is not possible and in arrhythmias. Several measurement and averaging may be needed during analysis by this method. This may be because LVEF is assessed by circumferential and radial myocardial fibers contraction while TMAD measures longitudinal deformation. Because of this there may be disparity between these methods, in our study we found moderate correlation between LVEF and TMAD. In our study there was no significant difference in pre-CPB and post-CPB period as patients with good LV function are only included in the study.

### **Advantages of TMAD by speckle-tracking echocardiography over other methods of assessment of LV systolic function:**

MAPSE and TDI of MAV are based on the longitudinal movement of mitral annulus which may reflect the global shortening deformation of the heart<sup>56</sup> considering that the apex of heart is stationary in cardiac cycle base of the heart moves towards the apex. Both methods reportedly to be simple to use with high temporal resolution and independent of image quality. However, MAPSE record mitral annular motion along the direction of ultrasound beam and not the actual excursion of the mitral annulus. And the measurements are taken in lateral or septal side of mitral annulus may not reflect the entire mitral motion. Similarly, MAV by TDI is also measured in the direction of ultrasound beam so limited by its angle dependency. TMAD by STE provides easier and faster assessment of LV function and gives angle independent displacement of midpoint between the two annular ROI. The other advantage is Percentage TMAD, which normalizes the motion with respect to LV length at end- diastole. Studies comparing TDI with TMAD recommended use of TMAD for assessing longitudinal function of LV<sup>56</sup>. In our study also TMAD % was in the range of 11 to 12 mm.

GLS by STE needs good quality 2D image with higher frame rate and regular and constant heart rate with clear ECG trace and aortic valve closure time. It is also dependent on

age and loading conditions. GLS needs tracking of subendocardial and sub epicardial borders of LV and takes times for bull's eye representation to give global GLS %.

TMAD is less dependent on image quality and technique of automated tissue tracking helps in tracing mitral annular motion even in patients with unfavourable acoustic windows. TMAD requires only three-point selection which can be done faster, easier and without all endocardial borders. Whereas other methods need manual tracing and may lead to unreliable results depending on the experience of investigator. A recent report has shown that TMAD accurately estimates EF, irrespective of LV endocardial definition<sup>57</sup>. In our study we were able to record TMAD in 15 seconds, which GLS requires average 70 seconds to complete the measurements. Perioperatively to decide on volume status or need for inotropic support TMAD can be preferred over GLS as it takes less than 15 second. Buss et al<sup>58</sup> reported that TMAD was fast and less time consuming compared to longitudinal strain imaging. Another study also reported TMAD was simple, sensitive, and reproducible LV systolic longitudinal function evaluation<sup>56</sup>.

### **Correlation of TMAD with other methods of assessing LV function**

In our study the midpoint TMAD in four-chamber had strong positive correlation with average of MAPSE ( $r=0.879$  in S-group and  $r= 0.775$  in P-group), and with average of tissue doppler velocity of mitral annulus ( $r= 0.803$  in S-group and  $r= 0.561$  in P-group). MAPSE measures mitral annular velocity in lateral and septal and so it is averaged, whereas in TMAD in addition to lateral and septal, we get computed measurement of midpoint displacement and percentage TMAD. LVEF had moderate positive correlation in both groups when compared to TMAD in four- chamber view ( $r=0.527$  in S-group and  $r=0.572$  in P-group). This may be because LVEF is assessed by circumferential and radial myocardial fibers contraction while TMAD measures longitudinal deformation. Midpoint TMAD showed strong negative correlation with GLS % in both the groups ( $r=-0.697$  S-group and  $r= -0.897$  in P-group) GLS also measures longitudinal function and takes into consideration of apical segments also, so we found good correlation with TMAD.

In a study done in heart failure patients with normal or preserved LVEF, found good correlation between MAPSE and longitudinal strain at rest<sup>34</sup>. Strachinaru et al<sup>44</sup> recently proposed STE derived TMAD is a clinically useful robust tool for rapid, accurate, and estimation of LVEF irrespective of LV endocardial definition. In another study<sup>46</sup> TMAD

showed good linear correlation with LVEF by simsons method ( $r^2 = 0.69$ ,  $p < 0.001$ ) and very strong correlation with MAPSE and TDI ( $r^2 = 0.77$ ,  $p < 0.001$ ),

### **Limitations of our study:**

1) No reference values of STE-based intraoperative TMAD have been published by any STE guidelines. Hence, our TMAD values are compared with previously published TTE studies.

2) TMAD and GLS values obtained by different software packages provided by various vendors are not interchangeable. Hence our results cannot be generalised to all vendors.

3) Our is a small study comparing the two anaesthetic regimens and their effect on longitudinal function of the myocardium. So many larger studies are required to validate our observations.

4) Our results were applicable in a small subset of patients operated for CABG having good LV systolic function. The results may vary in other cardiac surgical patients having deranged LV systolic function.

## Summary and Conclusion

1) When sevoflurane and propofol based anaesthetic regimens were titrated to maintain BIS between 40 to 50, it was observed that they do not defer significantly in their effect on longitudinal systolic function of myocardium.

2) Intra-group differences: There were no significant intra-group differences in the Propofol regimen between the pre-CPB and post-CPB periods in terms of LVEF, MAPSE, TDI of MAV, TMAD and GLS in patients undergoing CABG, except TMAD in four-chamber view midpoint and % TMAD in two-chamber view were better in post-CPB period. However, these exceptions were clinically not relevant. Similarly, there were no significant intra-group differences in patients receiving sevoflurane regimen between the pre-CPB and post-CPB periods concerning these parameters of LV systolic function, except septal and average tissue doppler velocities and septal GLS% in four-chamber view were better in the post-CPB period. However, these exceptions were clinically not relevant.

3) Inter-group differences: There were no significant inter-group differences between sevoflurane and propofol groups in the pre-CPB period related to LVEF, MAPSE, TDI of MAV, TMAD and GLS in patients undergoing CABG, except higher septal TMAD in two-chamber view in Propofol group. However, this exception was clinically irrelevant. Similarly, there were no significant inter-group differences between sevoflurane and propofol groups in the post-CPB period related to LVEF, MAPSE, TDI of MAV, TMAD and GLS in patients undergoing CABG, except septal tissue doppler velocities and %TMAD in four-chamber view. However, this exception was clinically irrelevant.

4) The midpoint TMAD in four-chamber had a strong positive correlation with average of MAPSE, average of TDV and strong negative correlation with GLS % in both sevoflurane and propofol groups in post-CPB period. LVEF had a moderate positive correlation in both groups.

5) Average time taken for processing TMAD and GLS using Phillips Q-lab software were 15.3 seconds and 70.3 seconds respectively. TMAD% values can be acquired quickly, which will be useful in the intraoperative period to estimate mitral annular displacement.

6) There were no significant intra-observer variability and inter-observer variability between % TMAD at four-chamber view and GLS %.

7) Percentage TMAD may be considered as a surrogate parameter for the GLS percentage during the evaluation of longitudinal systolic function of the LV myocardium.

## BIBLIOGRAPHY

1. Ascione R, Narayan P, Rogers CA, Lim KH, Capoun R, Angelini GD. Early and midterm clinical outcome in patients with severe left ventricular dysfunction undergoing coronary artery surgery. *Ann Thorac Surg.* 2003; 76:793-9.
2. Roques F, Nashef SA, Michel P et al. Risk factors and outcome in European cardiac surgery: Analysis of the Euro SCORE multinational database of 19030 patients. *Eur J Cardiothorac Surg.* 1999; 15:816–23.
3. Hamad MA, Van Straten AH, Schönberger JP, et al. Preoperative ejection fraction as a predictor of survival after coronary artery bypass grafting: Comparison with a matched general population. *J Cardiothorac Surg* 2010; 5:29.
4. Nesbitt GC, Mankad S, Oh JK. Strain imaging in echocardiography: methods and clinical applications. *Int J Cardiovasc Imaging* 2009; 25: 9–22.
5. Kalam K, Otahal P, Marwick TH. Prognostic implications of global LV dysfunction: a systematic review and meta-analysis of global longitudinal strain and ejection fraction. *Heart* 2014; 100: 1673–1680.
6. Klein P, Holman ER, Michel, Versteegh M, et al. Wall motion score index predicts mortality and functional result after surgical ventricular restoration for advanced ischemic heart failure. *European Journal of Cardio-thoracic Surgery* .2009 ;60 :847— 853.
7. Sheehan FH. Quantitative evaluation of regional left ventricular systolic function. In: Otto CM eds. *The Practice of Clinical Echocardiography*. Philadelphia: WB Saunders Company 2002; 65- 87.
8. Force T, Kemper A, Perkins L, et al. Overestimation of infarct size by quantitative two-dimensional echocardiography. The role of tethering and of analytic procedures. *Circulation* 1986.73.1360- 68.
9. Chandra S, Skali H, Blankstein R- Novel techniques for assessment of left ventricular systolic function. *Heart Fail Rev.* 2010;16: 327-337.
10. Ho, C. Y. (2006). A Clinician's Guide to Tissue Doppler Imaging. *Circulation*, 113(10), e396–e398. doi:10.1161/CIRCULATIONAHA.105.579268

11. Mor-Avi V, Lang RM, Badano LP, Belohlavek M, Cardim NM, Derumeaux G et al. Current and evolving echocardiographic techniques for the quantitative evaluation of cardiac mechanics: ASE/EAE consensus statement on methodology and indications endorsed by the Japanese Society of Echocardiography. *Eur J Echocardiogr.* 2011;12:167–205.
12. Sutherland GR, Di Salvo G, Claus P, et al: Strain and strain rate imaging: A new clinical approach to quantifying regional myocardial function. *J Am Soc Echocardiogr.* 2004; 17:788-802.
13. Nesbitt GC, Mankad S, Oh JK. Strain imaging in echocardiography: methods and clinical applications. *Int J Cardiovasc Imaging* 2009; 25: 9–22.
14. Hanekom L, Jenkins C, Jeffries L, et al. Incremental value of strain rate analysis as an adjunct to wall-motion scoring for assessment of myocardial viability by Dobutamine echocardiography: a follow-up study after revascularization. *Circulation* 2005; 112: 3892–3900.
15. Edvardsen T, Skulstad H, Aakhus S, Urheim S, Ihlen H. Regional myocardial systolic function during acute myocardial ischemia assessed by strain Doppler echocardiography. *J Am Coll Cardiol* 2001; 37: 726–730.
16. Adel W, Roushdy AM, Nabil M. Mitral Annular Plane Systolic Excursion-Derived Ejection Fraction: A Simple and Valid Tool in Adult Males With Left Ventricular Systolic Dysfunction. *Echocardiography.* 2016 Feb;33(2):179-84. doi: 10.1111/echo.13009. Epub 2015 Jul 14. PMID: 26178447.
17. Willenheimer, R.; Cline, C.; Erhardt, L.; Israelsson, B. (1997). Left ventricular atrioventricular plane displacement: an echocardiographic technique for rapid assessment of prognosis in heart failure. *Heart*, 78(3), 230–236. doi:10.1136/hrt.78.3.230.
18. Wenzelburger FW, Tan YT, Choudhary FJ, Lee ES, Leyva F, Sanderson JE. Mitral annular plane systolic excursion on exercise: a simple diagnostic tool for heart failure with preserved ejection fraction. *Eur J Heart Fail* 2011;13:953–960.
19. Kai Hu and others, Clinical implication of mitral annular plane systolic excursion for patients with cardiovascular disease, *European Heart Journal - Cardiovascular Imaging*, Volume 14, Issue 3, March 2013, Pages 205–212, <https://doi.org/10.1093/ehjci/jes240>.

20. Dai Asada, Kenichi Okumura , Kazuyuki Ikeda. Tissue Motion Annular Displacement of the Mitral Valve Can Be a Useful Index for the Evaluation of Left Ventricular Systolic Function by Echocardiography in Normal Children. *Pediatr Cardiol* 2018 Jun;39(5):976-982. doi: 10.1007/s00246-018-1847-2. Epub 2018 Mar 8.
21. Braunwald E. Heart failure. *JACC Heart Fail* 2013; 1:1—20.
22. Cheitlin MD, Armstrong WF, Aurigemma GP, et al. ACC/AHA/ASE 2003 guideline update for the clinical application of echocardiography- summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASE Committee to Update the 1997 Guidelines for the Clinical Application of Echocardiography). *J Am Coll Cardiol*. 2003; 42:954-70.
23. Lang R, Addetia K, Narang A, et al. 3-Dimensional Echocardiography. *J Am Coll Cardiol Img*. 2018 Dec, 11 (12) 1854–1878. <https://doi.org/10.1016/j.jcmg.2018.06.024>
24. Doenst T, Thiele H, Haasenritter J, Wahlers T, Massberg S, Haverich A. The Treatment of Coronary Artery Disease. *Dtsch Arztebl Int*. 2022 Oct 21;119(42):716-723. doi: 10.3238/arztebl.m2022.0277. PMID: 35912444; PMCID: PMC9835700.
25. Han MM, Zhao WS, Wang X, He S, Xu XR, Dang CJ, Zhang J, Liu JM, Chen ML, Xu L, Wang H. Echocardiographic Parameters Predict Short- and Long-Term Adverse Cardiovascular Events in Patients with Acute Myocardial Infarction. *Int J Gen Med*. 2021 Jun 3;14:2297-2303. doi: 10.2147/IJGM.S304449. PMID: 34113159; PMCID: PMC8184283.
26. Song, J., Yao, Y., Lin, S. et al. Feasibility and discriminatory value of tissue motion annular displacement in sepsis-induced cardiomyopathy: a single-center retrospective observational study. *Crit Care* 26, 220 (2022). doi.org/10.1186/s13054-022-04095.
27. Simonson JS, Schiller NB. Descent of the base of the left ventricle: an echocardiographic index of left ventricular function. *J Am Soc Echocardiogr*. 1989 Jan-Feb;2(1):25-35. doi: 10.1016/s0894-7317(89)80026-4. PMID: 2534047.
28. Shah, A. M., & Solomon, S. D. (2012). Myocardial Deformation Imaging: Current Status and Future Directions. *Circulation*, 125(2), e244–

e248. doi:10.1161/circulationaha.111.086348.

29. Adachi H, Asanuma T, Masuda K, Nakatani S. Deterioration of longitudinal, circumferential, and radial myocardial strains during acute coronary flow reduction: which direction of strain should be analyzed for early detection? *Int J Cardiovasc Imaging*. 2020 Sep;36(9):1725-1735. doi: 10.1007/s10554-020-01888-4. Epub 2020 May 28. PMID: 32462451.
30. Geyer H, Caracciolo G, Abe H, Wilansky S, Carerj S, Gentile F, Nesser HJ, Khandheria B, Narula J, Sengupta PP. Assessment of myocardial mechanics using speckle tracking echocardiography: fundamentals and clinical applications. *J Am Soc Echocardiogr*. 2010 Apr;23(4):351-69; quiz 453-5. doi: 10.1016/j.echo.2010.02.015. Erratum in: *J Am Soc Echocardiogr*. 2010 Jul;23(7):734. PMID: 20362924.
31. Hoit BD. Strain and strain rate echocardiography and coronary artery disease. *Circ Cardiovasc Imaging*. 2011 Mar;4(2):179-90. doi: 10.1161/CIRCIMAGING.110.959817. PMID: 21406664.
32. Muraru D, Niero A, Rodriguez-Zanella H, Cherata D, Badano L. Three-dimensional speckle-tracking echocardiography: benefits and limitations of integrating myocardial mechanics with three-dimensional imaging. *Cardiovasc Diagn Ther*. 2018 Feb;8(1):101-117. doi: 10.21037/cdt.2017.06.01. PMID: 29541615; PMCID: PMC5835646.
33. Chong, Adrian et al. Perioperative Applications of Deformation (Myocardial Strain) Imaging With Speckle-Tracking Echocardiography. *Journal of Cardiothoracic and Vascular Anesthesia*, Volume 28, Issue 1, 128 – 140.
34. Aurich M, Keller M, Greiner S, Steen H, Aus dem Siepen F, Riffel J et al. Left ventricular mechanics assessed by two-dimensional echocardiography and cardiac magnetic resonance imaging: comparison of high-resolution speckle tracking and feature tracking. *Eur Heart J Cardiovasc Imaging*. 2016 Dec; 17:1370-78.
35. Poorzand H, Alborz H, Alimi H, Emadzadeh M. Assessment of tissue mitral annular displacement in patients with coronary artery stenosis. *ARYA Atheroscler*. 2021 May;17(3):1-6. doi: 10.22122/arya.v17i0.2197. PMID: 35685826; PMCID: PMC9133710.
36. Iwakura K, Onishi T, Okamura A, Koyama Y, Inoue K, Nagai H, Hirao Y, Tanaka K, Iwamoto M, Tanaka N, Nakatani D, Hikoso S, Sakata Y, Sakata Y,

- Fujii K. Tissue Mitral Annular Displacement in Patients With Myocardial Infarction - Comparison With Global Longitudinal Strain. *Circ Rep*. 2021 Aug 20;3(9):530-539. doi: 10.1253/circrep.CR-21-0076. PMID: 34568632; PMCID: PMC8423660.
37. De Hert SG1, Cromheecke S, Ten Broecke PW, Mertens E, De Blier IG, Stockman BA et al. Effects of propofol, desflurane, and sevoflurane on recovery of myocardial function after coronary surgery in elderly high-risk patients. *Anesthesiology*. 2003;99(2):314-23
38. Joo HS, Perks WJ. Sevoflurane versus propofol for anesthetic induction: a metaanalysis. *Anesthesia & Analgesia*. 2000;91(1):213-9.
39. Landoni G, Biondi-Zoccai GG, Zangrillo A, et al. Desflurane and sevoflurane in cardiac surgery: a meta-analysis of randomized clinical trials. *J Cardiothorac Vasc Anesth* 2007; 21: 502-11.
40. Lurati Buse GA, Schumacher P, Seeberger E, Studer W, Schuman RM, Fassl J, Kasper J, Filipovic M, Bolliger D, Seeberger MD. Randomized comparison of sevoflurane versus propofol to reduce perioperative myocardial ischemia in patients undergoing noncardiac surgery. *Circulation*. 2012 Dec 4;126(23):2696-704. doi: 10.1161/CIRCULATIONAHA.112.126144. Epub 2012 Nov 7. PMID: 23136158.
41. Li F, Yuan Y. Meta-analysis of the cardioprotective effect of sevoflurane versus propofol during cardiac surgery. *BMC Anesthesiol*. 2015 Sep 24;15:128. doi: 10.1186/s12871-015-0107-8. PMID: 26404434; PMCID: PMC4583176.
42. Yao Y-T, Li L-H. Sevoflurane Versus Propofol for Myocardial Protection in patients Undergoing Coronary Artery Bypass Grafting Surgery: a Meta-analysis of Randomized Controlled Trials. *Chin Med Sci J*. 2009;24(3):133-41.
43. Beverstock J, Park T, Alston RP, et al. A Comparison of Volatile Anesthesia and Total Intravenous Anesthesia (TIVA) Effects on Outcome From Cardiac Surgery: A Systematic Review and Meta-Analysis. *Journal of Cardiothoracic and Vascular Anesthesia*. 2021 Apr;35(4):1096-1105. DOI: 10.1053/j.jvca.2020.10.036. PMID: 33191042.
44. Chennakeshavallu G, Gadhinglajkar S, Sreedhar R, Babu S, Sankar S, Dash P. Comparison of effects of sevoflurane versus propofol on left ventricular

- longitudinal global and regional strain in patients undergoing on-pump coronary artery bypass grafting. *Ann Card Anaesth.* 2022;25(2):188.
45. Coleman SR, Cios TJ, Riela S, Roberts SM. The Effects of Propofol on Left Ventricular Global Longitudinal Strain. *Semin Cardiothorac Vasc Anesth.* 2021 Sep;25(3):185-190. doi: 10.1177/1089253221991372. Epub 2021 Feb 5. PMID: 33543681.
46. Suzuki K, Akashi YJ, Mizukoshi K, Kou S, Takai M, Izumo M, Hayashi A, Ohtaki E, Nobuoka S, Miyake F. Relationship between left ventricular ejection fraction and mitral annular displacement derived by speckle tracking echocardiography in patients with different heart diseases. *J Cardiol.* 2012 Jul;60(1):55-60. doi: 10.1016/j.jjcc.2012.01.014. Epub 2012 Mar 21. PMID: 22445596.
47. Chiu, D.Y.Y., Abidin, N., Hughes, J. et al. Speckle tracking determination of mitral tissue annular displacement: comparison with strain and ejection fraction, and association with outcomes in haemodialysis patients. *Int J Cardiovasc Imaging* 32, 1511–1518 (2016). <https://doi.org/10.1007/s10554-016-0946-5>.
48. Kukucka M, Nasser B, Tscherkaschin A, Mladenow A, Kuppe M, Habazettl H. The Feasibility of Speckle Tracking for Intraoperative Assessment of Regional Myocardial Function by Transesophageal Echocardiography. *Journal of Cardiothoracic and Vascular Anesthesia.* 2009;23; 462-467.
49. Nishikawa k, Kanayab N, Kawamata M, Namiki A. Left ventricular mechanical performance in elderly patients after induction of anesthesia. A comparison of inhalational induction with sevoflurane and intravenous induction with fentanyl and propofol. *Anesthesia* 2004, 59, 948-953.
50. Jakobsen C-J, Berg H, Hindsholm KB, Faddy N, Sloth E. The influence of propofol versus sevoflurane anesthesia on outcome in 10,535 cardiac surgical procedures. *J Cardiothorac Vasc Anesth.* 2007; 21(5):664–71.
51. Yu CH, Beattie WS. The effects of volatile anesthetics on cardiac ischemic complications and mortality in CABG: a meta-analysis. *Can J Anaesth* 2006; 53: 906–18.
52. Lindholm E E , Aune E, Froland G, Kirkeben KA, Otterstad JE. Analysis of transthoracic echocardiography data in major vascular surgery from a

- prospective randomized trial comparing sevoflurane and fentanyl with propofol and remifentanyl anesthesia. *Anaesthesia* .2014;69 :6.
53. Jakobsen CJ, Berg H, Hindsholm KB, Faddy N, Sloth E. The influence of propofol versus sevoflurane anesthesia on outcome in 10,535 cardiac surgical procedures. *J Cardiothorac Vasc Anesth* 2007; 21: 664–71
54. Symons JA, Myles PS. Myocardial protection with volatile anaesthetic agents during coronary artery bypass surgery: a meta-analysis. *Br J Anaesth* 2006; 97: 127–36.
55. Chengode S. Left ventricular global systolic function assessment by echocardiography. *Ann Card Anaesth* 2016;19:S26-34
56. Terada, K., Hozumi, T., Fujita, S. et al. Feasibility of tissue-tracking mitral annular displacement in single four-chamber view as a simple index of left ventricular longitudinal deformation. *J Echocardiogr* 20, 224–232 (2022). <https://doi.org/10.1007/s12574-022-00578-5>
57. Teraguchi I, Hozumi T, Emori H, Takemoto K, Fujita S, Wada T, Kashiwagi M, Shiono Y, Shimamura K, Kuroi A, Tanimoto T, Kubo T, Tanaka A, Akasaka T. Prognostic value of tissue-tracking mitral annular displacement by speckle-tracking echocardiography in asymptomatic aortic stenosis patients with preserved left ventricular ejection fraction. *J Echocardiogr*. 2021 Jun;19(2):95-102. doi: 10.1007/s12574-020-00490-w. Epub 2020 Sep 24. PMID: 32970310.
58. Buss, S.J., Mereles, D., Emami, M. et al. Rapid assessment of longitudinal systolic left ventricular function using speckle tracking of the mitral annulus. *Clin Res Cardiol* 101, 273–280 (2012). <https://doi.org/10.1007/s00392-011-0389-x>.



Clinical Trial Details (PDF Generation Date :- Sat, 11 Feb 2023 14:32:35 GMT)

<b>CTRI Number</b>	CTRI/2023/02/049598 [Registered on: 09/02/2023] - <b>Trial Registered Prospectively</b>	
<b>Last Modified On</b>	07/02/2023	
<b>Post Graduate Thesis</b>	Yes	
<b>Type of Trial</b>	Interventional	
<b>Type of Study</b>	Surgical/Anesthesia	
<b>Study Design</b>	Randomized, Parallel Group Trial	
<b>Public Title of Study</b>	Effects of two commonly used anaesthetic agents on mitral valve dynamics for left ventricular function assessment using transesophageal echocardiography.	
<b>Scientific Title of Study</b>	Effects of sevoflurane versus propofol on mitral annular displacement evaluated using speckle tracking.	
<b>Secondary IDs if Any</b>	<b>Secondary ID</b>	<b>Identifier</b>
	NIL	NIL
<b>Details of Principal Investigator or overall Trial Coordinator (multi-center study)</b>	<b>Details of Principal Investigator</b>	
	<b>Name</b>	Suda Naveen Kumar
	<b>Designation</b>	Senior resident
	<b>Affiliation</b>	Sree Chitra Tirunal Institute of Medical Sciences and Technology.
	<b>Address</b>	Division of Cardiac Anaesthesiology, Sree Chitra Tirunal Institute of Medical Sciences and Technology. Thiruvananthapuram KERALA 695011 India
	<b>Phone</b>	
	<b>Fax</b>	
	<b>Email</b>	sudanaveen@gmail.com
<b>Details Contact Person (Scientific Query)</b>	<b>Details Contact Person (Scientific Query)</b>	
	<b>Name</b>	Shrinivas V Gadhinglajkar
	<b>Designation</b>	Senior Professor
	<b>Affiliation</b>	Sree Chitra Tirunal Institute for Medical Sciences and Technology.
	<b>Address</b>	Head of the department, Division of Cardiac Anaesthesia, Sree chitra tirunal institute for medical sciences and Technology SCTIMST. Thiruvananthapuram KERALA 695011 India
	<b>Phone</b>	
	<b>Fax</b>	
	<b>Email</b>	shri@sctimst.ac.in
<b>Details Contact Person (Public Query)</b>	<b>Details Contact Person (Public Query)</b>	
	<b>Name</b>	Suda Naveen Kumar
	<b>Designation</b>	Senior resident
	<b>Affiliation</b>	Sree Chitra Tirunal Institute of Medical Sciences and Technology.
	<b>Address</b>	Division of Cardiac Anaesthesiology, Sree Chitra Tirunal Institute for Medical Sciences and Technology. Thiruvananthapuram KERALA 695011 India



**Institutional Ethics Committee**  
(IEC Regn No. ECR/189/Inst/KL/2013/RR-21)

SCT/IEC/1890/MAY-2022

04.06.2022

**Dr. Suda Naveen Kumar**  
Senior Resident  
Department of Anaesthesiology  
SCTIMST, Thiruvananthapuram

Dear Dr. Suda Naveen Kumar,

The project proposal with the title "EFFECTS OF SEVOFLURANE VERSUS PROPOFOL ON MITRAL ANNULAR DISPLACEMENT EVALUATED USING SPECKLE TRACKING" submitted to Institutional Ethics Committee (IEC) has been reviewed in the IEC Meeting held on 13<sup>th</sup> May, 2022 and assigned number as IEC/1890.

**List of documents submitted:**

1. Covering letter addressed to the Chairman, IEC, SCTIMST dated 3.9.2021
2. Checklist Form
3. Project Proposal
4. Data Collection Proforma
5. IEC Application Form
6. Patient Information Sheet in English and Malayalam
7. Informed Consent in English and Malayalam
8. CV of PI and Co-PIs
9. Covering letter addressed to the Chairman, IEC, SCTIMST dated 13.04.2022
10. Declaration form
11. SRC Recommendation Letter

**IEC Recommendations**

1. The primary and secondary objectives of this study lacks clarity. The write up reads as an interventional study. Consider employing the SPIRIT guidelines if it is an RCT, giving clear indications of interventions being employed, allocation and concealment processes and assessment methods if any.
2. How will be randomization done? Please clarify.
3. There is no indication to which arm patients has gone?
4. Why these two drugs are being compared?
5. CTRI registration is required.
6. The patient details from Proforma should be removed.

One set of all the documents including those revised may be submitted. The covering letter should indicate the revisions made.

Sincerely,

  
**Dr. G. Srinivas**  
Member Secretary, IEC



Scanned by CamScanner

## INFORMED CONSENT

I \_\_\_\_\_ aged  
\_\_\_\_\_(in years/months),  
\_\_\_\_\_(Father/Mother name), give  
consent to participate in this study titled: **“Effects of sevoflurane versus propofol on mitral  
annular displacement evaluated using speckle tracking.”**

Please tick the relevant boxes

- I confirm that I have read and understood the information sheet dated for the above study and had the opportunity to ask questions to clarify any doubts that I had. [ ]
- I also understand that my participation in this study is entirely voluntary and that I am free to withdraw permission to continue to participate at anytime without affecting my usual treatment or my legal rights. [ ]
- I understand that the investigators, institutional ethics committee members and regulatory authorities will not need my permission to look at the health records even if I withdraw myself from the trial. I agree to this access. [ ]
- I understand that my identity will not be revealed in any information released to third parties or published. [ ]
- I agree not to restrict the use of any data of results that arise from this study provided such a use is only for scientific purposes. [ ]
- I have been given contact numbers to know more about the study and rights of participants in this study. [ ]
- I voluntarily agree to take part in this study. [ ]
- I have received a copy of this signed consent form. [ ]

Name:

Signature:

Date:

Name of witness: Relation

to participant: Signature:

Date:

I attest that the requirements for informed consent for the medical research project described in this form have been satisfied. I have discussed the research project with the participant and explained to him or her in nontechnical terms all of the information contained in this informed consent form, including any risks and adverse reactions that may reasonably be expected to occur. I further certify that I encouraged the participant to ask questions and that all questions asked were answered.

Name and Signature of person obtaining consent

Date:

Principal investigator:

Dr. Suda Naveen Kumar

Ph: 9885520970

Witness:



അനസ്തൈറ്റിസ് ആ നിരീക്ഷണ ഉപകരണം താങ്കളുടെ തൊണ്ടയിലൂടെ ഈസോഫാഗസിലേയ്ക്ക് (താങ്കളുടെ വായിലൂടെ വയറ്റിലേയ്ക്കുള്ള വഴി) കടത്തും. താങ്കൾ മയക്കത്തിലായിരിക്കുമ്പോഴാണ് ഇത് ചെയ്യുന്നത് എന്നതിനാൽ അസ്വസ്ഥതയൊന്നും ഉണ്ടാകില്ല. ഈസോഫാഗസ് ഹൃദയത്തിന് നേരെ പുറകിലാണെന്നതിനാൽ ഡോക്ടർക്ക് താങ്കളുടെ ഹൃദയത്തിന്റെ കൂടുതൽ വിശദമായ ചിത്രങ്ങൾ ലഭിക്കാൻ ഈ സമീപനം സഹായകരമാകും.

**ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫിയുടെ അപായങ്ങളും പാർശ്വഫലങ്ങളുമെന്തെല്ലാം?**

ഹൃദയശസ്ത്രക്രിയയ്ക്ക് വിധേയരാകുന്ന രോഗികളിൽ പതിവായി ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫി ഉപയോഗിക്കുന്നതും അതിലടങ്ങിയ അപായം നിസ്സാരവുമാണ്. ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫിയുടെ 2013ലെ അമേരിക്കൻ സൊസൈറ്റി ഓഫ് ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫിയുടെയും സൊസൈറ്റി ഓഫ് കാർഡിയോവാസ്കുലാർ അനസ്തീഷ്യോളജിസ്റ്റിന്റെയും മാർഗ്ഗനിർദ്ദേശങ്ങൾ പ്രകാരം ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫി വഴി ഉണ്ടാകാനിടയുള്ള സങ്കീർണ്ണതകൾ വായിൽനിന്നുള്ള ലഘുവായ രക്തസ്രാവം (0.01%) ഗുരുതരമായ രക്തസ്രാവം (0.03% മുതൽ 0.8%വരെ), എൻഡോട്രാക്കിയൽകുഴലിന്റെ സ്ഥാന വ്യതിയാനം (0.03%), പല്ലിനുള്ളിലൂടെ പരുക്ക് (0.03%), കടുത്ത തൊണ്ടവേദന (0.1%) ഈസോഫാഗസിൽ തുളവിഴുക (0 മുതൽ 0.3%) എന്നിവയാണ്.

ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫിയുടെ ഉപയോഗവുമായി ബന്ധപ്പെട്ടവയാണ് ഈ അപായങ്ങൾ, പഠനത്തിന്റെ പ്രത്യേകതയോ ബന്ധപ്പെട്ടതോ അല്ല. താങ്കൾ ഈ പഠനത്തിൽ പങ്കെടുത്താലും ഇല്ലെങ്കിലും നിരീക്ഷണത്തിനും ചികിത്സയ്ക്കുമായി ഹൃദയശസ്ത്രക്രിയാ നടപടിയിൽ ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫി ചെയ്യും.

മിട്രൽ ആനൂലാർ സ്ഥാനഭ്രംശം എന്നാലെന്ത്?  
സ്പിൻഡിൾ ട്രാക്കിംഗ് വഴിയുള്ള കോശസംയുക്ത മിട്രൽ ആനൂലാർ സ്ഥാനഭ്രംശം എന്നത് പുതിയ ഒരു സങ്കേതമാണ്. അതിൽ പതിവ് ട്രാൻസ്-ഇസോഫേജിയൽ എക്കോകാർഡിയോഗ്രാഫി ചെയ്യുമ്പോൾ ശേഖരിക്കുന്ന ചിത്രങ്ങൾ അതിനുശേഷം കമ്പ്യൂട്ടറിൽ വച്ച് ഹൃദയ പ്രവർത്തനത്തിന്റെ അളവ് വസ്തുനിഷ്ഠമായി നിർണ്ണയിക്കുന്നു.

**ഞങ്ങൾ എന്തുകൊണ്ട് ഈ പഠനം നടത്തുന്നു?**

സിറോഹ്ളിറൈൻ അല്ലെങ്കിൽ പ്രൊപ്പൊഫോളിന്റെ സ്വാധീനത്തിൽ ശസ്ത്രക്രിയയ്ക്ക് വിധേയരാകുന്ന രോഗികളിലെ ശസ്ത്രക്രിയയ്ക്കുമുമ്പും ശേഷവുമുള്ള ഹൃദയ പ്രവർത്തനത്തിലെ മിട്രൽ ആനൂലാർ സ്ഥാനഭ്രംശത്തിൽ സൂക്ഷ്മവും വസ്തുനിഷ്ഠവുമായ എക്കോകാർഡിയോഗ്രാഫിപരമായ വിലയിരുത്തൽ നടത്താനാണ് ഈ പഠനം ഉദ്ദേശിക്കുന്നത്.

**പഠനമാരംഭിച്ചശേഷം താങ്കൾക്ക് പിൻമാറാനാകുമോ?**

താങ്കളുടെ പഠനത്തിലുള്ള പങ്കാളിത്തം പൂർണ്ണമായും സ്വമേധയാ ഉള്ളതും പഠനത്തിൽ നിന്ന് പിൻമാറാൻ സ്വാതന്ത്ര്യം ഉള്ളതും ആണ്. അങ്ങനെ ചെയ്യുന്നതുകൊണ്ട് ഈ ആശുപത്രിയിലെ താങ്കളുടെ സാധാരണ ചികിത്സയെ ഒരുവിധത്തിലും ബാധിക്കുകയില്ല.

പഠനസംബന്ധിയായി എന്തെങ്കിലും പരമപദങ്ങളോടൊത്ത് എന്തുചെയ്യും?

താങ്കൾ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതുകൊണ്ട് താങ്കൾക്ക് ഒരു പതിക്കും ഉണ്ടാവുമെന്ന് ഞങ്ങൾ പ്രതീക്ഷിക്കുന്നില്ല. പക്ഷേ താങ്കൾക്ക് പാർശ്വഫലങ്ങളോ പ്രശ്നങ്ങളോ ഉണ്ടാവുകയാണെങ്കിൽ ആ സങ്കീർണ്ണതകൾ താങ്കൾക്ക് അധികച്ചിലവുണ്ടാകാതെ ഞങ്ങൾ ചികിത്സിക്കും

പഠനത്തിന് താങ്കൾ അധികം പണം നൽകുമോ?

വേണ്ട

താങ്കളുടെ വ്യക്തിപരമായ വിവരങ്ങൾ രഹസ്യമായി വയ്ക്കുമോ ?

താങ്കളുടെ വ്യക്തിവിവരങ്ങൾ രഹസ്യമായി സൂക്ഷിക്കും. പഠനഫലങ്ങൾ ഒരു വൈദ്യശാസ്ത്ര ട്രേണിംഗിൽ പ്രസിദ്ധീകരിക്കുമെങ്കിലും താങ്കളുടെ പേരു വിവരങ്ങൾ പ്രസിദ്ധീകരണത്തിലോ പഠനഫലങ്ങളുടെ പ്രദർശനത്തിലോ ഉണ്ടാവില്ല.

താങ്കൾക്ക് കൂടുതൽ എന്തെങ്കിലും ചോദ്യങ്ങൾ ഉണ്ടെങ്കിൽ ദയവായി ഡോക്ടറോട് ചോദിക്കുക

ഡോ. ശ്രീനിവാസ് വി ഗോയിംഗ്ലജ്കർ, പ്രൊഫസർ, ഡിപ്പാർട്ട്മെന്റ് ഓഫ് അനസ്തീഷ്യോളജി ഫോൺ 9446304043

പ്രധാന ഗവേഷകൻ ഡോ. സുധ നവീൻ കുമാർ, സീനിയർ റെസിഡന്റ്, ഡിപ്പാർട്ട്മെന്റ് ഓഫ് അനസ്തീഷ്യോളജി (ഫോൺ 9885520970) ഇമെയിൽ [sudanaveen10@gmail.com](mailto:sudanaveen10@gmail.com)

പഠനത്തിന്റെ നൈതിക അനുവാദസംബന്ധമായ വിശദീകരണങ്ങൾക്ക് ഡോ. ശ്രീനിവാസ് ജി മേമ്പൽ സെക്രട്ടറി, ഇൻസ്റ്റിറ്റ്യൂഷണൽ എത്തിക്സ് കമ്മിറ്റി, ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി

ഫോൺ 0471- 2524689, ഇമെയിൽ: [iec.mem.sec@sctimst.ac.in](mailto:iec.mem.sec@sctimst.ac.in)

പ്രധാന ഗവേഷകന്റെ പേരും ഒപ്പും

ഡോ. സുധ നവീൻ കുമാർ

ഫോൺ -9885520970

പ്രസ്ഥാവനയും സമ്മതപത്രവും

ഞാൻ..... വയസ്സ് (വർഷത്തിലും മാസത്തിലും) .....  
.(അച്ഛൻ/അമ്മയുടെ പേര്).....

ഇടത് വെൻട്രിക്കിളിലെ തിരശ്ചീന പ്രവർത്തനത്തിൽ സിറോഹ്ജുറൈൻഡ്രിയം പ്രൊപ്പോഫോളിൻഡ്രിയം പ്രഭാവം, സ്പൈക്കിൾ ട്രാക്കിംഗ് ഉപയോഗിച്ചുള്ള മിട്രൽ ആനുലാർ സ്ഥാനഭ്രംശത്തിന്റെ വിലയിരുത്തൽ എന്ന പഠനത്തിൽ പങ്കെടുക്കാവാൻ സമ്മതം നൽകുന്നു.

(കോളങ്ങൾ അടയാളപ്പെടുത്തുക).

- പഠനസംബന്ധിയായി എനിക്കു നൽകിയ തിയതിയിലെ..... വിവരങ്ങൾ വായിച്ചു എന്നും എനിക്കുണ്ടായ സംശയങ്ങൾ പരിഹരിക്കാൻ അവസരം ലഭിച്ചു എന്നും ഉറപ്പാക്കുന്നു.
- എന്റെ ഈ പഠനത്തിലുള്ള പങ്കാളിത്തം പൂർണ്ണമായും സ്വമേധയാ ആണെന്നും അനുവാദം എനിക്ക് ഏതുസമയത്തും എന്റെ ചികിത്സയെ ബാധിക്കാതെ പിൻവലിക്കാൻ അവകാശമുണ്ടെന്നും ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- ഞാൻ ഈ പഠനത്തിൽ നിന്നും പിൻമാറിയാലും പഠനം നടത്തുന്നവർക്കും സ്ഥാപനത്തിലെ നൈതിക കമ്മിറ്റി അംഗങ്ങൾക്കും നിയന്ത്രണാധികാരികൾക്കും എന്റെ ആരോഗ്യരേഖകൾ പരിശോധിക്കുന്നതിന് എന്റെ അനുവാദം ആവശ്യമില്ലെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. അതിനോട് ഞാൻ യോജിക്കുന്നു. [ ]
- എന്നെ തിരിച്ചറിയാനുതകുന്ന വിവരങ്ങൾ ഒന്നും മറ്റുള്ളവർക്കു നൽകുകയോ പ്രസിദ്ധീകരിക്കുകയോ ചെയ്തില്ലെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- ശാസ്ത്രീയ ആവശ്യങ്ങൾക്കൊന്നെങ്കിൽ ഈ പഠനത്തിലെ വിവരങ്ങൾ ഉപയോഗിക്കുന്നതിന് ഞാൻ പരിധി കൽപ്പിക്കുന്നില്ല [ ]
- എനിക്ക് പഠനത്തെപ്പറ്റിയോ പങ്കാളിയുടെ അവകാശങ്ങളെപ്പറ്റിയോ കൂടുതൽ അറിയണമെങ്കിൽ പ്രധാനഗവേഷകയെ ബന്ധപ്പെടാനുള്ള നമ്പർ നൽകിയിട്ടുണ്ട് [ ]
- ഞാൻ സ്വമേധയാ പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിക്കുന്നു [ ]
- സമ്മതപത്രത്തിന്റെ ഒപ്പിട്ട ഒരു കോപ്പി എനിക്കു കിട്ടി [ ]

പേര്  
ഒപ്പ്  
തീയതി  
സാക്ഷിയുടെ പേര്  
പങ്കെടുക്കുന്ന ആളുമായുള്ള ബന്ധം  
തീയതി

(സമ്മതം വാങ്ങുന്നയാൾ)

മെഡിക്കൽ റിസർച്ച് പ്രോജക്ടിനാവശ്യമായ സമ്മതപത്രത്തിനു വേണ്ടുന്ന എല്ലാ ഘടകങ്ങളും തൃപ്തികരമായി നിർവഹിച്ചിരിക്കുന്നുവെന്ന് ഞാനു ബോധ്യപ്പെടുത്തുന്നു. പഠനപങ്കാളിയുമായി ഗവേഷണപദ്ധതിയെപ്പറ്റി സാങ്കേതികത പരങ്ങളുപയോഗിച്ച് എല്ലാ വിവരങ്ങളെപ്പറ്റിയും ചർച്ച നടത്തുകയും പ്രതീക്ഷിക്കാവുന്ന അപകടസാധ്യതകളും പാർശ്വഫലങ്ങളും വിശദീകരിക്കുകയും ചെയ്തു. പങ്കാളിയെ ചോദ്യങ്ങൾ ചോദിക്കാൻ പ്രേരിപ്പിക്കുകയും എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം നൽകുകയും ചെയ്തു എന്നും ഞാൻ സാക്ഷ്യപ്പെടുത്തുന്നു.

സമ്മതപത്രം വാങ്ങുന്ന ആളുടെ പേരും ഒപ്പും

ഡോ. സുധ നവീൻ കുമാർ,

ഫോൺ -9885520970

സാക്ഷി





	Parameter	Pre-CPB	Post-CPB
2	<b>TMAD (cm)</b>		
	SEPTAL (cm)		
	LATERAL (cm)		
	MIDDLE(cm)		
	PERCENTAGE TMAD %		
3	<b>TISSUE DOPPLER VELOCITY (cm/sec)</b>		
	LATERAL		
	SEPTAL		
4	<b>GLOBAL LONGITUDINAL STRAIN (%)</b>		
	FOUR CHAMBER LATERAL		
	FOUR CHAMBER SEPTAL		
	<b>Four chamber regional</b> TWO CHAMBER ANTERIOR		
	TWO CHAMBER INFERIOR		
	<b>Two chamber regional</b> THREE CHAMBER ANTERIOR		
	INFERIOR		
	Three chamber regional		
	GLS (%)		

**CPB weaning values**

Sl No	PARAMETER	VALUE	Sl. No	PARAMETER	VALUE
1	HR beats/ min		7	LVOT DIAMETER (cm)	
2	SBP mmHg		8	LVOT CROSS SECTIONAL AREA cm <sup>2</sup>	
3	DBP mmHg		9	LVOT VTI cm	
4	MBP mmHg		10	LVOT STROKE VOLUME ml/beat	
5	CVP mmHg		11	LVOT CARDIAC OUTPUT (L/min)	
6	HEMOGLOBIN gm/dl		12	LVOT CARDIAC INDEX (L/min/m <sup>2</sup> )	

## Master Charts

Sl.No	Group	Age	Sex	Weight in Kgs	Height in cm	Body Surface area m2	Diagnosis	Comorbidities
1	1	55	1	74	171	1.86	CAD,TVD IW rwma	DM,HTN, DLP
2	1	72	1	65	166	1.72	CAD, TVD	DLP, Hypothyroid
3	1	64	1	68	162	1.73	CAD,TVD IW rwma	HTN,DLP,CVA
4	1	57	1	74	159	1.77	CAD TVD, P/PCI LAX LAD	DM,HTN, DLP
5	1	61	1	67	166	1.75	CAD, TVD	DM,HTN, DLP
6	1	67	1	66	164	1.72	CAD, TVD	DM
7	1	42	1	78	165	1.85	CAD, TVD	DM HTN
8	1	57	1	63	160	1.66	CAD, TVD	DM, HTN
9	1	51	1	71	166	1.79	CAD, TVD p/PCI RCA	DLP,HTN, CVA
10	1	55	1	66	161	1.70	CAD, DVD	DM, POVD
11	1	68	1	65	165	1.72	CAD, TVD, P/Pci LAD	DM,DLP,HTN
12	1	61	1	71	166	1.79	CAD,TVD	DM
13	1	70	1	68	155	1.67	CAD LM TVD	DM, DLP
14	1	57	2	58	156	1.57	CAD, TVD	HTN, DLP, Hypothyroid
15	1	58	1	67	167	1.75	CAD, LM TVD p/PCI	HTN, DLP
16	1	62	1	71	164	1.77	CAD, LM TVD	HTN, Dm, Aki
17	1	63	1	74	164	1.81	Cad, LM TVD, P/PCI RCA	DM
18	1	66	1	68	160	1.71	CAD, LM TVD	P/PPI
19	1	63	1	66	162	1.71	CAD, LM TVD	DM
20	1	51	1	75	158	1.77	CAD, TVD	DM, HTN
21	1	70	1	78	161	1.82	Cad, TVD	DLP, HTN
22	1	67	1	68	162	1.73	CAD,TVD, LM	DLP,HTN, CVA
23	1	69	1	68	166	1.76	CAD,TVD,RCC ,RT nephrectomy	DM,HTN

24	1	50	2	60	156	1.59	CAD, LM SVD, SR	DM, PIVd disectomy
25	1	48	2	67	157	1.68	CAD, TVD	DM,HTN, DLP
26	1	57	1	75	166	1.83	CAD,TVD	DM,CKD,POVD
27	1	67	2	71	149	1.79	CAD, LM TVD	DM,HTN
28	1	55	1	73	164	1.79	CAD,TVD,	DM,HTN, DP, CVA, POVD
29	1	71	1	68	162	1.73	CAD TVD	DM HTN
30	1	38	1	68	156	1.68	CAD, TVD	HTN
31	1	71	1	77	164	1.84	CAD, LM TVD	DM,HTN
32	1	65	2	68	157	1.69	CAD,TVD	DM,DLP,HTN,Hypothyroid
33	1	56	1	72	158	1.74	CAD,TVD,	DM, HTN
34	1	68	1	77	163	1.83	CAD,TVD,p/PCI LAD,RCA	DM,HTN,TB,CVA
35	1	59	2	72	162	1.77	CAD,DVD	DM,DLP,HTN
36	1	62	1	74	162	1.79	CAD, DVD, GDLV,SR	HTN, DLP
37	1	58	1	72	164	1.78	CAD, TVD, SR	HTN, DM
38	1	58	1	72	166	1.80	CAD,TVD	Dm,HTN
39	1	61	1	76	166	1.84	CAD,TVD	DM,HTN
40	1	66	1	68	159	1.70	CAD,TV.	DM,HTN
41	1	67	2	66	153	1.64	CAD, TVD	HTN
42	1	63	1	65	160	1.68	CAD,TVD,OFF pump	DM,HTN
43	1	61	1	67	166	1.75	CAD,Lm TVD	DLP,HTN, CVA
44	1	76	1	70	164	1.76	CAD, TVD,	HTN,DM
45	2	52	2	67	150	1.62	CAD,TVD,	DM,HTN,DLP,Hypothyroid
46	2	54	1	84	165	1.91	CAD, LM 9, DVD, GDLV, SR	DM, HTN
47	2	60	1	71	165	1.78	CAD, TVD,IW IL hypokinesia at Base	DM, HTN
48	2	64	1	59	152	1.55	CAD, LM 40 TVD,	HTN
49	2	67	1	74	172	1.87	CAD,TVD,	HTN
50	2	52	1	66	161	1.70	CAD, TVD	HTN
51	2	61	1	71	166	1.79	CAD,TVD, P/PCI LAD	DM, DLP,povd
52	2	59	1	68	162	1.73	CAD,TVD	DM,DLP
53	2	68	1	57	160	1.59	CAD,TVD	DM,HTN

54	2	67	1	63	159	1.65	CAD,TVD,	DM,HTN
55	2	56	1	71	162	1.76	CAD,TVD	DLP,HTN
56	2	53	1	81	166	1.89	CAD, LM TVD	DM
57	2	75	1	66	161	1.70	CAD, LM TVD	HTN
58	2	61	1	73	159	1.76	CAD, TVD	DM, HTN
59	2	62	1	60	162	1.64	CA,LM TVD	DM
60	2	49	1	73	162	1.78	CAD,DVD, P/PCI RCA,mild LVD	DM
61	2	53	1	65	164	1.71	CAD,TVD	DM,DLP,POVD
62	2	46	1	66	171	1.77	CAD, TVD	HTN
63	2	61	1	80	159	1.82	CAD,LM TVD P/PCI TO LCX, GDLV	HTN
64	2	54	1	84	165	1.91	CAD, LM DVD	HTN
65	2	49	1	64	164	1.70	CAD,DVD	DM,HTN
66	2	69	2	64	154	1.62	CAD, TVD, P/PCI LAD	DM,HTN
67	2	46	1	66	164	1.71	CAD,LM TVD P/PCI TO LCX, GDLV	DM
68	2	53	1	63	155	1.62	CAD, TVD	DM
69	2	58	1	74	162	1.79	CAD,TVD	HTN
70	2	57	1	67	164	1.73	CAD,TVD	HTN
71	2	57	1	67	157	1.77	CAD, TVD LM 50%	HTN
72	2	62	1	71	167	1.80	CAD , LM TVD	DM,DLP
73	2	63	2	69	162	1.74	CAD,TVD	DM
74	2	62	1	70	163	1.76	CAD, LM TVD	DM,DLP,HTN
75	2	62	1	73	162	1.78	CAD, TVD P/PCI RCA,LCX	HTN
76	2	75	1	66	155	1.75	CAD, TVD	HTN
77	2	62	1	65	166	1.72	CAD, TVD	DLP,HTN
78	2	62	2	66	166	1.73	CAD, TVD, P/PCI RCA	DM,HTN
79	2	63	1	63	158	1.64	CAD, LM TVDp/PCI RCA	DM
80	2	50	2	71	155	1.70	CAD, DVD	DM
81	2	70	1	75	170	1.87	CAD,TVD	HTN,DM, DLP
82	2	64	1	59	152	1.55	CAD, LM 40 TVD,	HTN

83	2	67	1	74	172	1.87	CAD,TVD,	HTN
84	2	52	1	66	161	1.70	CAD, TVD	HTN
85	2	65	1	71	166	1.79	CAD,TVD	DM, DLP
86	2	56	1	72	158	1.74	CAD,TVD,	DM, HTN
87	2	68	1	77	163	1.83	CAD,TVD,p/PCI LAD,RCA	DM,HTN,TB,CVA
88	2	59	2	72	162	1.77	CAD,DVD	DM,DLP,HTN

Master chart

Sl.No	Dyslipidemia	Diabetes Mellitus	Hypertensive	Cardiovascular accident	CKD	Hypothyroidism	POVD	LVEFPreCPB	LVEFPostCPB	MAPSElateralImmPreCPB	MAPSEptalImmPreCPB	MAPSEaverageImmPreCPB	MAPSElateralImmPostCPB	MAPSEptalImmPostCPB
1	1	1	1	2	2	2	2	60	60	11.0	9.6	10.3	13.0	11.0
2	1	2	2	2	2	1	2	66	60	12.0	11.0	11.0	9.0	9.0
3	1	2	1	1	2	2	2	62	62	11.0	10.0	10.5	12.0	11.0
4	1	1	1	2	2	2	2	57	60	9.0	8.0	8.5	9.0	9.0
5	1	1	1	2	2	2	2	60	66	15.0	15.0	15.0	10.0	8.0
6	2	1	2	2	2	2	2	54	62	10.0	15.0	12.5	12.8	11.2
7	2	1	1	2	2	2	2	58	60	12.0	12.0	12.0	10.6	11.2
8	2	1	1	2	2	2	2	61	62	14.0	12.0	13.0	14.0	12.0
9	1	2	1	1	2	2	2	58	64	11.0	8.8	9.9	13.0	11.0
10	2	1	2	2	2	2	1	60	63	14.0	16.0	15.0	12.0	15.0
11	1	1	1	2	2	2	2	58	68	14.0	12.0	13.0	16.0	12.0
12	2	1	2	2	2	2	2	60	58	11.0	9.0	10.0	9.0	8.6
13	1	1	2	2	2	2	2	58	58	12.0	12.0	12.0	10.0	9.0
14	1	2	1	2	2	1	2	66	60	12.0	10.0	11.0	8.4	15.0
15	1	2	1	2	2	2	2	54	58	14.0	10.0	12.0	10.0	9.0
16	2	1	1	2	1	2	2	60	64	12.0	11.0	11.5	13.0	9.0
17	2	1	2	2	2	2	2	62	60	14.0	11.0	12.5	10.8	11.4
18	2	1	2	2	2	2	2	60	64	15.0	11.0	13.0	15.0	12.0
19	2	1	2	2	2	2	2	58	62	12.0	9.0	9.5	13.0	11.0
20	2	1	1	2	2	2	2	55	60	17.0	11.0	14.0	14.0	10.0
21	1	2	1	2	2	2	2	62	55	14.0	12.0	13.0	14.0	12.0
22	1	2	1	1	2	2	2	59	60	10.0	10.0	10.0	14.0	10.0

23	2	1	1	2	2		2	61	62	14.0	10.0	12.0	13.0	11.0
24	2	1	2	2	2	2	2	55	55	12.0	10.0	11.0	15.0	12.0
25	1	1	1	2	2	2	2	66	62	14.0	14.0	14.0	10.0	11.0
26	2	1	2	2	1	2	1	64	52	10.0	12.0	11.0	11.0	9.0
27	2	1	1	2	2	2	2	62	60	11.0	10.0	10.5	10.0	12.0
28	1	1	1	1	2	2	1	60	59	14.0	12.0	11.0	15.0	12.0
29	2	1	1	2	2	2	2	58	61	8.0	10.0	9.0	13.0	12.0
30	2	2	1	2	2	2	2	62	61	8.0	8.0	8.0	12.0	10.0
31	2	1	1	2	2	2	2	60	61	11.0	10.0	10.5	12.0	9.0
32	1	1	1	2	2	1	2	66	58	12.0	11.0	11.5	11.0	9.0
33	2	1	1	2	2	2	2	57	65	10.0	11.0	10.5	15.0	12.0
34	2	1	1	1	2	2	2	62	60	15.0	13.0	14.0	15.0	13.0
35	1	1	1	2	2	2	2	60	62	11.0	12.0	11.5	10.0	12.0
36	1	2	1	2	2	2	2	59	60	10.0	10.0	10.0	10.0	11.0
37	2	1	1	2	2	2	2	65	57	13.0	11.0	12.0	10.0	9.0
38	2	1	1	2	2	2	2	61	58	9.0	13.0	10.5	9.8	10.2
39	2	1	1	2	2	2	2	62	62	15.0	10.0	12.5	12.0	9.0
40	2	1	1	2	2	2	2	68	58	11.0	10.0	10.5	9.0	9.0
41	2	2	1	2	2	2	2	58	60	12.0	10.0	11.0	13.0	13.0
42	2	1	1	2	2	2	2	61	66	10.0	11.0	10.5	15.0	13.0
43	1	2	1	1	2	2	2	60	60	12.0	11.0	11.5	11.8	11.0
44	2	1	1	2	2	2	2	57	60	10.0	13.0	11.5	12.0	11.0
45	1	1	1	2	2	1	2	61	55	10.0	10.0	10.0	11.0	11.0
46	2	1	1	2	2	2	2	60	60	13.0	9.0	11.0	11.2	8.6
47	2	2	1	2	2	2	2	62	54	11.0	10.0	10.5	11.0	12.0
48	2	2	1	2	2	2	2	57	64	9.0	8.0	8.5	15.0	12.0
49	2	2	1	2	2	2	2	54	64	17.0	15.0	16.0	15.1	8.9
50	2	2	1	2	2	2	2	49	61	15.0	15.0	15.0	15.1	14.7
51	1	1	2	2	2	2	1	56	55	12.0	11.0	11.5	8.8	9.0
52	1	1	2	2	2	2	2	61	58	13.0	11.0	12.0	10.8	7.8
53	2	1	1	2	2	2	2	58	55	10.0	10.0	10.0	10.0	9.0
54	2	1	1	2	2	2	2	60	61	14.0	16.0	15.0	11.2	8.6
55	1	2	1	2	2	2	2	58	60	15.0	13.0	14.0	11.0	9.0
56	2	1	2	2	2	2	2	61	60	18.0	14.0	16.0	10.0	10.0
57	2	2	1	2	2	2	2	57	64	10.0	10.0	10.0	13.0	11.0
58	2	1	1	2	2	2	2	66	60	11.0	8.0	10.5	12.0	12.0
59	2	1	2	2	2	2	2	54	60	9.0	7.0	8.0	12.9	12.0
60	2	1	1	2	2	2	2	60	60	14.0	11.0	12.5	12.2	11.0
61	1	1	2	2	2	2	1	62	61	14.0	11.0	12.5	14.0	16.0

62	2	2	1	2	2	2	2	60	57	15.0	12.0	13.5	10.0	10.0
63	2	2	1	2	2	2	2	58	56	10.0	9.0	9.5	9.0	10.0
64	2	2	1	2	2	2	2	55	50	10.0	11.0	10.5	12.0	8.0
65	2	1	1	2	2	2	2	62	60	12.0	11.0	11.5	12.0	10.8
66	2	1	1	2	2	2	2	59	60	11.0	11.0	11.0	12.0	11.0
67	2	1	2	2	2	2	2	61	58	10.0	10.0	10.0	10.9	10.0
68	2	1	2	2	2	2	2	55	57	9.8	9.7	9.8	9.0	8.9
69	2	2	1	2	2	2	2	66	58	10.8	7.8	9.3	9.0	7.0
70	2	2	1	2	2	2	2	64	56	12.2	11.0	11.6	9.9	9.9
71	2	2	1	2	2	2	2	62	68	11.0	10.0	10.5	9.8	9.7
72	1	1	2	2	2	2	2	60	56	14.0	12.0	13.0	11.6	11.0
73	2	1	2	2	2	2	2	60	62	11.0	8.0	10.5	15.0	11.0
74	1	1	1	2	2	2	2	60	60	10.0	10.0	10.0	14.0	12.0
75	2	2	1	2	2	2	2	64	60	10.8	9.2	10.0	10.0	8.4
76	2	2	1	2	2	2	2	62	49	9.9	9.9	9.9	11.8	9.0
77	1	2	1	2	2	2	2	59	62	11.0	12.0	11.5	13.0	11.0
78	2	1	1	2	2	2	2	61	62	10.0	10.0	10.0	15.2	12.0
79	2	1	2	2	2	2	2	60	61	13.0	13.0	13.0	11.0	8.0
80	2	1	2	2	2	2	2	60	60	14.0	12.0	13.0	10.0	10.0
81	1	1	1	2	2	2	2	60	56	11.0	12.0	11.5	9.9	10.2
82	2	2	1	2	2	2	2	57	59	9.0	8.0	8.5	9.8	9.2
83	2	2	1	2	2	2	2	54	62	17.0	15.0	16.0	14.3	14.2
84	2	2	1	2	2	2	2	49	62	15.0	15.0	15.0	15.0	13.0
85	1	1	2	2	2	2	2	56	61	12.0	11.0	11.5	11.0	15.0
86	2	1	1	2	2	2	2	60	60	10.0	10.0	11.0	12.0	11.0
87	2	1	1	1	2	2	2	56	60	8.8	10.2	9.5	14.3	14.2
88	1	1	1	2	2	2	2	60	65	11.0	9.0	10.0	15.1	14.7

Sl.No	LateralTD VPreCPB	SeptalTD VPreCPB	AvrTDVPr eCPB	LateralTD VPostCPB	SeptalTD VPostCPB	AvrTDVpo stCPB	LateralTM AD4CPost CPB	SeptalTM AD4CPreC PB	Midpoint TMAD4CP reCPB	Percentag eTMAD4C PreCPB
1	8.5	5.8	7.2	8.8	8.0	8.4	7.8	5.6	7.6	10.0
2	9.0	6.7	7.9	6.6	8.6	7.6	7.8	8.6	8.4	11.6
3	9.8	8.2	9.0	7.8	7.6	7.7	9.4	7.2	7.5	10.8
4	11.0	8.6	9.8	7.6	7.8	7.7	12.6	8.8	12.1	13.2
5	5.8	6.2	6.0	6.7	9.7	8.2	9.9	11.3	10.2	14.5
6	8.4	7.8	8.1	7.9	8.6	8.3	10.6	9.2	11.2	13.8
7	5.9	5.9	5.9	6.8	7.6	7.2	11.8	7.2	7.6	12.4
8	8.9	6.8	7.9	11.4	9.0	10.2	9.7	6.7	6.8	11.0
9	7.8	7.5	7.7	10.0	8.1	9.1	8.6	9.0	7.1	10.8
10	9.4	8.1	8.8	8.5	7.6	8.1	8.6	10.6	7.2	11.8
11	10.6	9.2	9.9	10.8	11.6	11.2	10.2	8.8	8.4	10.5

12	6.8	9.0	7.9	7.8	7.2	7.5	8.5	8.8	7.9	10.6
13	7.8	6.0	6.9	7.6	7.3	7.5	7.2	8.6	7.8	11.3
14	8.6	6.3	7.5	6.8	7.5	7.2	12.0	11.8	8.9	12.8
15	8.7	7.8	8.3	5.8	6.2	6.0	8.6	12.0	8.5	13.4
16	9.4	6.8	8.1	10.0	9.0	9.5	7.8	7.6	7.5	10.6
17	8.0	9.4	8.7	8.2	8.7	8.5	7.2	7.6	5.8	10.8
18	10.2	7.3	8.8	9.4	11.0	10.2	7.2	5.8	5.5	9.8
19	11.0	9.7	10.4	5.8	8.2	7.0	8.5	6.2	5.9	10.0
20	8.8	8.4	8.6	8.8	7.8	8.3	8.6	12.8	6.8	13.4
21	7.8	7.8	7.8	8.8	8.1	8.5	10.4	9.8	7.5	12.7
22	9.1	7.5	8.3	9.6	8.4	9.0	8.2	7.2	7.6	12.2
23	8.0	7.4	7.7	11.8	11.6	11.7	8.3	8.2	9.3	13.2
24	7.9	8.9	8.4	12.8	5.8	9.3	7.5	4.8	5.8	8.9
25	8.5	8.2	8.4	8.8	9.0	8.9	11.5	2.6	7.2	12.6
26	9.1	8.1	8.6	7.8	9.8	8.8	8.6	8.2	8.2	13.6
27	9.0	7.6	8.3	8.8	7.8	8.3	11.0	10.6	10.6	14.6
28	8.6	7.5	8.1	10.2	8.1	9.2	7.2	7.2	7.8	10.9
29	5.6	6.4	6.0	8.2	10.2	9.2	11.0	5.8	8.7	9.9
30	7.4	6.8	7.1	8.9	9.1	9.0	11.6	10.8	10.0	13.5
31	7.9	8.2	8.1	7.5	7.1	7.3	9.4	7.8	8.5	10.7
32	8.6	7.6	8.1	7.6	8.8	8.2	8.6	7.8	8.5	11.1
33	8.8	7.7	8.3	10.2	11.4	10.8	8.1	7.6	7.6	10.1
34	9.9	8.2	9.1	11.0	10.2	10.6	8.2	8.1	7.6	12.2
35	10.5	9.1	9.8	9.4	7.5	8.5	5.8	8.2	7.5	10.7
36	4.2	5.6	4.9	8.8	7.6	8.2	6.4	7.5	5.8	9.8
37	9.8	8.6	9.2	9.3	6.8	8.1	11.6	9.3	10.3	13.8
38	7.8	7.1	7.5	8.2	8.3	8.3	11.0	10.6	10.0	13.0
39	6.7	5.6	6.2	8.5	8.6	8.6	11.9	7.8	10.2	13.2
40	6.8	5.6	6.2	5.4	6.7	6.1	9.9	4.8	7.2	8.2
41	5.5	6.8	6.2	8.3	7.8	8.1	5.8	6.7	5.8	9.5
42	5.6	5.8	5.7	12.6	11.0	11.8	4.7	2.9	4.1	6.3
43	5.6	6.3	6.0	7.8	7.4	7.6	6.3	6.7	6.2	8.2
44	8.5	7.5	8.0	7.8	8.4	8.1	11.7	8.3	9.5	11.3
45	6.5	5.8	6.2	8.6	8.1	8.4	8.4	7.2	7.6	10.2
46	7.8	6.7	7.3	10.3	8.1	9.2	9.5	8.6	8.8	13.4
47	10.2	7.8	9.0	6.5	6.3	6.4	10.5	5.4	7.5	9.8
48	8.8	8.6	8.7	12.4	9.0	10.7	11.2	8.8	12.1	12.8
49	7.6	7.9	7.8	12.0	13.0	12.5	9.9	11.3	10.2	14.5
50	8.4	8.1	8.3	7.6	7.4	7.5	10.6	9.2	11.2	13.8
51	9.3	5.9	7.6	8.2	5.8	7.0	12.8	7.8	6.5	11.0
52	9.3	6.8	8.1	8.1	7.5	7.8	8.2	6.5	5.8	9.4
53	7.8	7.2	7.5	7.8	7.7	7.8	8.6	7.2	7.1	8.8
54	8.2	8.1	8.2	8.5	5.8	7.2	7.8	7.8	7.2	9.8
55	11.0	9.2	10.1	7.8	7.6	7.7	9.7	8.8	8.4	10.5
56	10.2	9.0	9.6	8.0	7.8	7.9	8.5	9.0	7.9	9.6
57	6.6	5.9	6.3	11.6	8.6	10.1	11.6	10.8	10.0	13.5
58	5.8	6.3	6.1	10.5	8.9	9.7	9.4	7.8	8.5	10.7
59	7.8	7.8	7.8	9.2	6.8	8.0	8.6	7.8	8.5	11.1
60	7.5	6.8	7.2	8.9	8.1	8.5	8.1	7.6	7.6	10.1

61	8.0	9.0	8.5	8.6	7.8	8.2	8.2	8.1	7.6	12.2
62	6.6	7.3	7.0	7.9	7.4	7.7	5.8	8.2	7.5	10.7
63	8.2	8.3	8.3	8.0	6.8	7.4	6.4	7.5	5.8	9.8
64	9.2	8.4	8.8	7.5	7.5	7.5	7.2	7.5	7.8	11.3
65	8.3	7.8	8.1	8.7	8.3	8.5	10.0	11.8	8.9	12.8
66	7.7	7.5	7.6	9.5	7.1	8.3	9.9	12.0	8.5	13.4
67	7.8	7.4	7.6	7.9	7.5	7.7	6.1	7.6	7.5	10.6
68	11.4	8.9	10.2	6.8	7.1	7.0	7.2	7.6	5.8	10.8
69	7.9	8.0	8.0	7.0	6.8	6.9	7.2	5.8	5.5	9.8
70	8.8	8.1	8.5	10.0	9.2	9.6	8.5	6.2	5.9	11.0
71	7.9	7.6	7.8	7.9	8.1	8.0	8.6	12.8	6.8	13.4
72	7.6	7.5	7.6	7.6	6.8	7.2	8.2	10.7	7.5	12.7
73	9.5	8.3	8.9	8.0	8.3	8.2	7.6	10.6	10.8	14.0
74	9.5	8.9	9.2	8.9	7.5	8.2	7.2	7.8	9.0	11.8
75	9.1	8.1	8.6	7.8	6.7	7.3	6.2	8.3	7.8	12.0
76	7.0	6.8	6.9	9.5	8.4	9.0	9.8	7.2	7.5	12.0
77	8.1	7.8	8.0	8.8	7.2	8.0	10.0	8.6	8.7	13.0
78	8.1	7.6	7.9	7.9	7.1	7.5	10.2	7.4	9.4	15.4
79	6.2	7.0	6.6	8.6	7.0	7.8	8.4	8.2	8.1	13.5
80	7.9	7.1	7.5	7.9	6.8	7.4	9.0	8.2	7.8	12.5
81	8.3	5.8	7.1	7.5	6.4	7.0	6.2	6.2	5.5	7.4
82	8.8	8.6	8.7	7.6	7.8	7.7	7.8	7.9	5.8	8.8
83	7.6	7.9	7.8	11.6	8.6	10.1	9.9	11.2	11.1	14.5
84	8.4	8.1	8.3	11.0	10.2	10.6	8.9	7.2	7.5	11.9
85	9.3	5.9	7.6	8.5	5.8	7.2	7.6	7.2	7.8	12.6
86	7.5	7.1	7.3	9.2	6.8	8.0	7.2	5.5	8.8	10.0
87	9.5	8.5	9.0	8.0	8.3	8.2	11.0	10.6	8.4	13.5
88	11.0	9.0	10.0	11.3	9.0	10.2	9.9	11.2	11.1	14.5

Sl.No	LateralGLS4CPreCPB	SeptalGLS4CPreCPB	RegionalGLS4CPreCPB	AnteriorGLS2CPreCPB	InferiorGLS2CPreCPB	RegionalGLS2CPreCPB	AnteriorGLS3CPreCPB	InferiorGLS3CPreCPB	RegionalGLS3CPreCPB	FinalGLSPreCPB
1	-14	-11	-9	-10	-11	-15	-11	-8	-6	-11
2	-10	-12	-13	-21	-16	-14	-9	-18	-11	-16
3	-13	-18	-15	-10	-9	-14	-15	-17	-11	-16
4	-20	-21	-16	-6	-15	-12	-9	-15	-8	-12
5	-15	-21	-16	-11	-18	-11	-16	-17	-8	-14
6	-15	-13	-10	-9	-8	-9	-10	-13	-11	-10
7	-8	-9	-10	-14	-18	-13	-11	-13	-12	-13

8	-17	-9	-24	-11	-17	-16	-14	-15	-17	-17
9	9	8	-7	-15	-6	-11	10	8	-11	-9
10	-13	-10	-11	-13	-15	-16	-18	-10	-13	-15
11	-12	-15	-14	-11	-18	-17	-11	-11	-10	-15
12	-7	-11	-13	-15	-9	-13	-11	-14	-12	-13
13	-18	-14	-19	-13	-13	-15	-18	-17	-13	-16
14	-13	-15	-10	-11	-14	-20	-11	-13	-11	-14
15	-17	-16	-18	-15	-15	-13	-11	-13	-12	-18
16	-9	7	-9	-11	-15	-13	-11	-15	-17	-10
17	-17	-12	-17	-13	-11	-14	-13	-11	-12	-15
18	-13	-15	-14	-18	-16	-11	-20	-18	-11	-18
19	-15	-13	-17	-11	-9	-12	-14	-11	-13	-11
20	-12	-15	-14	-18	-15	-17	-16	-13	-11	-15
21	-19	-22	-20	-17	-24	-17	-18	-9	-12	-22
22	-9	-11	-7	-9	-14	-11	-15	-14	-10	-10
23	-1	-2	-1	2	-1	2	-7	0	1	-8
24	-7	-11	-11	-15	-11	-4	-9	-13	-11	-11
25	-9	-20	-12	-10	-18	-14	-23	-22	-19	-19
26	-14	-18	-15	-14	-13	-15	-22	-18	-17	-16
27	-18	-22	-20	-18	-10	-18	-9	-16	-15	-18
28	-9	8	-7	-18	10	-10	-11	-10	-10	-9
29	-11	-10	-9	-10	-13	-16	-15	-15	-17	-17
30	-14	-13	-15	-10	-11	-13	-14	-15	-16	-16
31	-10	-9	-8	-10	-18	-14	-12	-15	-11	-14
32	-7	-10	-8	-10	-11	-10	-22	-9	-11	-15
33	-17	-12	-22	-14	-12	-14	-10	-9	-8	-10
34	-12	-14	-18	-11	-11	-16	-15	-9	-10	-14
35	-15	-15	-22	-14	-15	-12	-10	-16	-15	-16
36	-20	-17	-14	-6	-10	8	-12	-8	-12	-11
37	-17	-17	-24	-11	-17	-16	-14	-15	-17	-17
38	-19	-15	-21	-15	-16	-13	-15	-10	-11	-15
39	-14	-10	-10	-9	-10	-10	-14	-10	-13	-11
40	-8	-6	-8	-11	-10	-12	-11	-9	-10	-8
41	-7	-11	-11	-15	11	-4	-9	-13	-11	-11
42	-10	-20	-12	-10	-18	-14	-23	-22	-19	-19
43	-7	-11	-8	-11	-9	-10	-11	-9	-11	-11
44	-17	-16	-18	-15	-16	-13	-11	-13	-12	-18
45	-14	12	8	-8	-8	-9	-11	-8	-1	-9
46	-10	-10	-9	-25	-9	-9	-10	-21	-11	-10
47	-28	-20	-16	-9	-16	-14	-11	-17	-11	-13
48	-18	-21	-14	-6	-15	-11	-13	-15	-8	-12
49	-15	-21	-16	-12	-18	-11	-17	-17	-8	-14
50	-15	-13	-10	-9	-8	-9	-10	-13	-11	-10
51	7	7	6	-14	-24	-14	-11	-13	-12	-13
52	-17	-17	-24	-11	-17	-16	-14	-15	-17	-17
53	-19	-15	-21	-15	-16	-13	-15	-10	-11	-15

54	-14	-10	-10	-9	-10	-10	-14	-10	-13	-11
55	-8	-6	-8	-11	-10	-12	-11	-9	-10	-8
56	-14	-22	-18	-15	-17	-17	-11	-14	-12	-17
57	-11	-14	-12	-13	-15	-15	-18	-17	-13	-16
58	-7	-11	-8	-11	-9	-10	-11	-10	-11	-11
59	-17	-16	-18	-15	-15	-13	-11	-13	-12	-18
60	-14	-20	-11	-10	-12	-15	-18	-16	-12	-13
61	-20	-12	-17	-13	-11	-14	-10	-11	-7	-14
62	-18	-22	-18	-25	-11	-10	-10	-20	-11	-18
63	-14	-13	-14	-11	-20	-12	-14	-11	-13	-14
64	-9	-10	-11	-10	-18	-17	-10	-13	-11	-15
65	-19	-22	-17	-17	-24	-17	-18	-9	-12	-22
66	-9	-7	-7	-9	-14	-11	-15	-14	-10	-10
67	-1	-2	-1	2	-1	2	1	0	1	-8
68	-7	-11	-11	-15	11	-4	-9	-13	-11	-11
69	-10	-20	-12	-10	-18	-14	-23	-22	-19	-19
70	-9	-18	-15	-14	-13	-15	-22	-18	-17	-16
71	-18	-22	-20	-18	-10	-18	-9	-16	-15	-18
72	-9	8	-7	-18	10	-10	-11	-10	-10	-9
73	-20	-12	-17	-13	-11	-14	-10	-11	-7	-14
74	-18	-22	-18	-25	-11	-10	-10	-20	-11	-18
75	-14	-13	-14	-11	-20	-12	-14	-11	-13	-14
76	-12	-20	-18	-10	-13	-15	-18	-12	-19	-20
77	-17	-10	-14	-15	-14	-15	-13	-14	-15	-16
78	-20	-12	-10	-13	-11	-13	-10	-11	-7	-14
79	-18	-22	-18	-25	-11	-10	-9	-20	-11	-18
80	-14	-18	-14	-11	-14	-12	-14	-11	-13	-14
81	-14	-20	-11	-10	-12	-15	-18	-16	-12	-13
82	-18	-21	-14	-6	-15	-11	-13	-15	-8	-12
83	-15	-21	-16	-12	-18	-11	-17	-17	-8	-14
84	-15	-13	-10	-9	-8	-9	-10	-13	-11	-10
85	7	7	6	-14	-24	-14	-11	-13	-12	-13
86	-14	-13	-15	-11	-20	-12	-14	-11	-13	-15
87	-12	-20	-18	-10	-13	-15	-18	-12	-19	-20
88	-14	-10	-14	-15	-14	-15	-13	-14	-15	-16

Sl.No	Lateral GLS 4C Post-CPB	Septal GLS4C Post-CPB	Regional GLS4C Post-CPB	Anterior GLS2C-Post-CPB	Inferior GLS2C Post-CPB	Regional GLS2C PostCPB	Anterior GLS3C PostCPB	Inferior GLS3C PostCPB	Regional GLS3C PostCPB	Final GLS PostCPB
1	-18	-16	-17	-15	-19	-18	-20	-18	-17	-18
2	-10	-15	-11	-13	-18	-15	-16	-13	-15	-14
3	-9	-23	-18	-14	-8	-10	-17	-8	-13	-16
4	-14	-11	-15	-13	-17	-16	-8	-19	-12	-12
5	-20	-18	-16	-10	-18	-16	-20	-14	-12	-11
6	-10	-10	-16	-8	-13	-9	-13	-7	-13	-16
7	-16	-14	-18	-11	-17	-16	-14	-15	-17	-10
8	-10	-15	-21	-15	-16	-13	-15	-10	-11	-18
9	-14	-10	-18	-9	-10	-12	-14	-10	-13	-14
10	-15	-21	-15	-26	-11	-25	-17	-16	-21	-17
11	-16	-16	-21	-15	-16	-13	-15	-10	-11	-15
12	-14	-10	-18	-9	-10	-11	-14	-10	-13	-11
13	-8	-10	-8	-11	-10	-12	-11	-9	-10	-10
14	-14	-17	-14	-6	-19	6	-10	-22	-19	-11
15	-16	-10	-15	-13	-11	-14	-11	-12	-13	-11
16	-18	-14	-17	-11	-7	-10	-18	-12	-14	-16
17	-10	-17	-11	-15	-9	-10	-9	-13	-11	-13
18	-10	-20	-12	-10	-18	-14	-20	-18	-19	-17
19	-14	-18	-15	-16	-13	-15	-16	-18	-17	-17
20	-18	-22	-20	-18	-10	-18	-9	-16	-15	-16
21	-18	-22	-18	-25	-11	-9	-10	-20	-11	-19
22	-14	-13	-14	-11	-20	-12	-14	-11	-13	-18
23	-12	-20	-18	-10	-13	-15	-18	-12	-19	-18
24	-17	-14	-14	-15	-14	-15	-13	-14	-15	-17
25	-18	-12	-11	-13	-11	-13	-10	-11	-7	-14
26	-16	-22	-18	-25	-11	-10	-9	-20	-11	-14
27	-14	-15	-14	-11	-14	-12	-14	-11	-13	-15
28	-18	-13	-18	-15	-13	-10	-8	-12	-15	-17
29	-11	-10	-12	-9	-11	-12	-14	-13	-15	-18
30	-10	-15	-20	-15	-12	-14	-13	-11	-9	-15
31	-10	-18	-9	-10	-11	-14	-8	-16	-9	-11
32	-13	-9	-15	-12	-11	-19	-10	-10	-11	-14
33	-14	-16	-10	-11	-12	-13	-18	-14	-13	-18
34	-13	-16	-10	-22	-10	-13	-11	-12	-10	-17
35	-18	-22	-20	-12	-13	-13	-24	-18	-16	-15
36	-13	-18	-16	-11	-9	-13	-20	-11	-16	-14
37	-17	-23	-22	-17	-8	-13	-12	-14	-14	-11
38	-10	-9	-9	-11	-12	-8	-11	-9	-10	-12
39	-9	-11	-14	-11	-10	-11	-9	-11	-8	-15
40	-12	-13	-12	-11	-10	-11	-9	-11	-10	-10
41	-8	-20	-18	-9	-11	-15	-2	-8	-7	-19

42	-10	-20	-4	-10	-18	-14	-16	-16	-17	-17
43	-12	-14	-12	-13	15	-14	-11	-13	-15	-15
44	-13	-21	-17	-16	-21	-19	-12	-14	-15	-18
45	-10	-9	6	-8	11	-3	-4	-9	-4	-12
46	-9	-7	-7	-9	-21	-11	-14	-9	-10	-16
47	-18	-12	-18	-13	-11	-14	-10	-11	-7	-14
48	-12	-22	-16	-25	-11	-9	-12	-20	-11	-18
49	-15	-13	-15	-11	-15	-12	-14	-11	-13	-17
50	-13	-20	-18	-10	-13	-15	-18	-12	-19	-18
51	-1	-2	-1	2	-1	2	1	0	1	-10
52	-13	-13	-15	-8	-15	-16	-20	-15	-17	-9
53	-12	-15	-16	-22	-18	-15	-20	-13	-16	-11
54	-10	-11	-11	-10	-10	-11	-9	-8	-18	-15
55	-14	-11	-15	-13	-17	-16	-8	-19	-12	-15
56	-13	-17	-14	-10	-8	-11	-22	-10	-12	-15
57	-10	-10	-9	-8	-7	-11	-13	-12	-13	-17
58	-17	-14	-18	-11	-17	-16	-14	-15	-17	-15
59	-20	-15	-21	-15	-16	-13	-15	-10	-11	-15
60	-14	-10	-10	-9	-10	-12	-14	-10	-13	-16
61	-15	-21	-15	-26	-11	-25	-17	-16	-21	-17
62	-19	-15	-21	-15	-16	-13	-15	-10	-11	-11
63	-14	-10	-10	-9	-10	-11	-14	-10	-13	-11
64	-8	-10	-8	-11	-10	-12	-11	-9	-10	-14
65	-14	-17	-14	-6	12	6	-10	-22	-19	-17
66	-20	-10	-15	-13	-11	-14	-11	-12	-13	-16
67	-10	-15	-17	-11	-7	-10	-18	-12	-14	-11
68	-10	-11	-11	-15	-9	-10	-9	-13	-11	-8
69	-10	-20	-12	-10	-18	-14	-20	-18	-19	-8
70	-14	-18	-15	-16	-13	-15	-16	-18	-17	-11
71	-18	-22	-20	-18	-10	-18	-9	-16	-15	-10
72	-9	-11	-7	-15	10	-10	-11	-10	-10	-11
73	-17	-12	-17	-13	-11	-14	-10	-11	-7	-17
74	-18	-22	-18	-25	-11	-9	-10	-20	-11	-16
75	-14	-13	-14	-11	-20	-12	-14	-11	-13	-14
76	-12	-20	-18	-10	-13	-15	-18	-12	-19	-11
77	-17	-14	-14	-15	-14	-15	-13	-14	-15	-16
78	-18	-12	-11	-13	-11	-13	-10	-11	-7	-17
79	-16	-22	-18	-25	-11	-10	-9	-20	-11	-14
80	-14	-18	-14	-11	-14	-12	-14	-11	-13	-14
81	-20	-13	-11	-13	-10	-9	-12	-12	-17	-10
82	-12	-22	-16	-25	-11	-9	-12	-20	-11	-10
83	-15	-13	-15	-11	-15	-12	-14	-11	-13	-18
84	-13	-20	-18	-10	-13	-15	-18	-12	-19	-17
85	-1	-2	-1	2	-1	2	1	0	1	-14
86	-14	-16	-10	-11	-12	-13	-18	-14	-13	-16
87	-13	-16	-10	-22	-10	-13	-11	-12	-10	-17
88	-18	-22	-20	-12	-13	-13	-24	-18	-16	-19

Sl.No	HR beats/minute Preoperative	SBP mmHg Preoperative	DBP mmHg Preoperative	MBP mmHg Preoperative	SpO2 Preoperative	HR beats/min PreCPB	SBP mmHg PreCPB	DBP mmHg PreCPB	MBP mmHg PreCPB	CVP mmHg PreCPB	HR beats/min PostCPB	SBP mmHg PostCPB	DBP mmHg PostCPB	MBP mmHg PostCPB	CVP mmHg PostCPB
1	71	138	76	88	98	72	154	82	110	10	74	118	68	82	5
2	68	128	68	78	99	58	138	84	90	8	72	114	72	88	6
3	58	142	74	92	99	66	126	80	82	9	82	136	74	88	8
4	76	188	106	128	98	88	145	91	112	4	71	108	59	67	5
5	88	162	90	118	99	92	184	114	132	8	68	134	78	93	8
6	66	142	68	82	99	77	118	78	82	8	78	124	80	94	8
7	66	128	64	82	98	71	206	105	118	6	74	124	64	76	5
8	64	176	96	124	98	72	132	88	94	8	85	138	60	85	7
9	73	158	86	106	99	66	164	88	98	10	68	121	64	81	8
10	76	118	76	92	97	56	120	84	92	8	88	132	64	80	6
11	84	128	72	102	98	68	156	88	106	5	78	112	56	63	5
12	62	132	76	86	99	66	112	65	73	7	66	108	56	71	6
13	70	141	65	82	99	69	188	88	124	10	88	132	72	83	7
14	70	128	64	80	99	70	143	86	92	8	81	120	82	88	6
15	64	126	68	81	99	70	122	73	84	7	58	111	57	67	8
16	64	167	86	117	99	71	126	80	84	8	68	122	64	81	7
17	62	142	76	92	99	71	122	63	83	9	77	117	59	65	4
18	88	130	82	99	99	85	110	64	76	8	66	140	82	88	8
19	82	138	76	88	99	88	172	90	106	7	82	132	80	75	5
20	74	124	76	82	99	84	176	110	125	7	69	127	63	78	6
21	76	144	78	94	99	77	128	75	88	8	88	136	88	89	8
22	66	130	74	86	98	59	176	86	104	7	70	108	68	78	4
23	80	177	96	123	99	71	122	72	78	8	78	114	58	68	5
24	74	128	64	82	96	75	118	78	82	9	97	116	64	76	9
25	81	152	88	124	99	77	210	116	148	7	88	132	68	88	7
26	54	144	78	102	98	72	158	93	103	8	86	118	72	84	7
27	64	118	76	88	99	68	190	116	136	9	88	126	88	89	8
28	74	128	72	85	97	64	138	66	86	7	68	114	63	78	6
29	70	188	88	126	99	62	188	106	124	9	78	128	78	86	8
30	70	128	77	88	98	77	116	80	82	8	58	112	56	72	7
31	65	122	74	80	99	75	206	116	132	10	66	118	64	76	7
32	80	140	80	106	99	77	154	92	114	9	72	121	71	80	9
33	70	138	68	88	99	66	138	66	86	5	83	112	64	74	4
34	75	140	75	103	97	54	134	76	86	11	78	125	78	81	6
35	71	138	78	88	99	52	125	82	87	10	60	112	58	64	7
36	78	138	82	96	98	70	121	83	97	7	68	114	74	81	6
37	72	110	74	80	99	62	164	94	113	9	90	124	68	76	8

38	88	122	82	88	99	60	145	86	98	5	75	103	72	64	5
39	86	142	86	122	99	88	186	94	144	8	94	132	64	88	6
40	58	134	76	88	99	60	133	78	84	8	65	106	64	73	6
41	62	130	74	86	99	57	122	84	90	8	68	124	78	84	7
42	64	166	92	114	99	92	118	80	82	9	72	116	58	76	6
43	58	152	88	126	99	58	150	68	88	6	76	148	74	84	5
44	76	144	76	102	98	78	156	84	102	6	64	106	52	72	6
45	55	180	82	110	98	55	180	82	110	12	71	115	63	74	6
46	68	186	108	128	99	68	206	110	134	10	72	108	64	72	2
47	66	120	76	88	97	71	160	96	118	9	75	131	71	88	8
48	64	128	58	92	99	66	145	91	112	4	71	108	59	67	5
49	66	148	78	112	99	66	206	108	148	7	78	131	81	93	8
50	48	166	98	124	100	50	163	99	116	6	68	124	80	94	8
51	72	138	74	88	99	72	180	105	117	6	74	126	64	75	5
52	60	213	79	119	99	62	202	88	118	7	71	138	60	85	7
53	64	132	82	96	100	76	128	85	93	8	78	116	58	74	8
54	73	146	94	110	99	62	154	90	108	7	88	126	64	76	6
55	76	132	80	100	98	70	156	88	106	5	78	112	56	63	5
56	84	116	77	85	99	70	112	65	73	7	66	108	56	71	6
57	62	120	74	78	100	64	188	88	126	10	71	132	66	83	5
58	70	128	88	94	99	64	143	86	92	8	81	120	82	88	6
59	70	185	96	128	99	62	122	73	84	7	58	111	57	67	8
60	64	136	86	88	99	88	118	72	84	8	82	126	64	81	7
61	64	117	72	83	100	82	122	63	83	9	77	117	59	65	4
62	62	122	77	85	98	58	114	64	76	8	66	140	82	88	8
63	88	160	90	124	99	80	160	90	106	7	82	132	80	75	5
64	82	154	92	112	99	52	176	110	125	7	69	127	63	78	6
65	74	133	75	94	100	70	133	75	94	6	88	126	88	89	8
66	76	156	85	113	100	62	140	86	96	7	70	118	68	78	9
67	66	142	84	110	100	77	122	63	78	8	78	114	58	68	5
68	80	113	79	81	99	72	113	78	92	7	97	130	64	87	10
69	74	188	105	135	100	62	224	104	148	7	88	128	68	88	7
70	81	190	112	142	96	56	158	93	103	8	86	118	72	84	7
71	54	138	96	106	97	68	210	116	132	6	88	126	88	89	8
72	64	195	108	142	99	74	251	101	152	7	78	126	63	86	4
73	60	152	80	99	99	62	150	78	88	6	66	125	76	88	8
74	99	118	82	86	99	56	122	67	83	8	61	108	56	66	5
75	82	116	74	82	99	60	119	86	88	7	71	116	82	85	7
76	66	148	96	113	99	71	120	68	82	8	88	118	80	84	7
77	56	131	81	88	99	54	131	81	101	8	71	125	65	77	6
78	71	122	72	84	97	80	124	64	78	9	72	148	92	88	7
79	72	122	68	88	97	88	186	88	124	9	71	124	75	83	7
80	77	152	100	112	100	75	146	96	110	8	50	119	62	78	8
81	56	188	82	140	98	56	190	90	146	7	72	120	66	82	13
82	64	128	58	92	99	66	145	91	112	4	71	108	59	67	5
83	66	148	78	112	99	66	206	108	148	7	78	131	81	93	8

84	48	166	98	124	100	50	163	99	116	6	68	124	80	94	8
85	72	138	74	88	99	72	180	105	117	6	74	126	64	75	5
86	70	138	68	88	99	66	138	66	86	5	83	112	64	74	4
87	75	140	75	103	97	54	126	62	76	7	76	116	64	76	8
88	71	138	78	88	99	52	156	84	100	7	80	118	66	82	7

Sl.No	HR beats/min CPB Weaning values	SBP mmHg CPB Weaning values	DBP mmHg CPB Weaning values	MBP mmHg CPB Weaning values	CVP mmHg CPB Weaning values	Hb g/dl CPB Weaning values	LVOT diameter cm CPB Weaning values	LVOT cross-sectional area cm <sup>2</sup> CPB Weaning values	LVOT VTI cm CPB Weaning values	LVOT stroke volume ml/beat CPB Weaning values	LVOT cardiac output L/min CPB Weaning values	LVOT Cardiac Index l/min/m <sup>2</sup> CPB Weaning values	Inotropic support CPB Weaning values	CPB time Minutes	ACC time in minutes
1	72	110	66	76	5	9.1	18	2.20	18.10	75	3.8	2.10	1	110	56
2	82	156	87	92	8	10.0	22	3.20	26.30	75	6.4	3.70	2	104	61
3	64	111	65	76	7	11.6	18	3.10	25.00	62	5.4	3.10	2	141	88
4	72	108	64	71	8	9.6	21	2.60	22.00	63	4.2	2.40	2	105	55
5	78	126	66	78	6	9.7	19	2.30	18.60	63	4.7	2.70	2	116	66
6	90	108	76	78	10	9.7	19	3.00	22.00	71	4.9	2.80	2	105	70
7	86	116	66	76	8	10.6	20	3.20	25.00	78	6.6	3.60	2	153	94
8	76	108	58	66	7	10.8	19	2.80	22.00	58	3.6	2.20	2	114	70
9	78	100	58	72	9	8.6	20	2.80	21.00	65	4.5	2.50	2	116	78
10	72	123	64	79	10	9.4	20	3.20	21.60	68	4.2	2.40	2	108	70
11	72	108	54	62	4	9.8	19	2.80	1.72	47	2.9	1.68	1	100	55
12	68	126	76	88	7	10.4	20	4.10	23.00	72	5.7	3.20	2	118	62
13	77	114	74	83	8	8.8	20	3.80	18.20	62	6.0	3.60	2	109	50
14	74	120	74	82	6	8.6	19	3.10	25.70	73	5.8	3.70	2	110	55
15	74	118	70	84	6	10.2	20	3.20	19.00	62	4.2	2.40	2	108	58
16	84	124	68	72	6	9.3	19	2.70	18.00	63	3.8	2.10	2	128	60
17	56	112	54	62	7	9.8	19	2.80	17.20	47	3.4	1.80	2	106	61
18	58	117	65	74	8	9.1	19	2.80	21.00	56	5.6	3.30	1	108	59
19	64	112	63	75	7	10.0	19	2.70	22.00	58	5.6	3.30	2	114	62
20	72	108	68	76	5	8.9	19	2.20	18.10	75	3.8	2.10	2	114	62

21	56	118	68	74	6	9.6	20	2.30	20.00	68	5.4	2.90	2	108	60
22	76	110	52	66	5	10.2	19	2.60	20.00	63	6.6	3.80	2	104	60
23	79	128	66	82	6	10.2	21	3.46	13.10	37	2.9	1.60	1	108	62
24	92	136	74	82	8	9.6	20	3.14	20.40	64	6.2	3.80	2	132	60
25	56	108	54	68	8	9.6	18	2.27	11.90	27	4.5	2.70	2	120	70
26	55	110	52	66	5	10.2	19	2.60	20.00	63	6.6	3.60	2	114	70
27	79	128	66	82	6	10.2	21	3.46	13.10	37	2.9	1.60	1	140	92
28	95	108	58	75	6	10.2	19	3.14	20.40	57	5.3	2.90	2	120	80
29	56	99	54	62	6	9.6	17	2.27	18.00	27	2.6	1.50	1	149	78
30	55	110	52	66	5	10.2	19	2.60	20.00	63	6.6	3.90	2	110	64
31	79	132	78	90	9	11.4	21	3.46	13.10	57	4.8	2.60	2	135	82
32	95	124	58	75	6	10.2	20	3.14	20.40	64	6.0	3.60	2	140	90
33	83	102	54	62	4	9.8	19	2.84	1.72	47	2.9	1.70	1	120	80
34	87	128	76	88	7	10.4	19	2.30	23.00	72	6.3	3.40	2	108	60
35	76	114	74	83	7	9.4	20	2.30	18.30	65	5.8	3.30	2	106	60
36	74	116	54	68	4	9.6	23	4.15	20.10	85	6.0	3.40	2	110	64
37	78	124	58	72	8	11.1	23	2.27	18.30	57	4.3	2.40	2	120	70
38	90	106	56	71	4	10.1	18	2.54	17.70	45	4.1	2.20	2	110	56
39	87	140	68	84	9	9.3	20	2.80	23.00	72	6.3	3.50	2	108	56
40	76	124	63	71	7	10.2	22	18.10	18.10	75	3.8	2.20	2	108	60
41	56	99	54	62	6	9.6	17	2.27	11.90	27	2.6	1.60	1	110	60
42	55	110	52	66	5	9.8	19	2.60	20.00	63	6.6	3.90	2	127	55
43	79	128	66	82	6	11.2	21	3.46	13.10	48	3.8	2.20	1	107	54
44	95	124	58	75	6	10.2	20	3.14	20.40	64	5.7	3.20	2	140	82
45	76	132	76	83	11	9.7	19	3.00	22.00	71	4.9	3.00	2	110	56
46	112	119	68	78	4	11.4	20	3.10	25.00	58	3.5	1.83	1	104	56
47	90	118	72	82	5	9.4	19	2.80	23.00	62	4.1	2.30	2	167	111
48	65	123	62	77	6	8.8	21	3.10	22.40	64	4.2	2.70	2	105	55
49	76	126	74	90	8	8.6	18	2.80	25.70	73	5.8	3.10	1	116	66
50	89	131	76	84	6	9.4	20	3.20	17.00	66	4.0	2.30	2	105	70
51	66	124	68	72	6	9.3	19	2.80	18.00	63	3.8	2.10	1	127	55
52	72	104	56	71	5	10.2	19	2.80	23.00	62	3.8	2.20	2	107	54
53	62	122	78	88	7	11.2	21	3.20	25.00	72	6.2	3.80	2	140	82
54	78	117	65	74	8	9.1	19	2.80	21.00	56	5.8	3.50	2	123	70
55	76	112	72	76	7	10.0	19	2.70	21.00	58	5.6	3.10	2	100	55
56	70	108	68	76	5	8.9	19	2.20	18.10	75	3.8	2.10	2	121	56
57	58	156	87	92	8	10.0	22	3.20	26.30	75	6.4	3.70	2	109	50
58	64	111	65	76	7	11.6	18	2.80	23.00	62	4.3	2.44	2	110	55
59	88	108	62	71	8	9.6	21	2.80	22.00	63	4.1	2.60	2	108	58
60	68	100	56	62	5	9.1	19	2.30	19.00	51	3.5	2.00	2	128	60
61	77	132	76	83	11	9.7	19	3.00	22.00	71	4.9	2.80	1	106	61
62	52	116	66	76	8	9.3	20	3.20	25.00	78	6.6	3.70	2	153	94
63	76	108	58	66	7	10.8	19	2.80	22.00	58	3.6	2.00	2	114	70
64	78	148	86	92	9	11.8	20	2.80	21.00	65	6.7	3.50	2	116	78
65	72	119	58	79	14	9.4	20	3.00	21.60	68	4.2	2.50	2	108	70
66	72	108	54	62	4	9.8	19	2.80	1.72	47	2.9	1.80	2	104	60
67	80	126	76	88	8	10.4	20	4.10	23.00	72	5.7	3.40	2	108	62
68	77	114	74	83	5	8.8	20	3.80	18.20	62	6.0	3.70	1	132	60

69	75	120	74	82	6	8.6	19	3.10	25.70	73	5.8	3.20	2	120	70
70	76	131	67	84	6	9.4	20	3.20	19.00	66	4.0	2.30	2	114	70
71	84	124	68	72	6	9.3	19	2.70	18.00	63	3.8	2.20	2	140	92
72	66	112	54	62	4	9.8	19	2.80	17.20	47	2.9	1.60	2	120	80
73	58	117	65	74	8	9.1	19	2.80	21.00	56	5.6	3.20	1	149	78
74	64	112	63	75	7	10.0	19	2.70	22.00	58	5.6	3.20	2	110	64
75	72	108	68	76	5	8.9	19	2.20	18.10	75	3.8	2.20	2	135	82
76	75	146	82	94	8	10.0	22	3.20	25.20	75	5.8	3.30	2	140	90
77	75	110	66	82	12	11.2	20	3.30	22.00	62	4.8	2.80	1	120	80
78	76	126	74	76	8	8.9	20	3.20	25.00	63	5.1	2.90	2	108	60
79	88	120	76	80	7	9.7	18	2.80	18.00	48	3.7	2.30	2	106	60
80	76	110	70	78	7	10.5	19	2.90	19.00	58	4.3	2.50	2	110	64
81	76	108	62	80	14	9.4	22	3.80	18.40	70	5.1	2.70	1	123	70
82	65	123	62	77	6	8.8	21	3.10	22.40	64	4.2	2.70	2	105	55
83	76	126	74	90	8	8.6	19	3.10	25.70	73	5.8	3.10	1	116	66
84	89	131	76	84	6	9.4	20	3.20	17.00	66	4.0	2.40	2	105	70
85	66	124	68	72	6	9.3	19	2.80	18.00	63	3.8	2.20	1	127	55
86	83	102	54	62	4	9.8	19	2.80	1.72	47	2.9	1.70	1	110	61
87	87	136	76	88	8	10.4	20	4.10	23.00	72	6.3	3.40	2	104	62
88	76	114	74	83	5	8.8	20	3.80	18.20	62	6.0	3.50	2	118	58

Sl.No	TMAD Pre Intra-Observer Variability	TMAD Post Intra-Observer Variability	GLS Pre Intra-Observer Variability	GLS Post Intra-Observer Variability	TMAD 1Inter-Observer Variability	TMAD 2Inter-Observer Variability	GLS 1Inter-Observer Variability	GLS 2Inter-Observer Variability	TMAD time in seconds	GLS time in seconds
1	10.0	10.2	-11	-11	12.2	12.2	-9	-9	16	58
2	11.6	11.6	-16	-15	12.0	11.8	-10	-11	14	68
3	10.8	10.6	-16	-16	9.4	10.0	-13	-13	15	70
4	13.2	12.8	-12	-12	8.8	8.8	-12	-12	12	72
5	14.5	14.5	-14	-13	10.4	10.5	-14	-15	15	83
6	13.8	13.6	-10	-10	10.5	10.5	-10	-10	18	75
7	12.4	12.6	-13	-13	9.6	9.8	-13	-13	15	76
8	11.0	11.0	-17	-18	12.0	12.0	-17	-16	16	88
9	10.8	10.8	-9	-9	11.0	11.1	-15	-15	17	76
10	11.8	10.6	-15	-15	11.1	11.1	-11	-11	14	80
11	10.5	10.4	-15	-14	13.8	13.6	-8	-10	15	68
12	10.6	10.9	-13	-13	11.0	11.5	-17	-15	16	68
13	11.3	11.1	-16	-16	9.4	9.6	-16	-18	15	64
14	12.8	12.8	-14	-14	10.5	10.5	-11	-11	12	62

15	13.4	13.8	-18	-20	9.8	9.8	-18	-18	16	78
16	10.6	10.4	-10	-10	10.5	10.4	-13	-13	17	68
17	10.8	10.8	-15	-15	9.6	9.6	-14	-12	18	62
18	9.8	10.0	-18	-16	12.5	12.5	-18	-18	15	76
19	10.0	10.0	-11	-11	10.7	10.6	-14	-14	15	72
20	13.4	12.6	-15	-15	11.1	11.2	-15	-13	15	65
21	12.7	12.5	-22	-20	11.3	11.2	-22	-21	15	56
22	12.2	12.4	-10	-10	10.0	10.0	-10	-10	16	70
23	13.2	12.8	-8	-7	12.4	12.4	-8	-10	17	70
24	8.9	9.0	-11	-11	12.2	12.6	-11	-11	18	88
25	12.6	12.6	-19	-18	11.2	12.0	-19	-18	15	64
26	13.6	13.5	-16	-16	10.8	11.0	-16	-16	16	60
27	14.6	14.8	-18	-18	11.8	11.4	-18	-18	14	56
28	10.9	11.0	-9	-9	14.2	13.6	-9	-9	14	66
29	9.9	10.1	-17	-16	10.4	12.1	-14	-14	14	72
30	13.5	13.4	-16	-16	11.6	11.6	-18	-17	14	72
31	10.7	11.2	-14	-14	12.0	11.8	-14	-14	13	68
32	11.1	11.1	-15	-15	12.0	12.0	-20	-20	15	58
33	10.1	10.0	-10	-10	12.6	12.5	-16	-16	15	66
34	12.2	12.1	-14	-14	11.0	11.0	-14	-14	15	70
35	10.7	10.7	-16	-16	13.0	13.0	-18	-18	15	78
36	9.8	9.8	-11	-11	12.4	12.2	-14	-14	17	82
37	13.8	13.8	-17	-17	11.8	11.3	-13	-12	18	90
38	13.0	12.9	-15	-15	12.3	11.9	-12	-12	15	82
39	13.2	13.0	-11	-11	13.5	13.4	-14	-13	15	66
40	8.2	8.6	-8	-8	7.7	7.8	-10	-10	15	66
41	9.5	9.5	-11	-14	10.2	10.0	-13	-13	15	58
42	6.3	6.7	-19	-19	14.5	13.9	-15	-15	19	82
43	8.2	8.2	-11	-11	11.9	11.6	-20	-19	14	56
44	11.3	11.3	-18	-18	9.3	9.3	-16	-16	15	66

## Document Information

Analyzed document	TMAAd pliarism.docx (D173410431)
Submitted	2023-09-04 12:55:00
Submitted by	Shrinivas Gadhinglajkar
Submitter email	shri@sctimst.ac.in
Similarity	4%
Analysis address	shri.sctims@analysis.arkund.com

## Sources included in the report

<b>W</b>	URL: <a href="http://www.graphpad.com/faq/viewfaq.cfm?faq=135">http://www.graphpad.com/faq/viewfaq.cfm?faq=135</a> Fetched: 2023-09-04 12:55:00	 3
<b>J</b>	<b>19a6a24c710d3cbedae3b0ce583773d20446065e</b> URL: <a href="1cd0ede8-9afe-40e7-beae-c9e9cab73e93">1cd0ede8-9afe-40e7-beae-c9e9cab73e93</a> Fetched: 2019-08-01 03:16:13	 5
<b>W</b>	URL: <a href="https://s3.us-west-2.amazonaws.com/us-cslide-prod-presentations/asgct23/properties/3/ASGCT_pos...">https://s3.us-west-2.amazonaws.com/us-cslide-prod-presentations/asgct23/properties/3/ASGCT_pos...</a> Fetched: 2021-12-06 17:43:41	 1
<b>W</b>	URL: <a href="https://www.bioinformatics.babraham.ac.uk/training/GraphPadPrism/Analysis%20of%20quantitative%...">https://www.bioinformatics.babraham.ac.uk/training/GraphPadPrism/Analysis%20of%20quantitative%...</a> Fetched: 2022-02-23 21:34:53	 1

## Entire Document

INTRODUCTION Left ventricular (LV) systolic function predicts for perioperative morbidity and mortality in patients undergoing coronary artery bypass grafting (CABG) 1,2. Transoesophageal echocardiography (TEE) is a valuable tool for assessing intraoperatively LV systolic function. Various echocardiographic parameters have been used to define the LV function: such as fractional shortening, fractional area change, ejection fraction (EF) and wall thickening. For evaluation of regional and global myocardial function reliable and reproducible parameters are required which guides the perioperative physician in stratifying perioperative risk and management<sup>3</sup>. Unfortunately, the parameters mention above has several limitations in evaluating the LV myocardial function. These limitations include necessity for geometric assumptions, dependence on preload and afterload, less reproducibility and alteration with hemodynamic changes and translational motion<sup>4,5</sup>. Wall motion severity index (WMSI) is often used to predict outcomes after the CABG<sup>6</sup>. However, it is limited by necessity for expertise, failure to distinguish grades of hypokinesia and inability to pick up subtle abnormalities<sup>7</sup>. Wall motion of the endocardium denotes changes in the radial mechanics of heart, ignoring the longitudinal myocardial function which may be altered in the initial stage of myocardial ischemia. In addition, the LVEF may not be reduced unless many myocardial segments are involved in ischemic injury. An area of normally contracting myocardium surrounding the infarcted area may appear akinetic due to tethering effect, which may overestimate the infarct size by the method of WMSI<sup>8</sup>. Similarly, the LVEF may not be sensitive to detect the early changes in myocardial dysfunction<sup>9</sup>. Tissue doppler imaging (TDI) uses doppler principles to quantify the higher amplitude, lower velocity signals of myocardial tissue motion<sup>10</sup>. Systolic myocardial velocity at the lateral annulus measures longitudinal systolic function and correlates well with LV ejection fraction measurements. The assessment of myocardial deformation by doppler or speckle tracking techniques are considered more sensitive and consistent parameters for detecting subclinical dysfunction of myocardium, having a well – defined normal range<sup>11</sup>. The myocardial velocity and strain quantification performed using doppler based techniques using transthoracic echocardiography have been advocated for the quantification of myocardial function<sup>12</sup>. However, the doppler interrogation is limited by angle dependency and noise artifacts in the operation suite.