SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS

Dr. Kakarla Saikiran

DM Cardiology THESIS

2020 - 2022

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

An Institution of National Importance established by an Act of the Indian Parliament
(Act No.52 of 1980)

Dept. of Science and Technology, Govt. of India
www.sctimst.ac.in

SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST-OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS

A THESIS SUBMITTED BY

Dr. Kakarla Saikiran

TO

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF

DM Cardiology

2020 - 2022

DECLARATION BY THE STUDENT

CERTIFICATE

I, Dr. Kakarla Saikiran, hereby certify that I had personally carried out the work depicted in the thesis titled, "SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS".

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

Signature

Dr. Kakarla Saikiran

Name of the Candidate

Date: 13/8/22

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. K.M Krishnamoorthy

Department: Cardiology

This is to certify that Dr. Kakarla Saikiran, department of Cardiology of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

The thesis entitled, "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA) PATIENTS (IEC/1552)**" was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

Clearance was obtained from the Institutional Ethics Committee for carrying out the study.

Signature
Name of the Guide

Date 27.7.22

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. Krishna Kumar M

Division/Department: Cardiology

This is to certify that Dr. Kakarla Saikiran, department of Cardiology of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

The thesis entitled, "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA) PATIENTS (IEC/1552)**" was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

Clearance was obtained from the Institutional Ethics Committee for carrying out the study.

Signature

Name of the Co-guide

DR. KRISHNA KUMAR. M

Date 27/1/2022

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. Arun Gopalakrishnan

Department: Cardiology

This is to certify that Dr. Kakarla Saikiran, department of Cardiology of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

The thesis entitled, "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA) PATIENTS (IEC/1552)**" was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

Clearance was obtained from the Institutional Ethics Committee for carrying out the study.

Signature
Name of the Co-guide
Dr. Arun Gopalakrishnan

Date 27/7/2022

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. Baiju S. Dharan

Department: Cardiovascular and thoracic surgery

This is to certify that Dr. Kakarla Saikiran, department of Cardiology of this institute has fulfilled the requirements prescribed for the DM degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

The thesis entitled, "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA) PATIENTS (IEC/1552)**" was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

Clearance was obtained from the Institutional Ethics Committee for carrying out the study.

Signature

Name of the Co-guide

Dr. Baiju. S. Dharan.

Date 27/7/22

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

APPROVAL OF THE THESIS

The thesis entitled

SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS

Submitted by

Dr. Kakarla Saikiran

for the degree of

DM Cardiology

of

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

is evaluated and approved by

....

(Name & Signature of the Guide) (Name & Signature of thesis examiner)

ACKNOWLEDGEMENTS

It has both been a pleasure and a privilege to undertake dissertation work for my degree course. The path was not easy due to the ongoing covid pandemic, but it did not look tardy enough due to constant inspiration and well wishes from several people.

At the outset, I would like to thank my institute, Sree Chitra Tirunal Institute of Medical Sciences and Technology, Trivandrum, for giving us the opportunity to nurture ourselves under its huge wings. This work has been made possible due to the efforts of many people who need to be acknowledged.

Firstly, I would like to thank my guide, Dr. K.M.Krishnamoorthy, for guiding me through the entire study and being a constant source of inspiration. His wisdom and in-depth understanding of the subject have made this work an enriching experience for me.

I will always remain obliged and grateful to my co-guides, Dr Krishna Kumar Mohanan Nair, additional professor, department of Cardiology; Dr. Arun Gopalakrishnan, associate professor, Department of Cardiology; Dr Baiju S Dharan, professor and HOD, Department of Cardiovascular and Thoracic Surgery, for their continuous inspiration and support.

I want to thank Dr. Deepa S Kumar for the valuable input and advice provided during the course of the study. She enriched the study with her vast experience.

I would also like to thank all the other faculty members at the Department of Cardiology, SCTIMST, and Trivandrum for their guidance.

I would also like to thank Aswathy and Jincy, project staff, SCTIMST, Trivandrum for their help and support during the course of study in recruiting patients.

I would like to thank all my seniors, colleagues and juniors for creating an optimal work environment where the study could be performed. I thank all of them for their constant support.

Above all, I thank my parents, Shri K. Bhaskar Naidu and Smt. Sridevi, for making me what I am today. Last but not least, I want to thank my best friend and wife, Dr Manisha K, for her invaluable and continuous support throughout the process.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

S No	Abbreviation	Full Form
1.	ALCAPA	Anomalous Origin of The Left Coronary Artery from Pulmonary Artery
2.	RCA	Right coronary artery
3.	LCA	Left coronary artery
4.	LCX	Left circumflex artery
5.	EF	Ejection fraction
6.	RWMA	Regional wall motion abnormality
7.	GLS -LV	Global longitudinal strain of LV
8.	GCS -LV	Global circumferential strain of LV
9.	A3C	Apical 3 chamber
10.	APLAX	Apical long axis
11	A4C	Apical 4 chamber
12.	A2C	Apical 2 chamber
13.	BIS	Basal Inferoseptal segment
14.	MIS	Mid inferoseptal segment
15.	AIS	Apical inferoseptal segment
16.	AAL	Apical anterolateral segment
17.	MAL	Mid anterolateral segment
18.	BAL	Basal anterolateral segment

19.	BIL	Basal inferolateral segment
20.	MIL	Mid inferolateral segment
21.	AIL	Apical inferolateral segment
22.	AA	Apical anterior segment
23.	MA	Mid anterior segment
24.	BA	Basal anterior segment
25.	BI	Basal inferior segment
26.	MI	Mid inferior segment
27.	AI	Apical inferior segment
28.	AA	Apical anterior segment
29.	MA	Mid anterior segment
30.	BA	Basal anterior segment

SYNOPSIS

SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS

SYNOPSIS

BY

Dr. Kakarla Saikiran

for DM Cardiology

of

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

SYNOPSIS

Background:

Anomalous left coronary artery from pulmonary artery (ALCAPA) repair has excellent survival as when compared to their unrepaired counterparts in infantile subsets. Myocardial strain abnormalities are described in patients even after successful surgical repair of ALCAPA, even after recovery of ventricular function. The factors that predispose to the persistence of these strain abnormalities in presence of normal ventricular function are unknown.

Aims and objectives:

The aim of this study was to find out incidence of strain abnormalities in post operative ALCAPA patients, factors predicting the abnormal global longitudinal strain GLS-LV, effect of the GLS-LV on secondary outcomes and to find out whether the age at repair influences the persistence of global and regional strain abnormalities.

Hypothesis:

Strain abnormalities in the form of reduced GLS:LV exists even after successful ALCAPA repair regardless of ejection fraction.

Methods:

Data regarding preoperative clinical presentation, perioperative period and operative variables along with postoperative hospital stay events and follow-up

events of 59 patients who underwent ALCAPA repair were collected retrospectively and crossectionally investigated with conventional detailed 2D echocardiography and global longitudinal strain (GLS-LV) by speckle tracking echocardiography. Segmental, regional, and territorial strains were analyzed in QLAB software as postprocessing of 2D images with same Philips epiq 7 C machine to avoid vendor specific error. With the obtained data predictors for abnormal strain by both univariate and multivariate analysis was done. An ROC curve was plotted by keeping age as continuous variable and normalization of strain as categorical variable to determine cut off for the age at repair which produces normal strain on follow-up. Subgroup analysis was done in patients basing on the obtained cutoff from ROC curve into early (n=21) and late repair groups (n=18) and incidence of strain abnormalities were studied in both groups. We used data from the metanalysis by levy et al. for setting a benchmark for normal age wise values for GLS-LV.

Significant findings:

Out of 59 patients female to male ratio was 1.26:1. Median age of presentation and diagnosis was 5 months (IQR:23.5). Median time duration from diagnosis to admission for surgery was 12 hrs. (IQR: 8.75). Median duration of follow-up was 7.4 years (IQR:10.19).62% of the patients were misdiagnosed as VSD, myocarditis, dilated cardiomyopathy, coronary AV fistula, mitral valve prolapse and referred to our center for management. Two patients at presntation were in cardiogenic shock needing inotropes. 95% if the patients had q in atleast 2 of the 4 lateral leads. 64% patients had LVH on ECG. Almost all of the patients had

subendocardial fibroelastosis and scarred anterolateral papillary muscle on echo. Majority of the patients 75% have mild and moderate MR at presentation. Severe MR in 12.5%. Anomalous coronary originating from non-facing sinus seen in 32%. Global longitudinal strain was abnormal in 41 % of patients with normal ventricular function. 16.9% (n=10) underwent mitral valve repair at index ALCAPA surgery. Median time for recovery of EF was 4.8months (IQR:8). Mean GLS-LV was -18.06 +/- 5.05. Mean RCA territory strain was 18.55 +/-5.06 SD, whereas mean LCA strain is 17.3+/-5.25 SD.

Univariate model higher the translocation distance and non-facing nature of sinus as origin of left coronary artery, higher the inotrope duration of usage and perioperative EF, composite secondary outcomes were predictors of strain abnormality. But none of these parameters predicted the strain abnormality in multivariate prediction model.

The probability of having normal longitudinal strain on follow up was 81.6% if surgery was done before 7.8 months of age (based on ROC curve) and odds of having normal myocardial strain was 11 times higher if repaired before 7.8 months of age.

Significantly more patients in the older repair age group had reduced global longitudinal strain (67% vs 19%, p = 0.001). Regional strain abnormalities were present in both left and right coronary artery territories and were more severe in the older age group.

Implications:

1. Approximately 50% of the patients post ALCAPA repair do have strain abnormalities and 40% of the normal LV function do have lesser global longitudinal strain which indicate though the clinical improvement and 2d ECHO wise parameters normalised patients do have subclinical LV dysfunction which might improve in early repair subsets and may not improve in late repair individuals warranting the close follow-up of these individuals.
2. There is no significant correlation between strain abnormality and secondary outcomes which may be due to shorter duration of follow-up of 7.4 years and lesser number of events in the overall cohort which warrants more extensive duration of follow-up and needs Holter and exercise stress test for unmasking more events.
3. GLS-LV improved over the follow-up period in the patients who underwent corrective repair early in life.
4. RCA territory strain abnormalities do exist in varying severity in post operative ALCAPA patients which may signifies the extensive strain abnormalities causing ischemia over the RCA territory or dominant left system associated and have PDA supplying the inferior territory.
5. Early surgical repair before 7.8 months of age conferred 85% probability of normal ventricular strain on follow up.

6. Though ventricular function was better in the older age group prior to repair when compared to the younger age group, global and regional strain abnormalities persisted more in the older age group after repair.

1 INTRODUCTION

1.1 General Introduction

Anomalous origin of the left coronary artery (LCA) from the pulmonary artery (ALCAPA), also known as Bland-White-Garland syndrome, is rare congenital heart disease, occurring approximately in 1 per 3,00,000 live births(1). Retrograde flow in the LCA supplied from the right coronary artery (RCA) through natural collaterals to the low-pressure main pulmonary artery causes extensive myocardial ischemia. Ischemia occurs due to loss of perfusion pressure in the coronary arteries resulting from this specific steal syndrome. It often manifests in early childhood with symptoms of congestive heart failure or myocardial ischemia, and if left untreated, the mortality reaches 90% in the first year of life. Preoperative myocardial ischemia results in reduced left ventricular (LV) ejection fraction (LVEF), mitral regurgitation, and LV dilation(2). The treatment of choice is immediate surgical reimplantation of the LCA into the aorta(3) or creation of an intrapulmonary baffle when coronary translocation is not feasible (Takeuchi repair)(4). Due to the rarity of the condition, limited data regarding long-term follow-up is available however most reports indicate that early diagnosis and immediate surgical intervention lead to excellent results, with normalisation of LV size and function, resolution of mitral regurgitation, especially when operated in early childhood(5–7). However, other studies reported on persistent mitral regurgitation, arrhythmia, sudden cardiac death, exacerbation of heart failure or coronary stenosis, necessitating surgical reintervention or even heart transplantation(2,8,9). As myocardial ischemia and fibrosis appear to deteriorate the

clinical course after corrective surgical intervention(10), detection of even minor abnormalities in the ALCAPA population is of paramount importance. Hence, we need an imaging study to identify patients with subclinical LV dysfunction. In the last few years, myocardial strain imaging has frequently been used to assess and quantify regional ventricular abnormalities. This very sensitive method enables the evaluation of myocardial function, well beyond standard echocardiographic techniques, and detection of early subclinical myocardial abnormalities, even in the presence of normal LVEF (11).

Given the paucity of data, we undertake this study to evaluate the strain echocardiographic parameters in post-operative ALCAPA patients.

PERTINENCE OF THE STUDY:

- Very few international studies assess association between LV STE post-ALCAPA repair & LV dysfunction: outcome.
- No Indian data regarding the association between LV STE post-ALCAPA repair & LV dysfunction; outcome.

HYPOTHESIS:

Strain abnormalities in the form of reduced GLS: LV exists even after successful ALCAPA repair regardless of ejection fraction.

RESEARCH QUESTION :

Does strain abnormality/subclinical LV dysfunction exist after successful ALCAPA repair?

AIM:

- ***Primary objective:***

To assess myocardial function in post-ALCAPA repair patients by LV Speckle Tracking Echocardiography (STE).

- ***Secondary objective*** **:**

  To find correlation between abnormal strain by LV Speckle Tracking Echocardiography (STE) and clinical outcome of patients after ALCAPA repair.

2 LITERATURE REVIEW

Anomalous left coronary artery arising from the pulmonary artery (ALCAPA) is a rare coronary anomaly. Mortality in untreated infants is more than 90% by the end of 1 year (12). Commonly left main anomalously originates from the posterior pulmonary sinus and rarely can originate from the anterior and non-facing sinus of the pulmonary artery. The presentation can be extremely varied in the majority, as two forms, infantile and adult type. The major difference in presentation is because of the development of coronary collaterals with the right coronary artery. Approximately 18-25% of the children remain asymptomatic due to extensive collateralization with RCA and can present later in adolescence or in adulthood with varied presentations like angina on exertion, ventricular arrhythmias, and mitral regurgitation(13,14).

Pathophysiological mechanisms:

The extent of collateral circulation establishment during the critical transition of the pulmonary vascular resistance determines the type of presentation. Adult type is seen in patients with extensive collateralisation, whereas infantile type is seen in patients with fewer collaterals.

At birth, the aortic and pulmonary artery pressures are identical, making the flow in left coronary artery antegrade. Once the pulmonary vascular resistance starts to fall, the antegrade flow starts to decline and the myocardium experiences hypoxia and ischemic cascade. As a result of hypoxia, local vasoactive and vasogenic factors favour development and establishment of extensive collaterals with the right coronary

circulation. Thus, collaterals are established between the main pulmonary artery and aorta via coronary arteries. As a result, it behaves as left to right shunt. It is not an obligatory shunt because change in the pulmonary vascular resistance alteration alters the shunt fraction.

If the infant is unable to develop a collateral circulation within the time of normalisation of pulmonary vascular resistance (i.e., usually within 4-6 weeks) due to reduced antegrade perfusion of the left coronary artery territory, it results in ischemia and infarction of the corresponding territory, causing early presentation with symptoms and signs of heart failure and failure to thrive. These are the sickest subsets of the entire ALCAPA cohort and need immediate correction as soon as identification because TIME IS MUSCLE as it is analogous to ST-elevation myocardial infarction.

Infants with adequately developed coronary collateral circulation survive the initial critical period of normalization of pulmonary vascular resistance and thereby m presentation in later stages of life. Despite well-developed collaterals, the myocardium is essentially ischemic and usually hibernates. Though these mechanisms are initially protective with higher pulmonary vascular resistance, as time advances due to normalisation of PVR, flow in the left coronary artery is reversed and as a result, left coronary artery fails to supply myocardium and instead shunts oxygenated blood via the right coronary collaterals into the pulmonary artery causing steal phenomenon ,i.e., collaterals act as a shunt from aorta to low pulmonary pressure circulation than into high-pressure myocardial circulation causing myocardial ischemia especially of the subendocardial region. The conductance of a well-developed collateral system at maximum serves only 1/3rd of the native LCA(15). Because of this chronic subclinical

ischemia, these patients are at risk for malignant ventricular arrhythmias and sudden cardiac death, which was documented in 80-90% of cases (14).

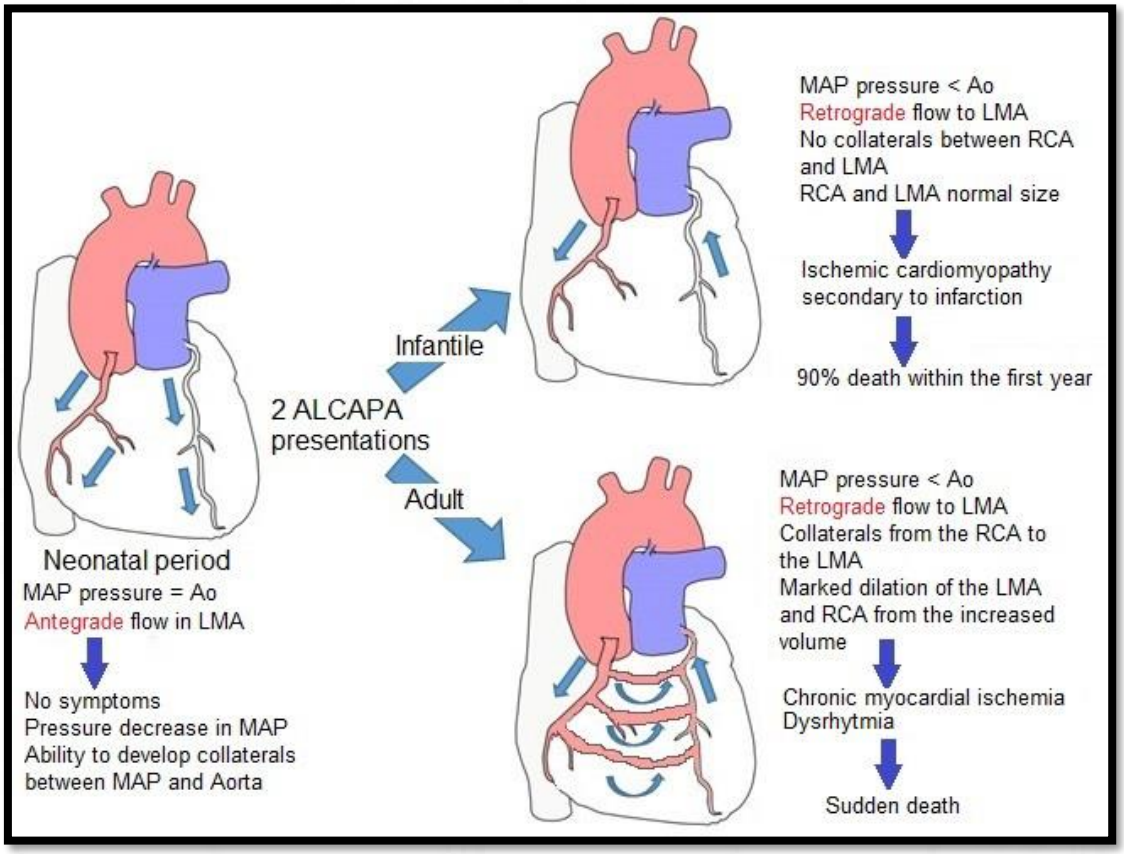


Fig.1: Pathophysiological mechanisms and differences in infantile and adult ALCAPA. MAP: main pulmonary artery, Ao: Aorta, LMA: left main artery, RCA: right coronary artery (16).

Factors enabling survival	Description
1. **Collateralisation between RCA and LCA**	Retrograde ventricular perfusion from RCA
2. **Dominant RCA**	Smaller myocardial area supplied by LCA leads to decrease in ischemic burden.
3. **Minimal coronary steal from pulmonary artery**	Ostial stenosis of left coronary artery Restrictive opening into the pulmonary artery limits steal into pulmonary artery
4. **Development of systemic blood supply to LCA**	Bronchial artery collateral vessels increase oxygenated blood flow and increases the perfusion pressure to the ischemic myocardium(17).

Table.1: Factors which enable improved survival to adulthood

Clinical suspicion is key for diagnosis. ECG hallmarks to diagnose are q waves with or without ST elevations in V5, V6, I, aVL and associated T wave inversions in the same leads. Echocardiography confirms the diagnosis in all cases. Dilated LV with regional wall motion abnormality in LCA territory with scarred and hyperechoic papillary muscle is confirmatory in all most all the cases. Subendocardial fibroelastosis is also documented in majority due to sub endocardial ischemia. Characteristic flow reversal in pulmonary artery is seen in most of the cases and is the hallmark feature on

echo to diagnose. Numerous septal collaterals may mimic multiple Swiss cheese ventricular septal defect. LV dysfunction and dilated LV is the striking echocardiographic finding in infant with ALCAPA which is deceptively mistaken for myocarditis, infantile dilated cardiomyopathies like Pompes disease etc.

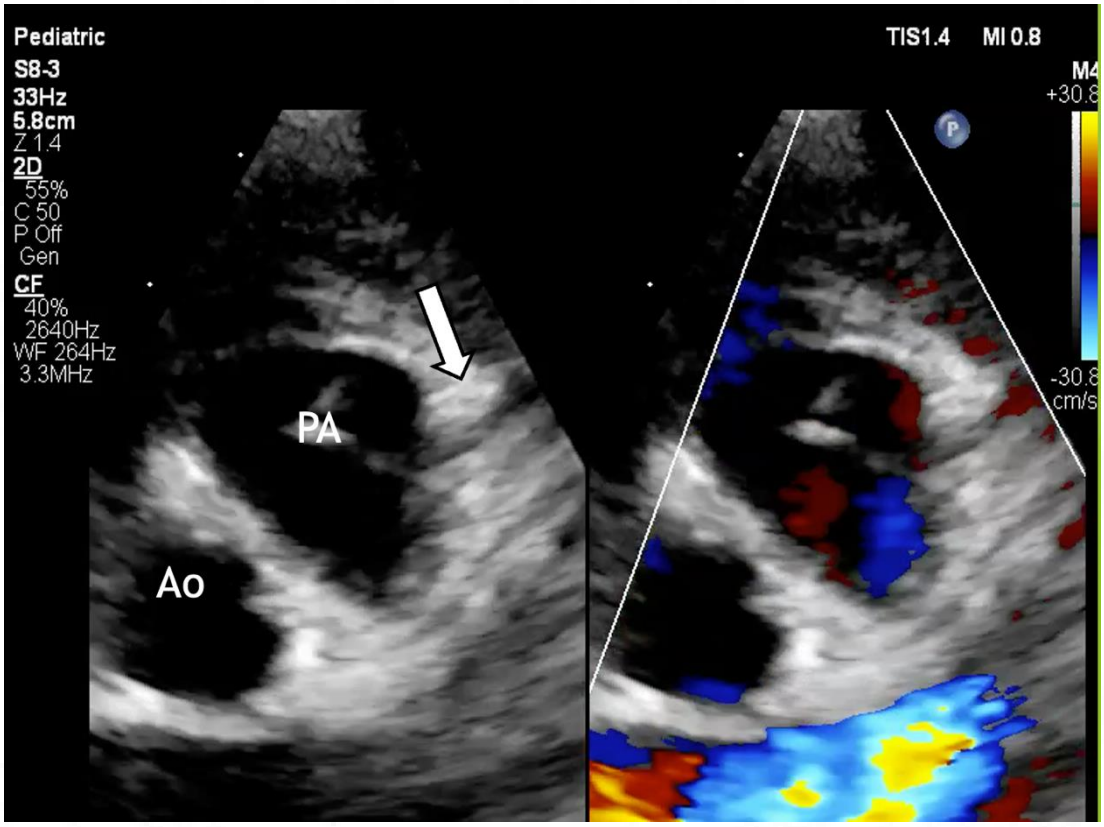


Fig.2: Modified short axis view of great vessels (Ao: aorta and PA: pulmonary artery) showing the left coronary artery arising from the pulmonary sinus which is non-facing and anterior (white arrow). Demonstration of red color flow into the pulmonary artery is virtually diagnostic of ALCAPA.

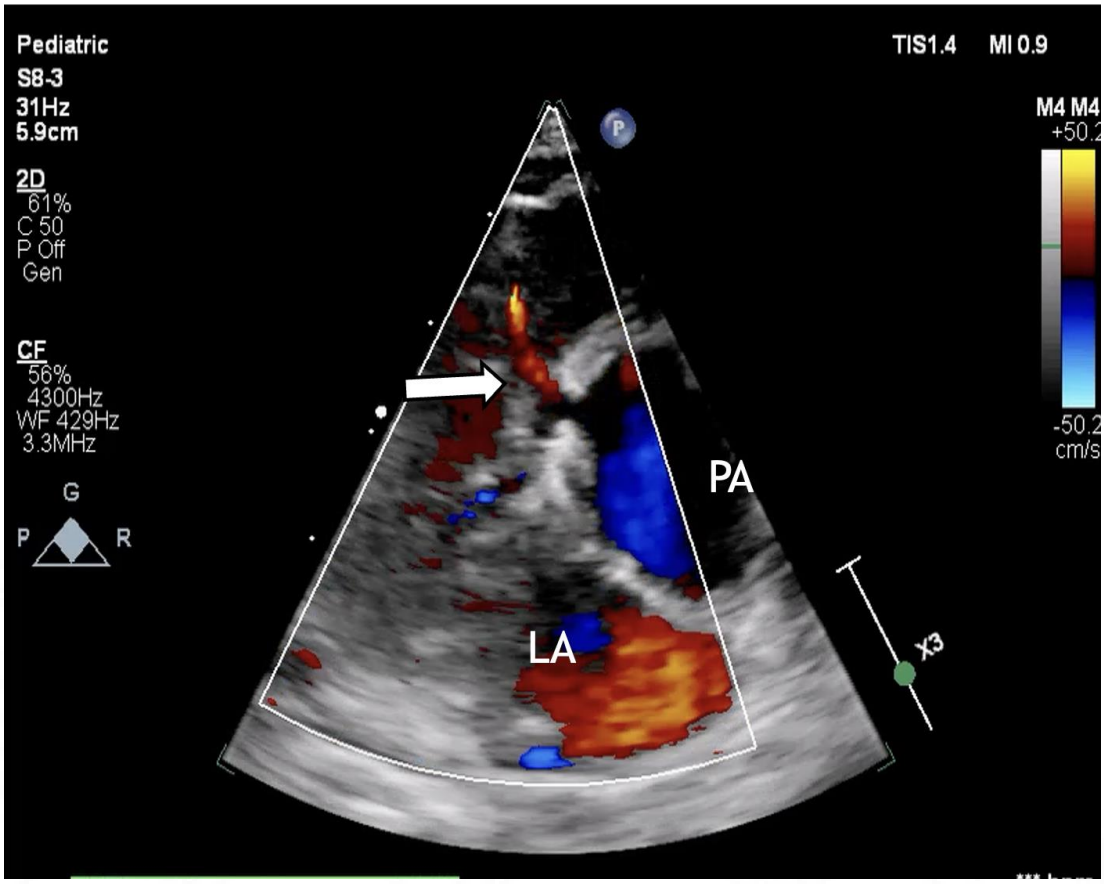


Fig.3: ***Modified parasternal long axis view with the probe tilted so as to visualize the pulmonary artery is one of the other views useful in diagnosis of ALCAPA. Here PA (pulmonary artery) is giving a branch (arrow)which divides into LAD and LCX with red color flow into the PA suggesting flow reversal.***

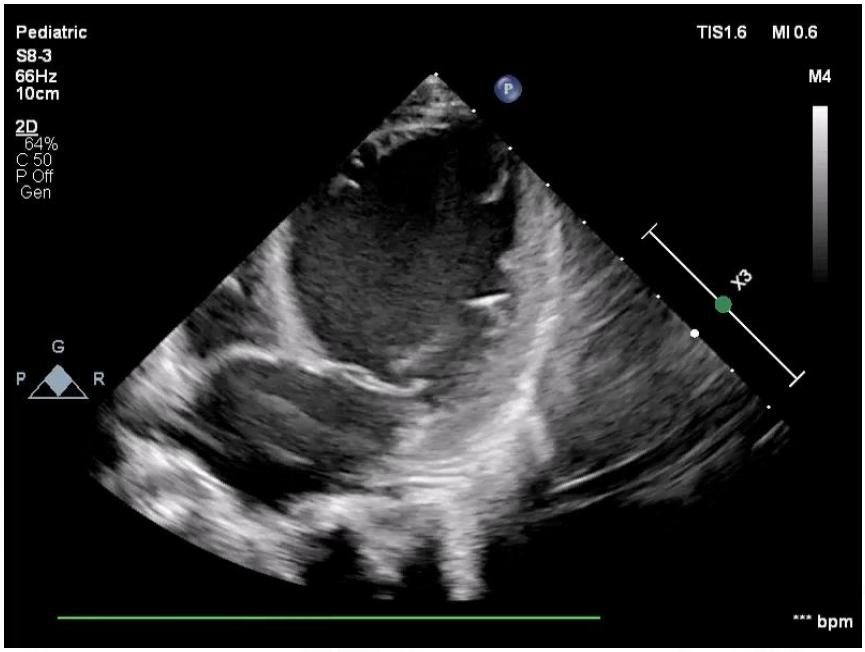


Fig.4: 2D image of apical 4 chamber view showing dilated LA and LV with hyperechogenic anterolateral papillary muscle.

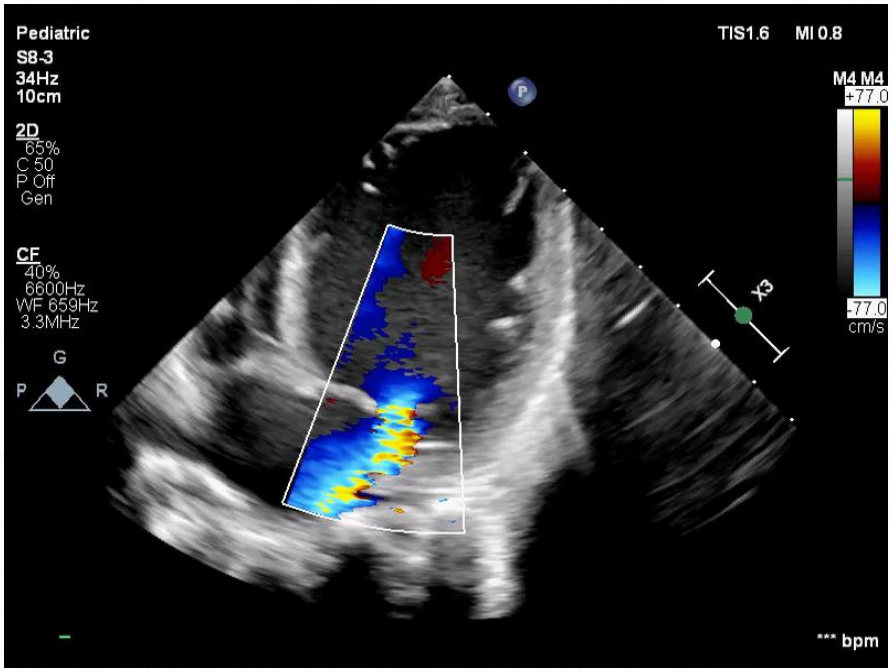


Fig.5: color flow assessment of the above image showing severe eccentric mitral regurgitation secondary to tethering of the posterior mitral leaflet.

Additional imaging is not generally required as the echocardiography offers 100% accuracy in showing the anomalous origin and flow pattern. But CT is useful in picking up the cases who are naturally selected with collaterals and present in adulthood with atypical symptoms. CT is often done for ruling out the coronary artery disease in intermediate pretest probability of CAD in these cases.

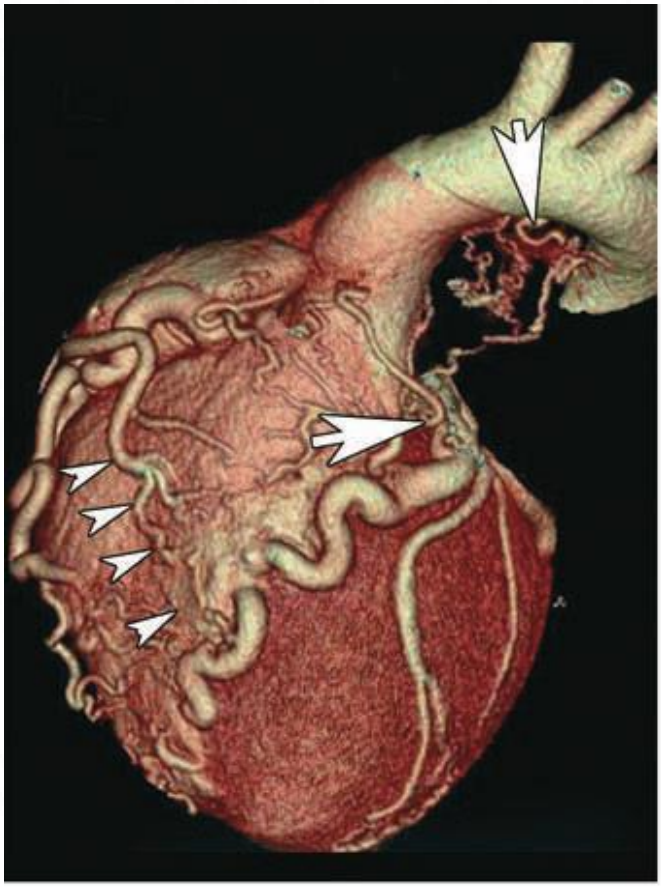


Fig.6: Volume rendered cardiac CT image showing the dilated RCA and LCA with extensive collateralization between them seen on epicardial surface (white arrow head) with multiple collaterals from the bronchial arteries supplying the dilated LCA(white arrows) (14).

Cardiac MRI is not routinely done in patients with ALCAPA preoperatively. It often demonstrates the sub endocardial perfusion defects and sub endocardial late gadolinium enhancement in LCA territory. Flow assessment by phase contrast imaging can demonstrate the flow reversal into the pulmonary artery.

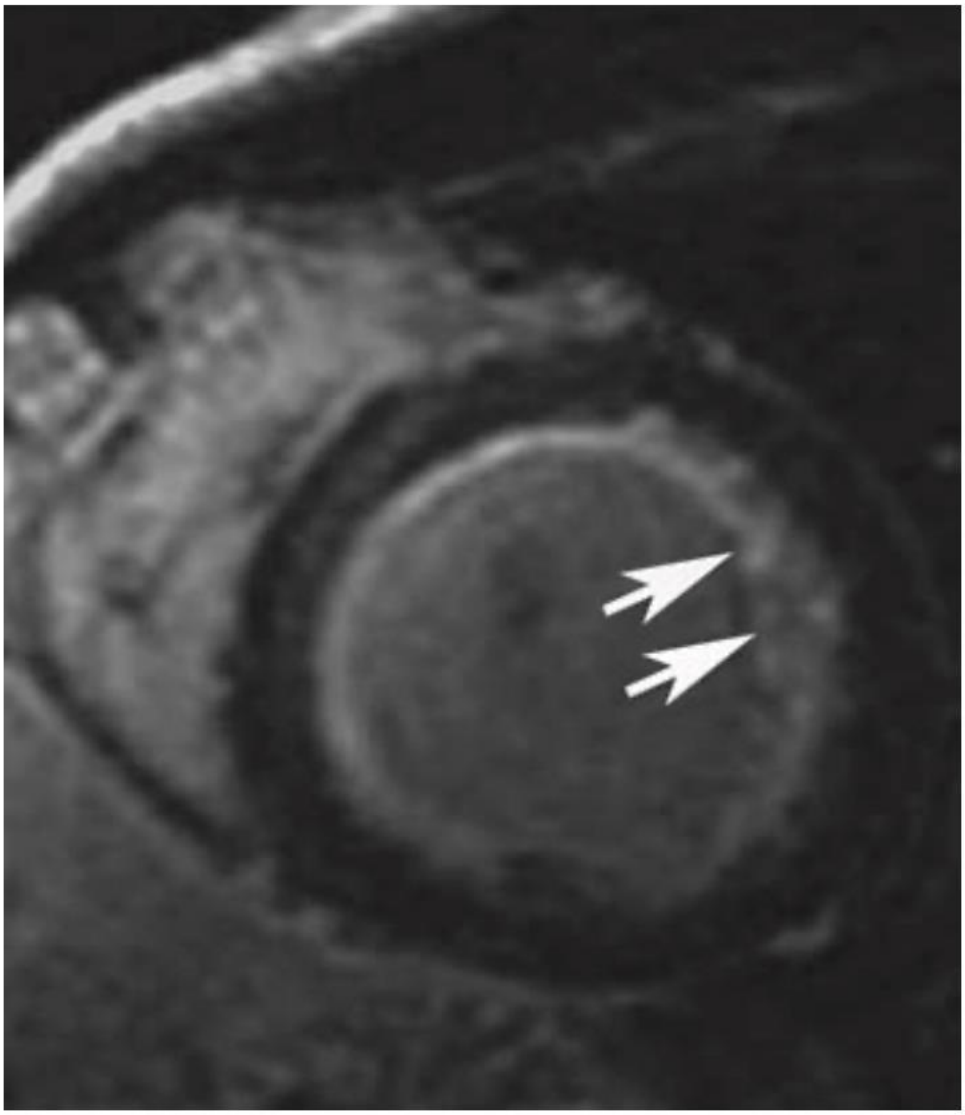


Fig.7: Oblique short-axis Cardiac MRI image post LGE sequence shows subendocardial enhancement (arrows) at the basal ventricular level in lateral wall corresponding to LCA territory suggestive of ischemia.

Table.2: Differences between infantile and adult ALCAPA syndrome

Factors	Infantile type	Adult type
1. Clinical manifestations	Symptomatic from infancy with heart failure and failure to thrive	Asymptomatic Subclinical ischemia and sudden cardiac death
2. ECG	Ischemic changes	Ventricular hypertrophy with or without ischemic changes
3. RCA	Mildly dilated	Markedly dilated
4. Septal collaterals	Insufficient	Abundant
5. RWMA	Anterior and lateral wall hypokinesia in milder forms and severe LV dysfunction with global hypokinesia usually.	None or subtle hypokinesis in lateral wall.
6. LV	Dilated	Normal or associated with LVH.
7. Outcome	Myocardial infarction and severe LV failure and cardiogenic shock in untreated infants cause mortality by the end of 1 year	Sudden cardiac death due to ventricular dysrhythmias.

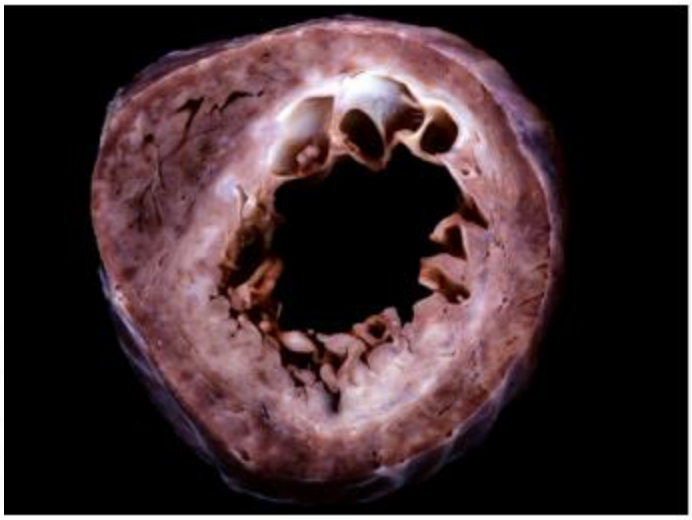


Fig. 8: Gross pathological cardiac specimen at mid ventricular level of an adult ALCAPA patient showing extensive sub endocardial scarring (white areas); nearly circumferential except for involvement of inferoseptal portion supplied by RCA (18).

Light microscopic studies often show similar findings of extensive sub endocardial scarring in pre operative ALCAPA patients suggesting it as a state of chronic hypoperfusion syndrome(19). Electron microscopic studies showed that these areas of myocardium show altered myocytes with loss of volume fraction of sarcomeres when compared to the healthy counterparts and the mitochondria are smaller with abundant lipofuscin and glycogen with sparse sarcoplasmic reticulum(19). Data on reversibility of these changes after correction are scanty.

Unlike that of epicardial coronary artery stenosis, the etiology of ischemia in adult variant of ALCAPA is secondary to steal phenomenon, which can cause pathological changes not only in subendocardial regions but also in other layers of heart like perivascular hyalinization and with increased perivascular fibrosis often extending into

the epicardium as demonstrated by recent histopathological and electron microscopic study in two post operative adult ALCAPA patients in 2020 by Kubota etal.(20)

Hence these patients are still at risk of the future events, not only mere anatomical narrowing at the implanted site of coronaries but also significant arrhythmic risk(20). The data with infantile type gross and histopathological studies post repair are not available.

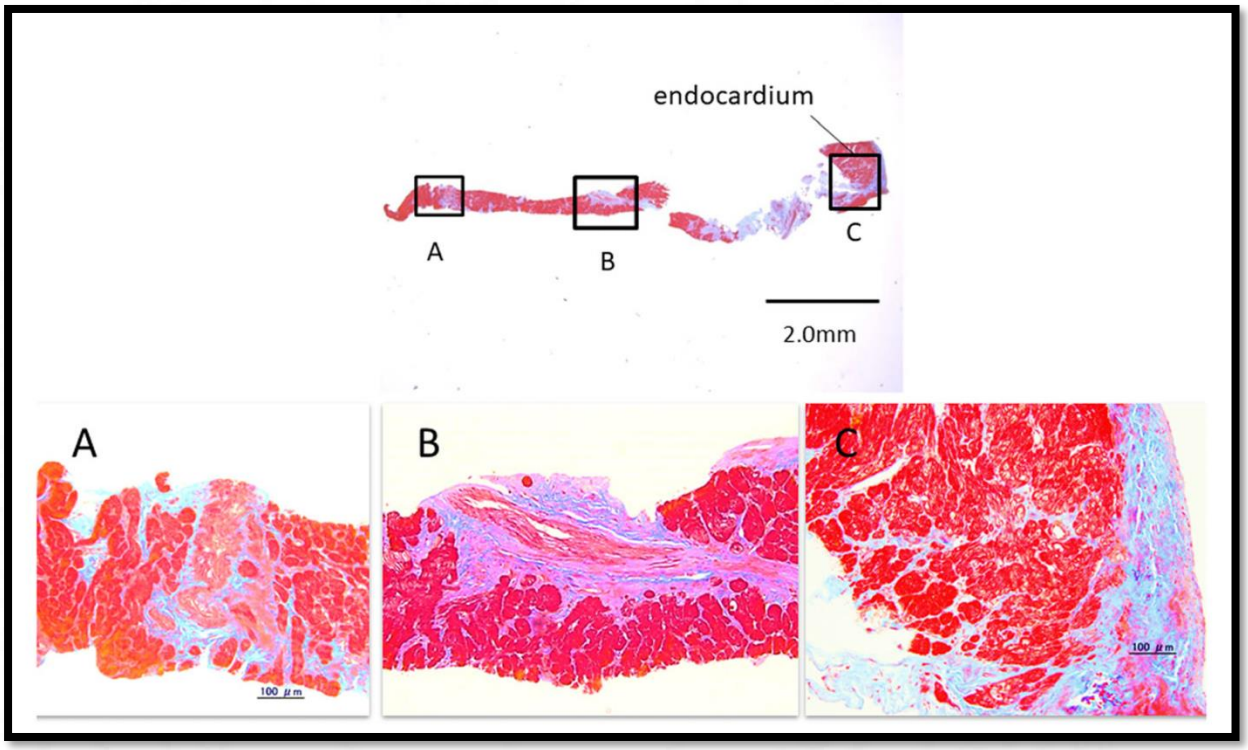


Fig.9: Histopathological image (light microscopy) of an adult with ALCAPA after 9 months of surgical repair showing extensive fibrosis in sub endocardium (panel C), which extends into the middle part of myocardium and severely hyalinized and fibrosed perivascular stromal tissue seen in middle myocardial layers (panel B), Epicardial portion (panel A) also shows perivascular stromal tissue fibrosis and hyalinization with severely thickened arteriolar wall (20).

Mechanisms of ventricular arrhythmias (20) in these patients described are

1. Local ischemia due to coronary steal phenomenon
2. Re-entry circuit in the border zone of myocardial infarction
3. Electrical instability secondary to fibrosis

Establishment of dual coronary system is treatment of choice which can be done by various surgical procedures like direct coronary reimplantation, coronary artery bypass grafting either with LIMA or saphenous venous grafts, rarely intrapulmonary baffling of LAD (Takeuchi or modified Takeuchi repair). With return of antegrade flow across LCA,there is associated reduction of size of dilated RCA and regression of inter coronary collaterals. Studies showed that direct coronary transfer is the most physiological form of repair although it is technically more difficult amongst all repair techniques (21).

Most of the previous studies document the improvement in EF post repair. The improvement in the infantile type is marked when compared to adult type. Adult variants have more LV asynergy. Postoperative MACE events are higher in adult type (22–25).

Immediate perioperative period may be stormy with increased requirement of ECMO in infantile ALCAPA because of absence or lesser collateral circulation as shown by recent study by El-Louali et al (26).

Conventional Echocardiographic assessment in post operative ALCAPA patients consistently showed improvement in most of the patients during follow-up in many studies(11,22,23,25).

Despite the presence of the residual fibrosis, conventional echocardiography shows normal LV function and improvement of mitral regurgitation in most of the patients (6,7,11–13,16,24,25,27,28) .Additional imaging modality which recognizes the subclinical LV dysfunction is essential to diagnose these abnormalities. Strain imaging was used as a tool in diagnosing these abnormalities as early as 2001 by Di Salvo etal (11). He demonstrated persistent strain abnormalities and altered myocardial despite normalization of ejection fraction in 13 patients with controls. Both strain and strain rate are less in the subendocardial region selectively (11). Initially tissue doppler based strain imaging was practiced later, switch to speckle tracking method of strain assessment in 2008 lead to revolution in the myocardial functional deformation imaging and assessment(29,30).

Castaldi et al. demonstrated with 10 post-operative ALCAPA patients with age and sex matched controls compared global longitudinal strain, radial strain, and circumferential strain and correlated with cardiac MRI and coronary angiography wherever necessary and showed decline in GLS-LV and circumferential strain in ALCAPA patients. They demonstrated LCA stenosis in 3 patients which was confirmed by coronary angiography. These investigators concluded that the presence of strain abnormalities may indicate residual coronary artery lesion(31,32).

Resynchronization of strain curves post ALCAPA repair was documented as early as 35 days post repair by Fornwalt et al (33).

Di Salvo et al. in 2017 with 30 post operative ALCAPA patients demonstrated correlation between GLS-LV and LV ejection fraction (Pearson coefficient of $r = -0.41$, $p = 0.02$) among all studied strain parameters. GLS- LV was significantly lower

when compared to controls (- 17.6 +/-3.5 % Vs -23.4 +/- 3.1%) ($p < 0.0001$). LV torsion (9.1+/-4.9 ° vs 11.9+/- 3.3 °) ($p = 0.046$) was significantly impaired in ALCAPA patients (34).

Kugacka et al compared coronary territorial strains of 18 post-operative ALCAPA patients with respective controls and demonstrated presence of diastolic dysfunction and GLS-LV of cases in LCA territory(35).

Naqvi etal compared pre and post operative strain imaging parameters in ALCAPA patients, showed that all parameters of strain like GLS-LV, circumferential strain, radial strain were significantly lower preoperatively and improved postoperatively. Despite improvement postoperatively, most of the affected segments demonstrated abnormal strain parameters and they concluded the necessity for addition of these strain parameters in routine assessment (36).

There are no studies in literature so far from India pertaining to strain or strain rate and recovery of cardiac mechanics or deformation imaging. Hence, we conducted this study to see the patterns of strain imaging abnormalities and their effects over the outcomes of these patients.

3 MATERIALS & METHODS

Design: Retrospective observational non interventional study with prospective cross-sectional assessment and analysis by speckle tracking echocardiography.

Study Setting: Department of Cardiology, Sree Chitra Tirunal Institute of Medical Sciences and Technology (SCTIMST), Trivandrum.

Study period: from 01.06.2020 to 30.04.2022

Sample Size: All consecutive patients post ALCAPA repair at SCTIMST from Jan 2006 to till Dec 2021. Preliminary search of medical records suggested an approximate sample size of 50.

INCLUSION CRITERIA:

- All consecutive patients who underwent ALCAPA repair as primary procedure in SCTIMST between 2006 – 2021 and can be traced for follow-up evaluation.

EXCLUSION CRITERIA:

- Patients whose ALCAPA repair was performed in other hospitals with insufficient data
- Those who refused consent
- Patients with significant acquired heart disease which is likely to alter the study parameters

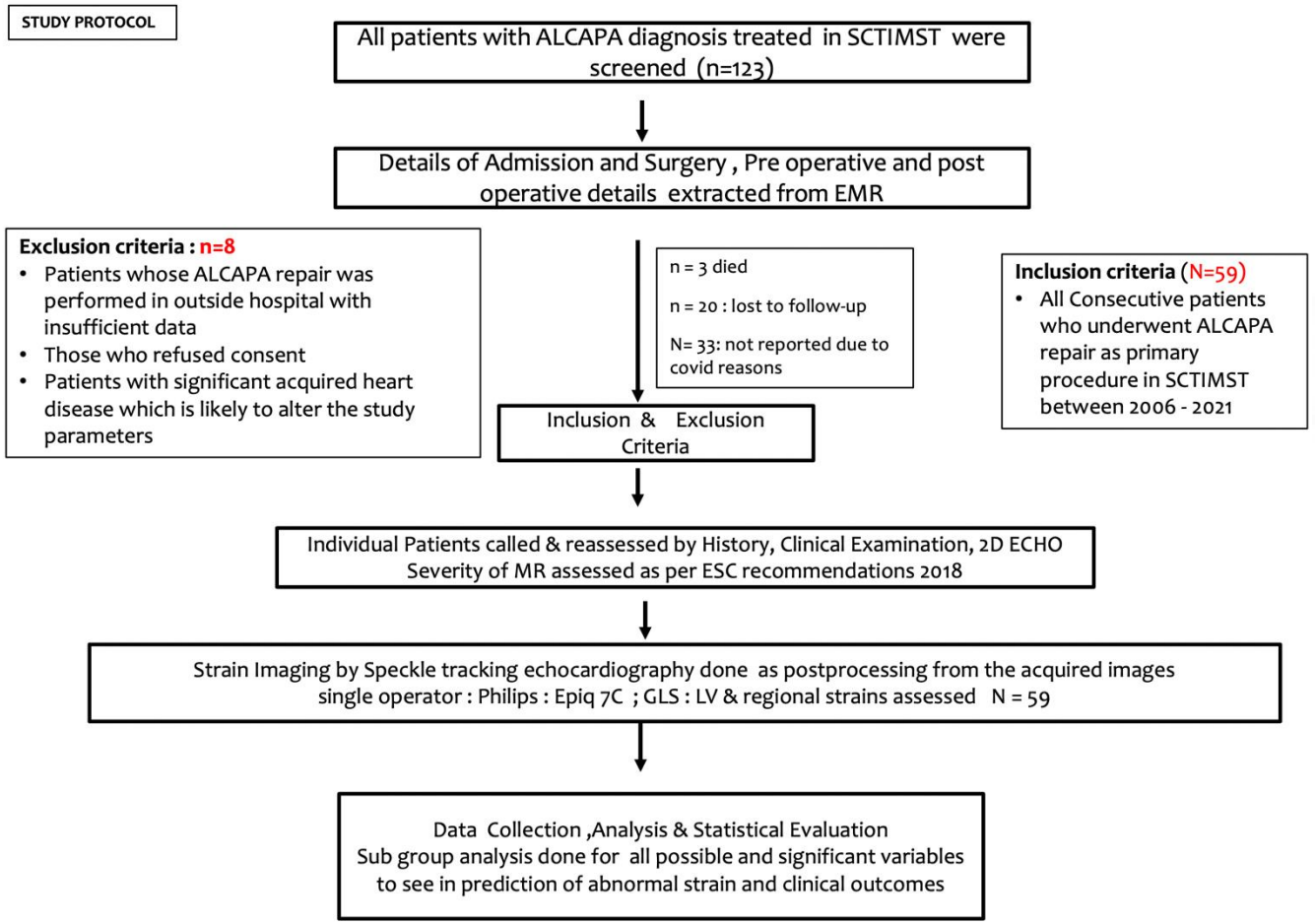


Fig. 10: Protocol used in this study

DATA COLLECTION & PROCEDURE:

All patients who underwent ALCAPA repair in SCTIMST since 1998 were included as per inclusion and exclusion criteria as laid in the study. Details regarding admission, surgery, perioperative and postoperative events were extracted from Electronic Medical Records.

Consent was taken from the patient for all patients above 18 years. Consent from guardian and assent for children 12 – 18 years, consent from guardian for smaller children prior to enrolment was obtained. Individual patients during follow-up were reassessed and detailed history , functional class, clinical examination, complications (if any) were recorded in a pre-designed proforma.

Age and Sex matched controls for normal strain values were identified and included after consent. 2D ECHO & STE was performed in both groups by using Philips Epiq 7 machine in detail and parameters were noted in a pre-designed format.

ECHOCARDIOGRAPHY:

2D ECHO parameters at the diagnosis and during follow-up was gathered from medical records of the institute. LV Ejection Fraction was calculated on the basis of Teichholz formula, with LV end diastolic (LVEDd) and end systolic (LVESd) diameters measured in parasternal long axis view. Follow-up examination was performed as per existing guidelines (37). Principal Investigator (PI) in supervision of other investigators performed all echocardiographs. MR was graded based on vena contracta width and ratio of MR area/ left atrial area to none (0), trivial (1+), mild (2+), moderate (3+) and severe (4+), based on current guidelines (38–40).

SPECKLE TRACKING ECHOCARDIOGRAPHY:

Myocardial strain was measured in all cardiac chambers. The degree of deformation is reported as percentage of peak longitudinal strain (LS) in systole. Decreased myocardial shortening (impaired function) is represented by lower absolute values. Normal values vary by age as demonstrated in the study by Marcus et al., which provided reference values of LV strain and trends of strain values in the pediatric population. LS values were lowest in the youngest and oldest age groups (41).

We used data from metanalysis by Levy et al. (42) which looked at normal strain values of 2325 children with mean normal GLS-LV of 20.2(95% CI -19.5 to -20.8). As there is wide range in age distribution of the patients recruited in our study cohort, we decided to use the age appropriate and vendor specific (Philips) reference strain values derived from the Levy et al (42). Strain values below the lower limit of 95% Confidence Interval (CI) of the normal age-appropriate values derived from the meta-analysis were considered as abnormal. Normal strain parameters vary significantly with vendor and software used(30,42,43). Hence for uniformity we performed all our patient data in Philips Epiq 7C machine using Q lab software.

Depth-adjusted two-dimensional (2D) LV images was acquired from the apical 2-, 3- and 4-chamber views for off-line measurements of LV-GLS using STE. Three consecutive cardiac cycles using a frame rate >60 fps were acquired. It was verified, whether peak systolic strain from each LV segment was measured prior to aortic valve closure. The LS was calculated in each segment separately. LV-GLS was calculated as the average of peak strain values from 18 LV segments. The LV was divided into 2

regions: the LCA and RCA region according to the guidelines (29,37) and the mean LS of each region was calculated.

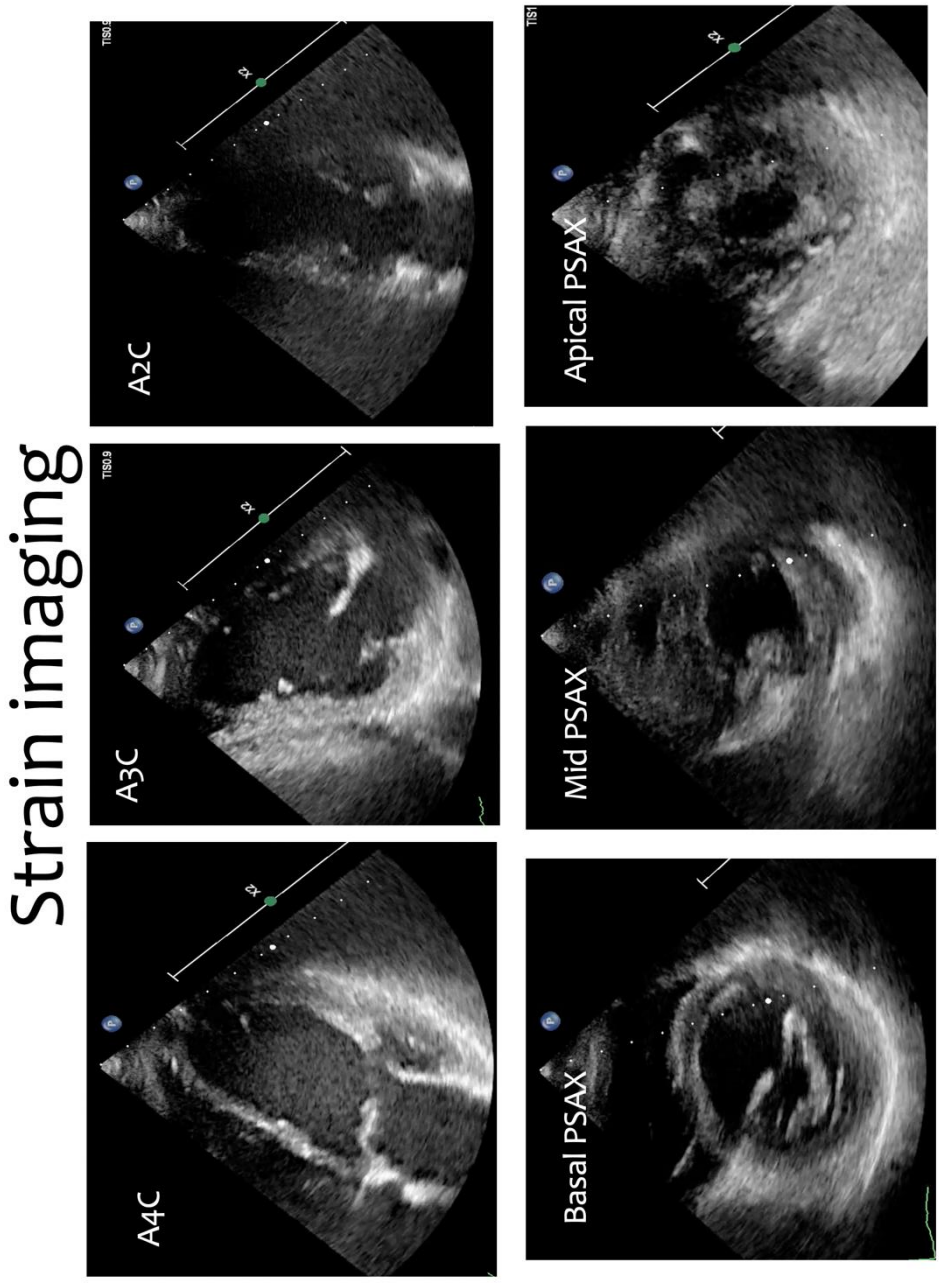


Fig:11: Acquiring 2D images in apical 4,3,2 chamber views and Basal, mid, and apical short axis views.

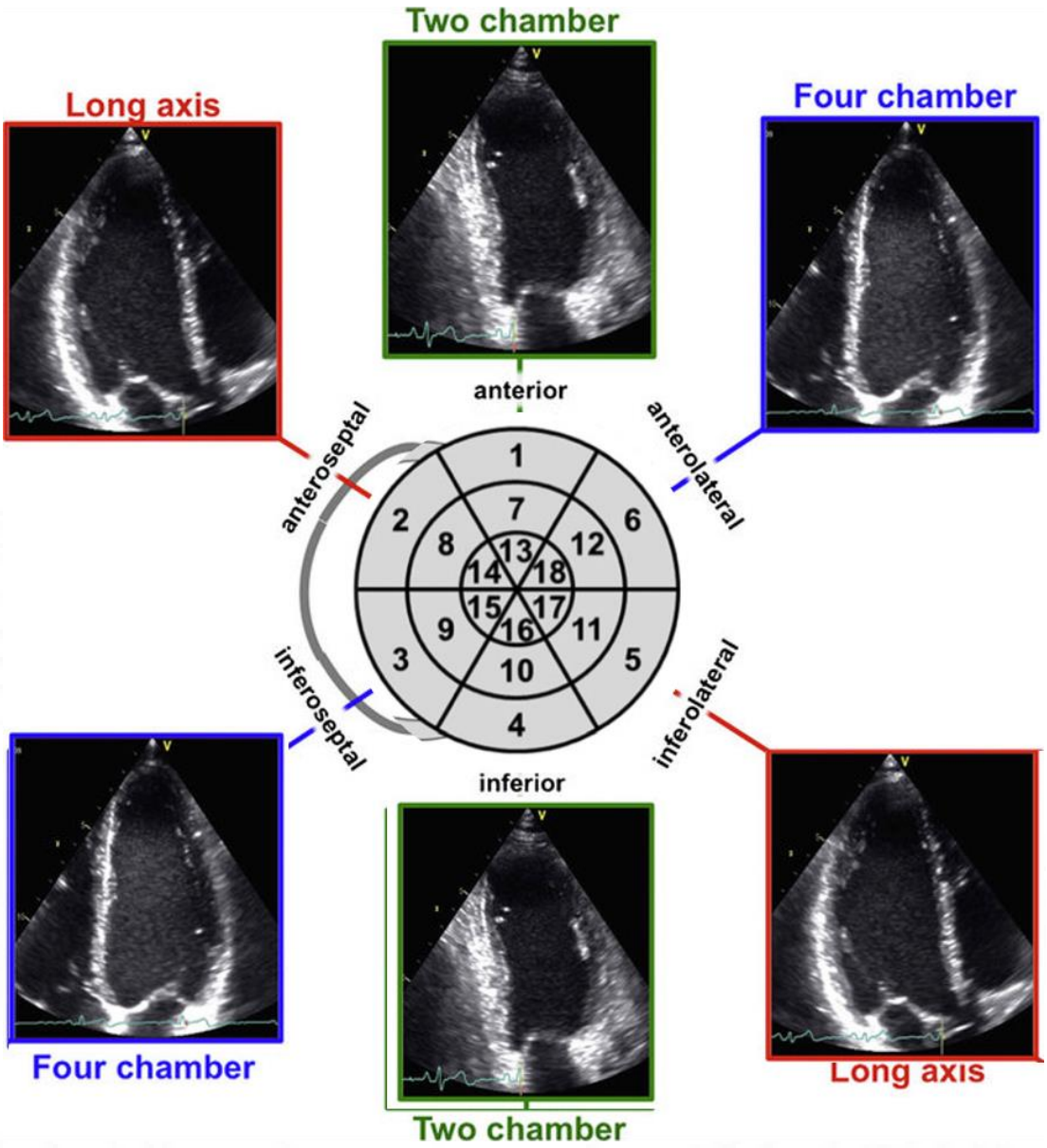


Fig:12: Regional 2D images in apical 4,3,2 chamber views reconstruct the entire 18 segment myocardial model

For the short-axis images, a circular region of interest was automatically drawn, and the LV was automatically segmented into 6 segments at the basal (mitral valve) and mid (papillary muscle) level and into 4 segments at the apex. Circumferential peak systolic strain was assessed from the 6 basal and mid-segments of the anteroseptal, anterior, anterolateral, inferolateral, inferior, and inferoseptal walls (44). At the apical level, circumferential peak systolic strain was measured from the septal, anterior, lateral, and inferior walls (44,45)

Raw data was transferred to a workstation for off-line analysis using dedicated two-dimensional speckle tracking software (QLab, Philips). If the automated tracking was not satisfactory at visual assessment, manual adjustment of the region of interest was performed. (Fig.13-15).

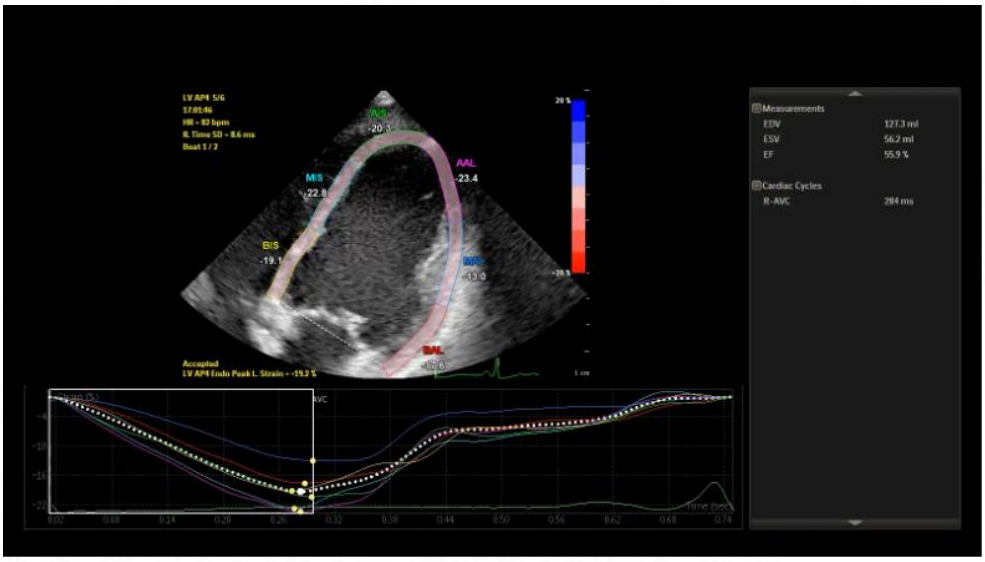


Fig:13: Regional 2D images of apical 4 chamber view over which region of interest is laid down and respective myocardial segments are tracked in QLAB software

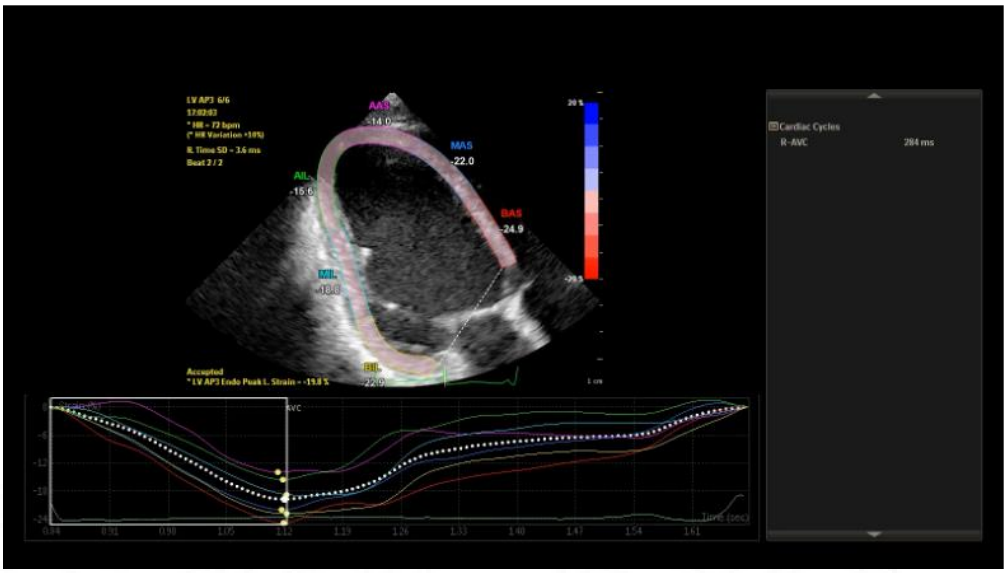


Fig:14: Regional 2D image of apical 2 chamber view over which region of interest is laid down and respective myocardial segments are tracked in QLAB software

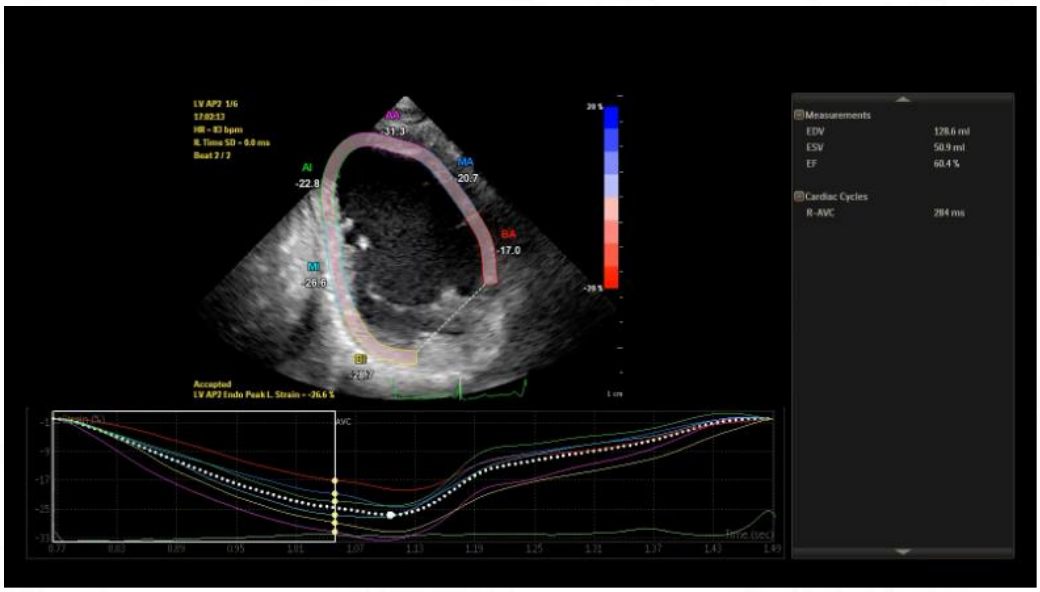


Fig:15: Regional 2D image of apical 3 chamber view over which region of interest is laid down and respective myocardial segments are tracked in QLAB software

A bulls eye plot was generated by integrating the regional and segmental strains of the LV as GLS-LV for longitudinal strain and global circumferential strain as GCS. (Fig. 16,17)

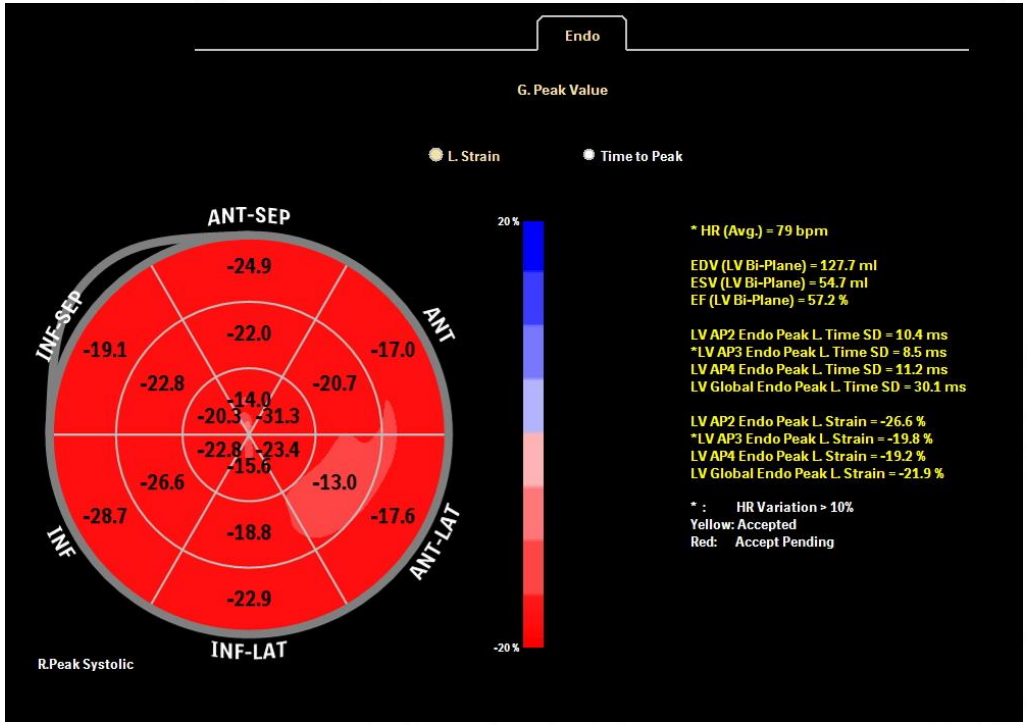


Fig.16: Global longitudinal strain of LV: demonstration of individual segments in Bulls eye plot

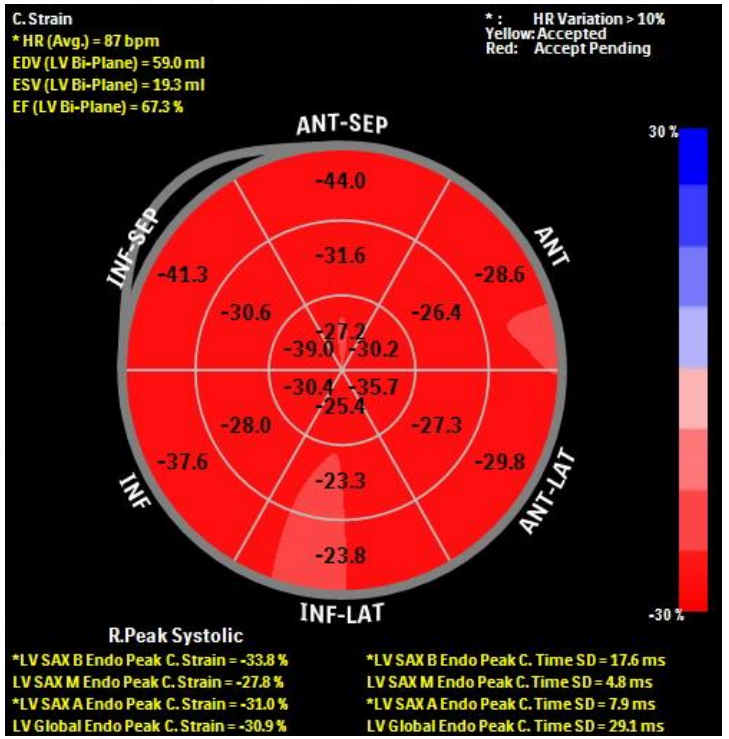


Fig.17: Global circumferential strain of LV: demonstration of individual segments in Bulls eye plot

PRIMARY OUTCOME:

- Prevalence of Strain abnormalities by STE

SECONDARY OUTCOMES:

- Arrhythmia
- Deterioration in Severity of MR
- Heart failure Hospitalization
- Reoperation
- Catheter intervention
- Device Implantation

Primary Outcome	Definitions
➢ Prevalence of subclinical LV dysfunction by STE	➢ Type of abnormalities in global longitudinal and segmental strains ➢ To look for coronary territorial strains
Secondary outcomes	
➢ Arrhythmia	➢ Any significant arrhythmia after index hospitalisation for surgery which may or may not need admission for stabilisation.
➢ Deterioration in Severity of MR	➢ Worsening of existing MR by at least > 1 grade during point of assessment or which changes the management.
➢ Heart failure Hospitalisation	➢ Hospitalisation for management of heart failure
➢ Reoperation	➢ Any cardiac surgical intervention after index surgery , includes mv repair , replacement etc indications of surgery as per existent guidelines for intervention.
➢ Catheter intervention	➢ Includes patients who underwent revascularisation by PCI ➢ (Diagnostic) procedures like CAG were excluded.

Table.3: Definitions of outcomes.

STATISTICAL ANALYSIS

- Statistical analysis was done using IBM SPSS version 28.0.1.1.
- Continuous variables were reported as means with SD or medians with IQR for skewed data.
- Categorical variables were summarised as absolute frequencies and proportion (%)
- Normalized Strain values using the mean and standard deviation were compared with corresponding benchmarks of respective age groups using unpaired t test and Mann Whitney's test.
- Univariate and multivariate logistic regression model was used to see independent predictors of strain abnormalities and p value of <0.05 was considered significant.
- Sub group analysis with age at repair was performed and baseline and echocardiographic parameters were compared between the two age groups using Mann Whitney U tests for continuous variables and Chi square or Fisher exact test for categorical variables, and a p value <0.05 was taken as statistically significant.
- We then computed a Receiver operating characteristic curve (ROC) taking age at repair as the continuous variable to predict normalization of GLS. From the obtained coordinate points, the cut-off with the maximum Youden’s J value

was used to identify the optimal threshold value for the benefit of surgical repair in reference to time of surgery.

- Odds Ratio and 95% confidence intervals were also computed to express the strength of association between age at repair and the outcome.
- Binary logistic regression analysis was considered to explore for potential predictors as only one variable was significant and multivariable analysis was therefore not warranted with this sub group analysis dataset.
- A repeated measure ANOVA analysis was performed for displaying marginal means.

3 RESULTS

Out of 59 patients included in this study, 55.93%(n= 33) were female and 44.07% (n=26) were male , with median age of diagnosis and presentation being 5 months (IQR 23.5). Median age at repair was 5.02 months (IQR 24). Median time duration from diagnosis to admission for surgery was 0.5 days (12 hrs) (IQR 8.75 days). Median age during study period was 8 years (IQR 14).

Out of 59 patients, 62 % (n=37) were misdiagnosed and referred for evaluation. Only 37.9% (n=22) were diagnosed as ALCAPA and referred for corrective surgery.

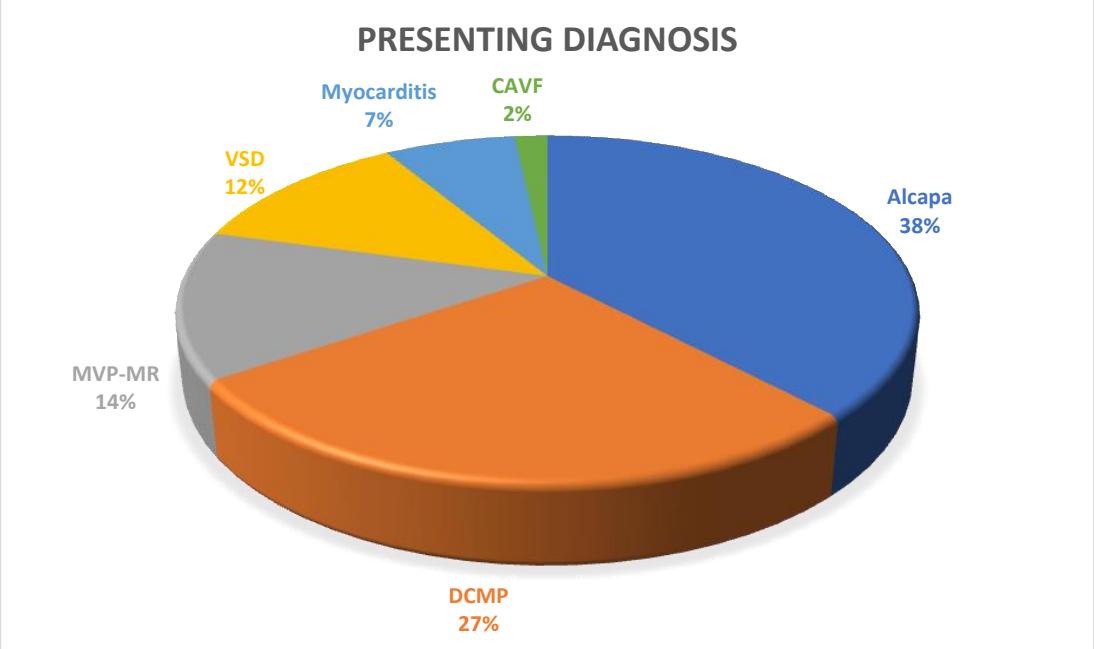


Fig. 18: Pie diagram showing distribution of various referral diagnosis

Most of the patients, 66.7% (n=28) were in class II NYHA or ROSS class at presentation. Only 2.3%(n=2) were in class IV at presentation. 50% (n=30) were in heart failure at presentation. 3% (n=2) were in cardiogenic shock needing inotropes at admission.

Table: 4: Presenting complaints among the cohort

Presenting complaint	n (%)
SOB	42 (91.3%)
FTT	1 (2.17%)
Murmur	2(4.35%)
Angina	2(4.35%)
palpitations	1 (2.17%)

ECG changes at presentation		
Rhythm	SR	56(94.9%)
	Atrial fibrillation	3 (5.08%)
QRS axis:	Normal	32 (71%)
	LAD	9 (20%)
	RAD	4 (8.89%)
STE in any 2 of 4 leads (I, aVL, V5, V6) at presentation		Present 5 (10.64%)
		Absent 42 (87.23%)
Q in I, aVL		46 (95.83%)
TWI in I, aVL		45 (93.75%)
LVH		38 (64%)

Table: 5: Preoperative ECG changes in the cohort

94.9% (n=56) of the patients were in sinus rhythm at presentation. 71%(n=32) had normal QRS axis in presenting ECG. 87% (n=42) of the patients did not show any ST elevation in I, aVL ,V5,V6 at presentation. Q waves in I, aVL were seen in 95.83%(n=46). 64% (n=38) had evidence of left ventricular hypertrophy on presenting ECG.

Chest x-ray showed cardiomegaly in 94.9% (n=56) of patients. 77% (n=46) had PVH and 28% (n=17) had PAH on x-ray at presentation. Mean EF at presentation was 36.69 +/- 17.03 (SD). Regional wall motion abnormalities were present in 93% (n=55)

of patients. Mean translocation distance (echocardiographic measurement from left coronary cusp (LCC) to left coronary artery (LCA)) was 6.42 +/- 3.49 mm. All the patients had flow reversal in LCA. Septal collaterals were documented in 30% (n=18) of patients. 81% (n=48) of patients had subendocardial fibroelastosis with scarred anterolateral papillary muscle. Mitral regurgitation (MR) was seen in 83% (n= 49) of patients at presentation. 98 % (n = 58) had ischemia as mechanism of MR. 16% (n =10) had associated mitral valve prolapse (MVP) as mechanism of MR.

Moderate MR was seen in 50% (n = 24) at presentation. Severe MR was seen in 12.5% (n=6).

Degree of MR at presentation	n (%)
None	1 (2.08%)
Trivial	5 (10.42%)
Mild	12 (25%)
Moderate	24 (50%)
Severe	6 (12.5%)

Table.6.: Table showing severity of mitral regurgitation at presentation

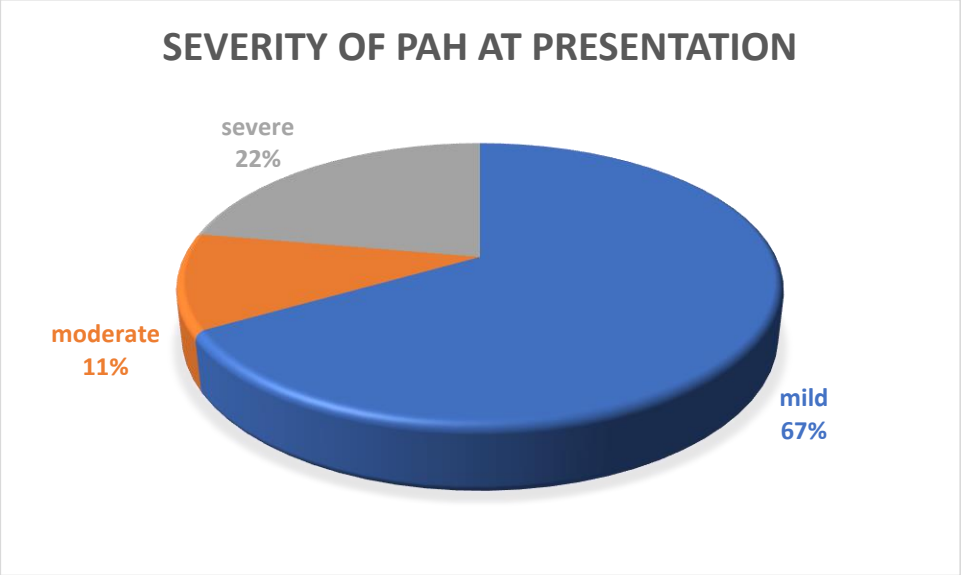


Fig.19: Pie chart showing varying severity of PAH at presentation.

Surgical details:

91% (n=54) underwent LMCA translocation as primary procedure for ALCAPA, 5 patients (8.4%) underwent LMCA ligation with CABG – graft to LAD.

LCA was arising from anteriorly located non-facing sinus in 32% (n=19), and from posterior sinus in 64.5% (n = 38), two patients (3.3%) had LCA originating from the main pulmonary artery above the level of pulmonary sinus.

Other coronary abnormalities were seen in 8.4% (n=5), of which 2 have high RCA origin and 3 have absent left main with separate origin of LAD and LCX.

Mean cardiopulmonary bypass time (CPB) time was 201 min +/-83 (SD). Mean aortic cross clamp time was 102 min +/- 40 (SD). Mean length of hospital stay was 17.9 days +/- 7.6 (SD). 18.6 % (n = 11) underwent mitral valve intervention at index surgery of which 10 patients (16.9%) undergone repair and 1 (1.69%) had mitral valve replacement.

Mean inotrope hours were 91 +/- 40 (SD). ECMO was used in 13 patients (n= 8) postoperatively. Immediate post operative complications like acute kidney injury (AKI) managed with peritoneal dialysis was seen in 6%(n=4), seizures in 3.3% (n=2), arrhythmias like atrial fibrillation seen in 3.3% (n=2), reintubation secondary to worsening respiratory failure in 5% (3). 3.3% (n=2) were resuscitated from cardiac arrest. 1 patient had mediastinal hematoma and hemothorax which needed re exploration for control of bleeding.

Follow-up:

Median follow-up duration 7.4 yrs (IQR:10.19).

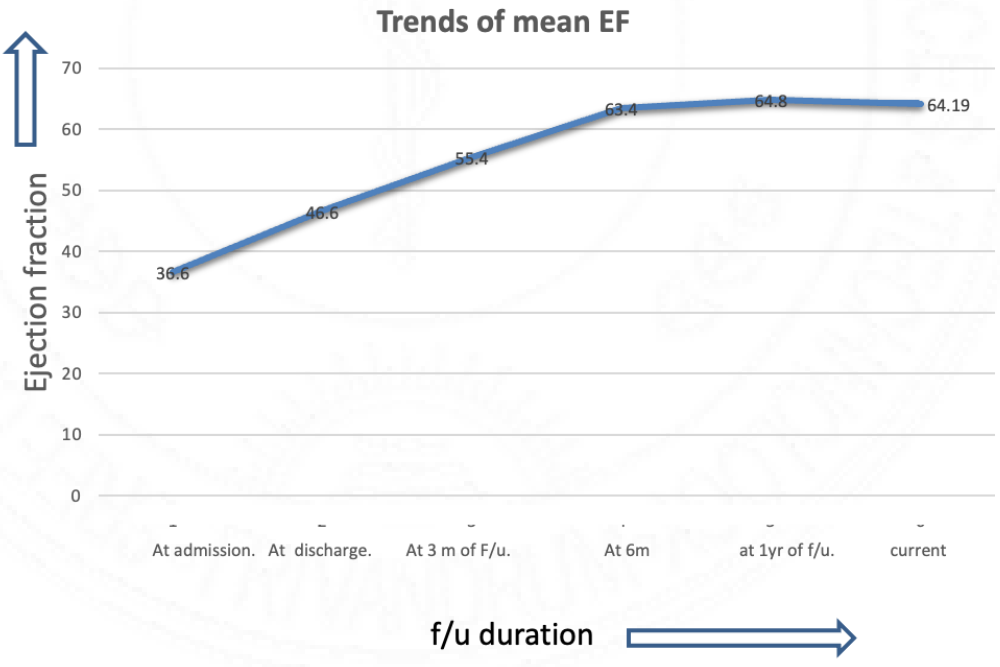


Fig.20: Trends of mean EF on follow-up

Median time for normalization of ejection fraction EF (>60%) was 4.8 months (IQR:8).

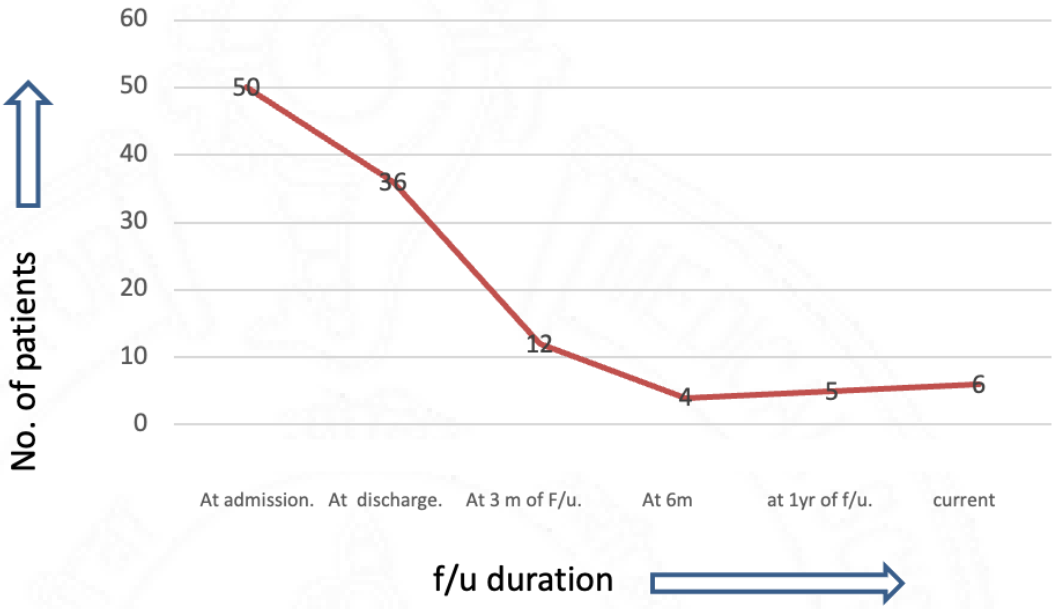


Fig.21: Trend of RWMA on follow-up

Median time for normalization of regional wall motion abnormality (RWMA) was 5 months (IQR:3).

Primary outcomes:

Mean global longitudinal strain of left ventricle (GLS-LV) was 18.06 +/- 5.05 (SD). Other individual and segmental strain are tabulated below (table. 7)

Table.7: Speckle tracking echocardiographic data: segmental longitudinal strain of individual segments and their mean segmental longitudinal strain of each view.

Myocardial segment imaged		**Mean Segmental strain (- % +/- SD)**
Mean apical 4 chamber strain (A4C) -17.7%+/- 5.59 (SD)	1. Basal Inferoseptal segment	17.03 +/- 6.022
	2. Mid inferoseptal segment	18 +/-6.3
	3. Apical inferoseptal segment	20 +/- 7.1
	4. Apical anterolateral segment	18.8 +/- 7.618
	5. Mid anterolateral segment	16.5 +/- 6.29
	6. Basal anterolateral segment	16 +/- 7.6
Mean apical 3 chamber (APLAX) strain -17.8% +/- 5.72 (SD)	1. Basal inferolateral segment	17.38 +/- 6.25
	2. Mid inferolateral segment	17 +/-6.5
	3. Apical inferolateral segment	19 +/- 6.16
	4. Apical anterior segment	19.6 +/- 6.16
	5. Mid Anterior segment	17.2 +/- 5.93
	6.Basal anterior segment	17 +/- 6.7

Mean apical 2 chamber strain -18.4% +/- 5.42 (SD)	1. Basal Inferior segment	18.1+/- 5.88
	2. Mid inferior segment	19 +/- 6.1
	3. Apical inferior segment	19 +/- 6.7
	4. Apical anterior segment	19.72 +/- 7.23
	5. Mid anterior segment	16 +/- 6.4
	6. Basal anterior segment	15 +/- 5.9

Table.8: Mean global longitudinal strain of individual regional strain and mean coronary territorial strains.

	Strain (- %) mean +/- SD
Apical 3 chamber (APLAX) strain	17.8 +/- 5.72
Apical 2 chamber strain	18.4 +/- 5.42
Apical 4 chamber strain (A4C)	17.7 +/- 5.59
GLS: LV	**18.06 +/- 5.05**
Mean RCA strain	18.55 +/- 5.06
Mean LAD strain	17.3 +/- 5.28
Mean LCX strain	17.4 +/- 5.56
Mean LCA strain	17.3 +/- 5.25

Secondary outcomes:

Overall composite secondary outcome events were seen in 8 patients in entire cohort.

Table.9: Secondary outcomes of cohort

Secondary outcome	n (%)
Heart failure hospitalization	2 (3.3%)
Arrhythmias	1(1.6%)
Catheter interventions (CAG)	1(1.6%)
Coronary revascularization	0
Device implantations	0
Reoperations: MV surgery (repair / replacement)	1(1.6%)
Deterioration in MR severity	1(1.6%)
Mitral stenosis post MV repair	1(1.6%)
New onset LV dysfunction	1 (1.6%)

Predictors of abnormal global longitudinal strain of LV (GLS-LV):

Predictors of abnormal strain were analyzed with univariate analysis using Mann Whitney U test. Of all variables, mean translocation distance, left coronary artery arising from the non-facing sinus, total inotrope hours, ejection fraction recovery from baseline at follow-up and incidence of composite secondary outcomes were significantly associated with abnormal global longitudinal strain (GLS-LV).

Table.10: Preoperative predictors of abnormal GLS-LV (Univariate model)

Preoperative Variable	P value
Age at surgery	0.063
Gender	0.5
Current age	0.18
NYHA class at presentation	0.14
Presence of heart failure at admission	0.60
EF at admission	0.058
LCA translocation vs LCA ligation with CABG	0.32
Distance between LCC and LCA in mm	0.049
LCA arising from non-facing sinus	0.013
MR severity at presentation	0.87
Presence of PAH prior to surgery	0.49
Length of hospital stay for surgery	0.369
Time since surgery	0.23

Table.11. Perioperative predictors of abnormal GLS-LV (univariate model)

Intraoperative variables	P value
CPB time	0.16
ACC time	0.491
Post operative variables	**P value**
Total inotrope hours	0.040
Total mechanical ventilation time	0.41
Preoperative EF	0.09
EF at discharge	0.40
EF at 3 months post op	0.03
EF at 6 months post op	0.047
EF at 1 year post op	0.012
EF at last follow-up	0.038
Post operative complications	0.76
Composite Secondary outcome which includes ➢ **Arrhythmia ,** ➢ **Deterioration in Severity of MR needing intervention** ➢ **Heart failure Hospitalisation** ➢ **Reoperation** ➢ **Catheter intervention / revascularisation** ➢ **Device Implantation**	0.044

Table.11: Regional strain parameters in prediction of abnormal global longitudinal strain LV (Univariate model)

Regional strain parameter	P value
GLS: LV apical 3 chamber region	<0.00001
GLS: LV apical 4 chamber region	<0.00001
GLS: LV apical 2 chamber region	<0.00001
Time to peak – apical 4 chamber	<0.02
Time to peak - apical 3 chamber	0.058
Time to peak - apical 2 chamber	0.034
Time to peak: LV	0.0393
Mean RCA territory strain	<0.00001
Mean LAD territory strain	<0.00001
Mean LCX territory strain	<0.00001
Mean LCA territory strain	<0.00001
Mean Circumferential strain	<0.00001

Multivariate predictor model with mANOVA used for prediction of abnormal global longitudinal strain of LV failed to demonstrate significant association with individual variables. However individual regional strain was statistically significant.

variable	P value
Translocation distance	0.4
LCA from non-facing sinus	0.36
Total Inotropic hours	0.2
Total Inotrope hours	0.09
Preoperative EF	0.08
EF at discharge	ns
EF at 3 months post op	ns
EF at 6 months post op	ns
EF at 1 year post op	ns
EF at last follow-up	ns
Composite Secondary outcome	ns

Table.12: Multivariate predictors of abnormal strain (GLS-LV)

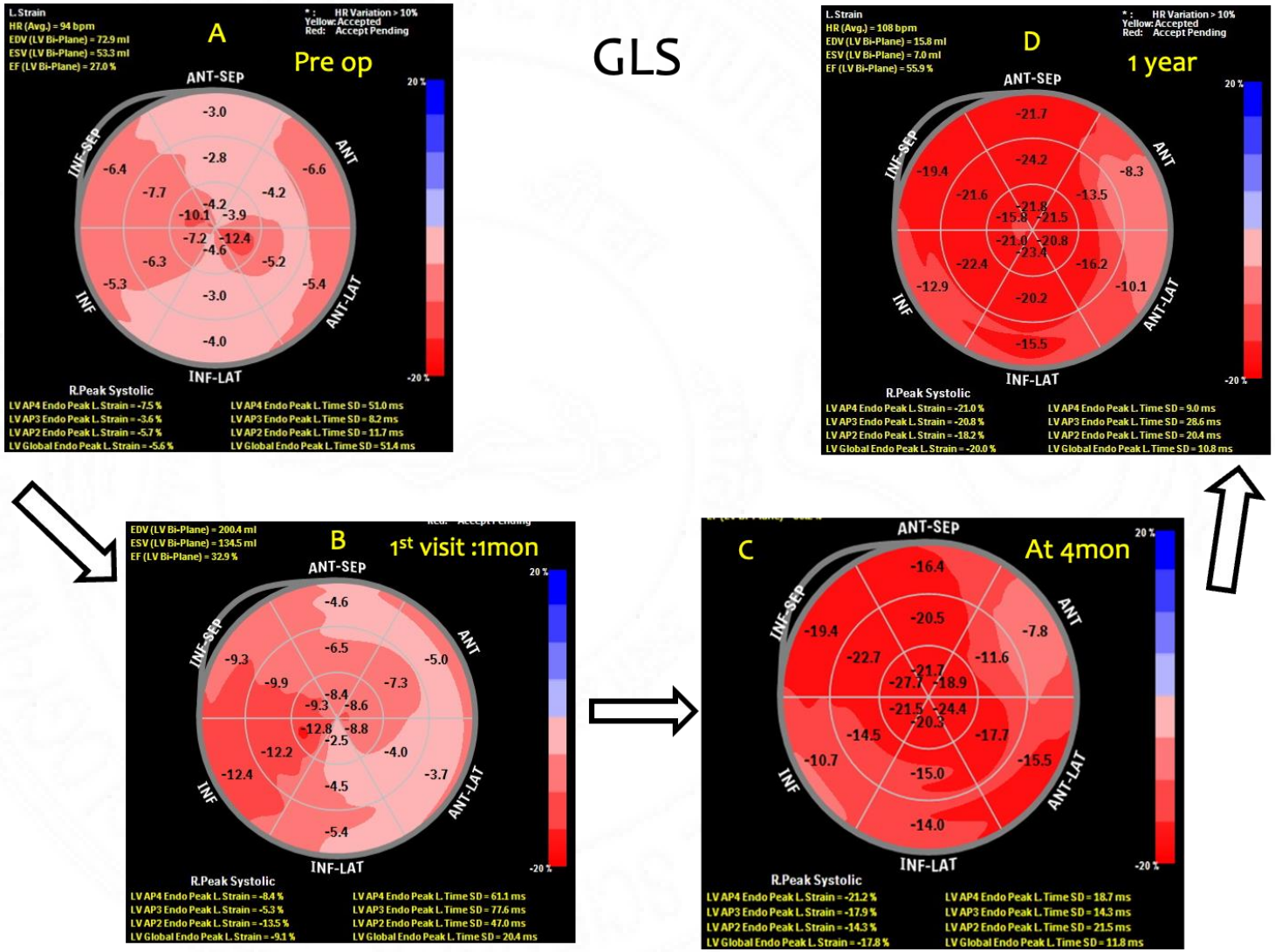


Fig.22: Global longitudinal strain of LV (GLS-LV) representative images of a child who underwent surgery at 3.9 months of age with preoperative EF of 27%. Preoperative GLS-LV was -5.7% (Panel A), post-surgery at 1month GLS-LV of -9.1% (panel B), which increased to -17.8% at 4months post repair (panel C), and to -20.8% at 1 year of age (panel D)

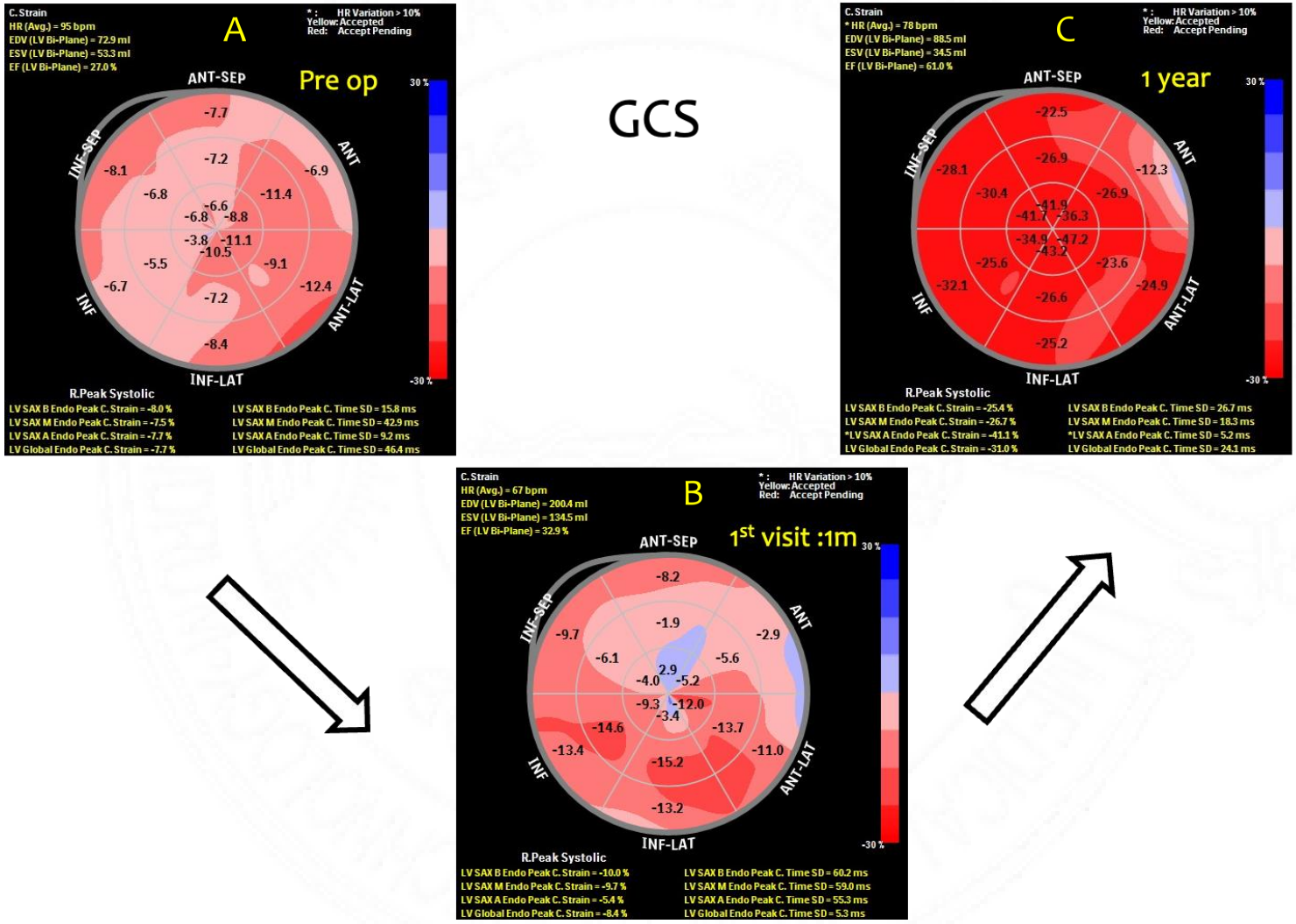


Fig.23: Global circumferential strain of LV (GCS-LV) representative images of a child who underwent surgery at 3.9 months of age with preoperative EF of 27%. Preoperative GLS-LV was -7.7%(Panel A), post-surgery at 1month GLS-LV of -8.4% (panel B), which increased to -31% at 1 year of age (panel C)

On follow-up, prospectively strain imaging was done in the patients who underwent surgery during the study period for assessment of global longitudinal strain of LV along with conventional echocardiography, which showed interesting findings.

Circumferential and longitudinal strain gradually improved on follow-up. Right coronary territory strain abnormality improved first, followed by left coronary territory strain. GLS lags behind the ejection fraction in normalization.

On extrapolation to the other patient by patient years and we calculated the significant correlation by means of Pearson coefficient test showed significant correlation. (R score: 0.59, p value :<0.00001).

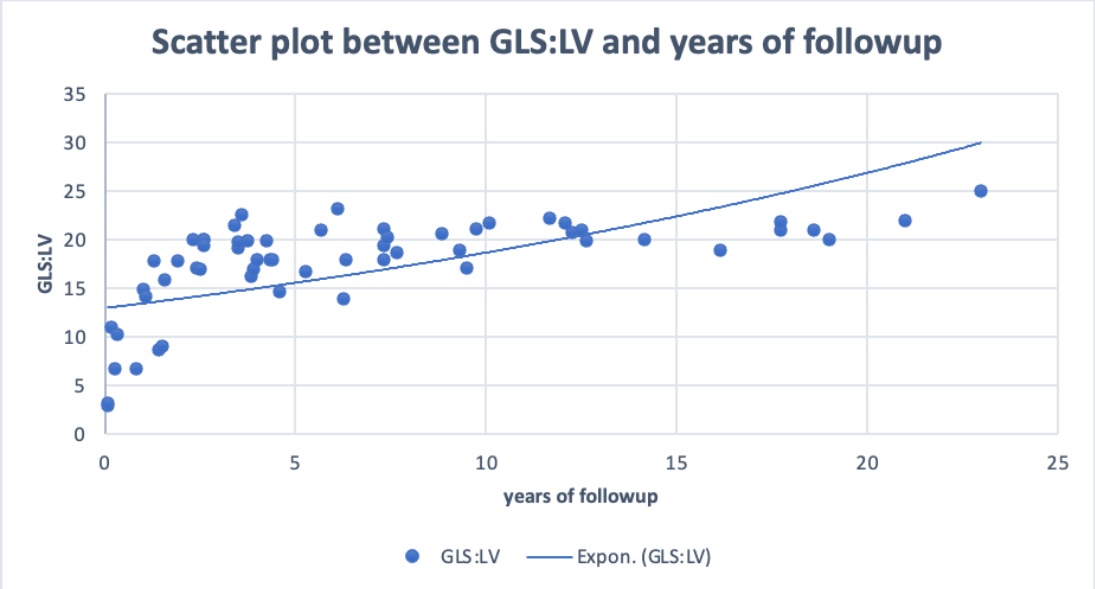


Fig.24: Scatter plot showing the significance of median follow-up and ejection fraction.

By using the age specific cutoffs from Levy etal, we compared patients with normal and abnormal GLS-LV. In our cohort 30 patients (50.8%) were noted to have abnormal strain. Normal strain was noted in 29 patients (49.1%).

	Abnormal GLS-LV (n=30) ; 50.8%	Normal GLS - LV (n=29) ,49.1%	P value
Median (GLS: LV) -%; IQR	- 16.7% (8)	-21.5 % (2.5)	<0.00001

Table .13: Distribution of normal and abnormal strain in the study cohort with median GLS:LV

Median GLS-LV in patients with abnormal strain was 16.7% (IQR:8) and median GLS-LV in patients with normal strain was 21.5% (IQR:2.5). The difference between the two groups was statistically significant (p value :<0.00001).

Among the patients who have strain abnormalities, 23%(n=7) presented at a later age with median age at presentation of 10.9 (IQR:9) and 33% (n=10) had LV dysfunction. In patients with normal strain (n=29), none of the patients had LV dysfunction.

	Patients with abnormal strain n = 30	patients with normal strain n= 29	P value
Late surgical repair n (%)	7 (23%)	1 (3.4%)	0.022
LV dysfunction n (%)	10 (33%)	0	0.0008 *
Mean Preoperative EF	40% +/- 16.6	33% +/- 17	0.058 #
Mean current EF	57 +/- 15	66.7 +/- 6	0.0017 #

*Fisher exact test

unpaired T test

Table.14: Important factors affecting the strain

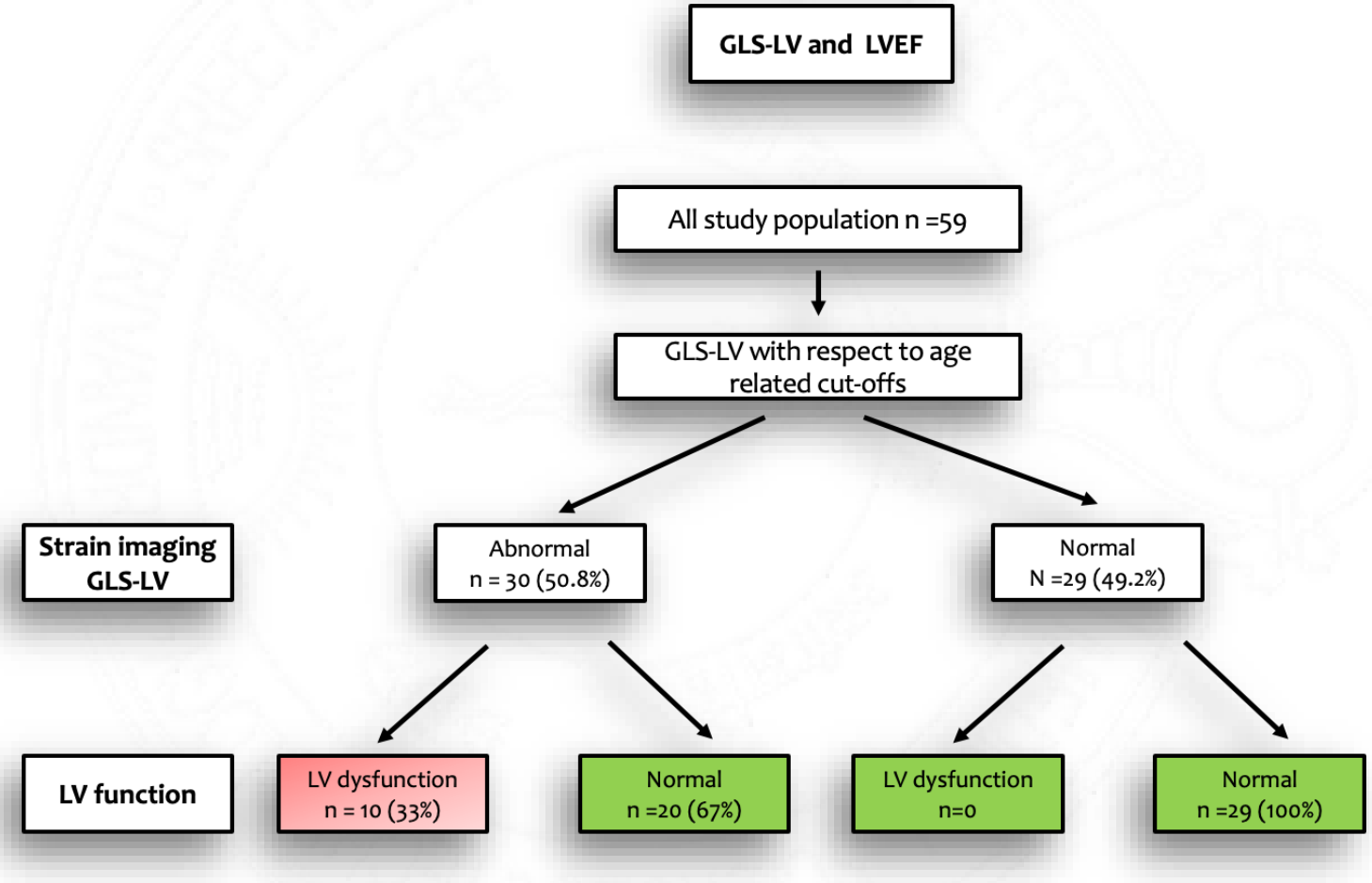


Fig.25: Flowchart showing the distribution of patients when GLS-LV compared against the LV function.

In patients with normal LV function 83% (n=49) of the total cohort, 40.8% (n=20) had low GLS-LV values when compared to normal counterparts, and 59.1% (n=29) had normal GLS-LV values.

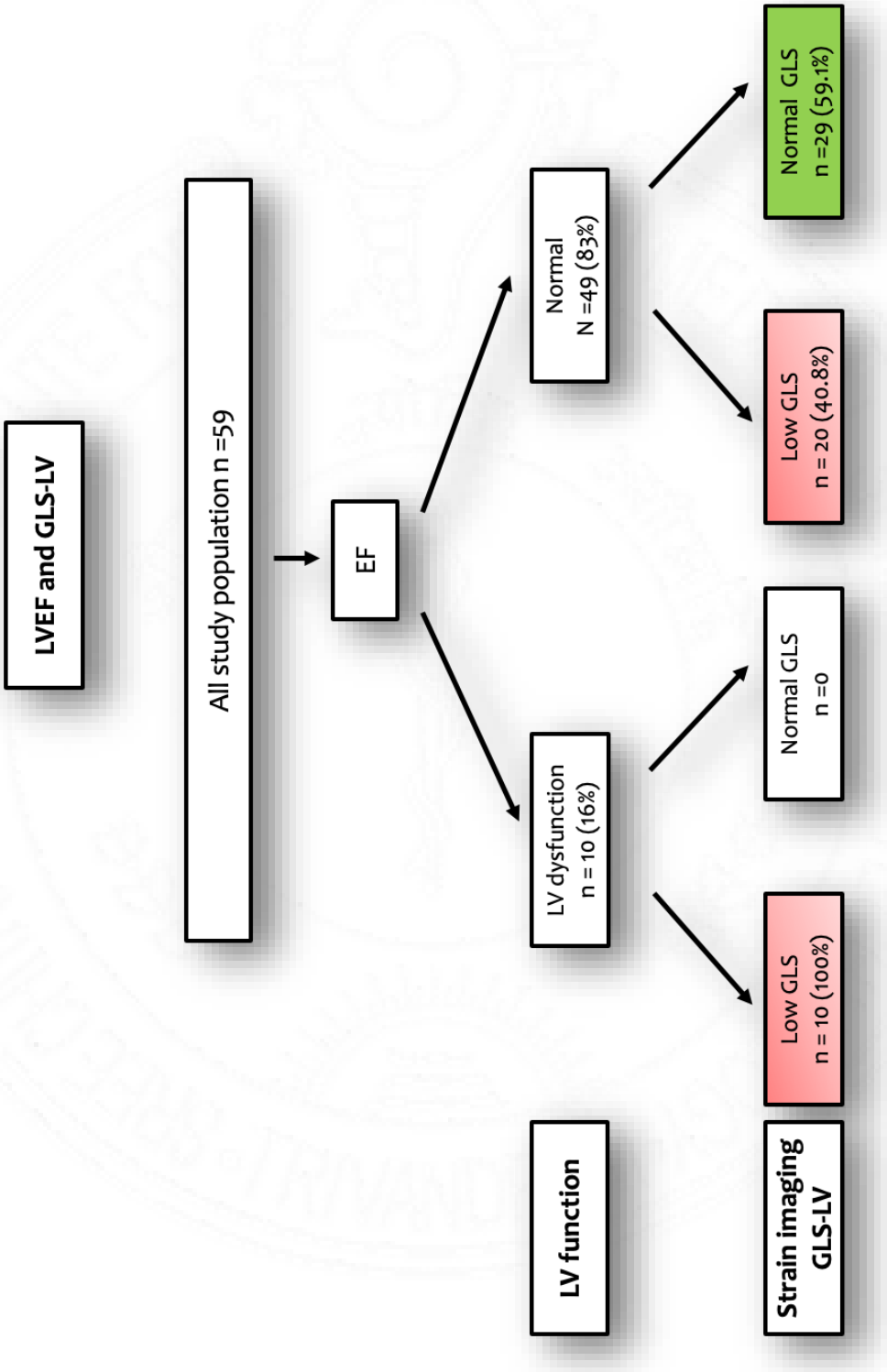


Fig.26: Flowchart showing the distribution of patients when LV function compared against the GLS-LV.

A subgroup analysis done in patients with normal ejection fraction (>60%) and patient who have confounding factors which affect the strain , like those who have more than moderate mitral regurgitation, those who had mitral valve replacement during the index procedure and those who underwent surgical repair other than direct coronary translocation were excluded with a final cohort comprising of 39 patients.

Receiver operating characteristic curve (ROC curve) was obtained by using age at repair as a continuous variable to predict the normalization of left ventricular strain taken as a categorical variable. Area under curve (AUC) was 0.825 (p= 0.001); the maximum Youden's J value was 0.65. The probability of normalization of LV strain is 81.6% if surgical repair was done before 7.8 months of age. The odds of having normal strain values on follow-up is 11.3 times higher, if repair was done before 6 months of age (95% CI 2.4 – 54.5).

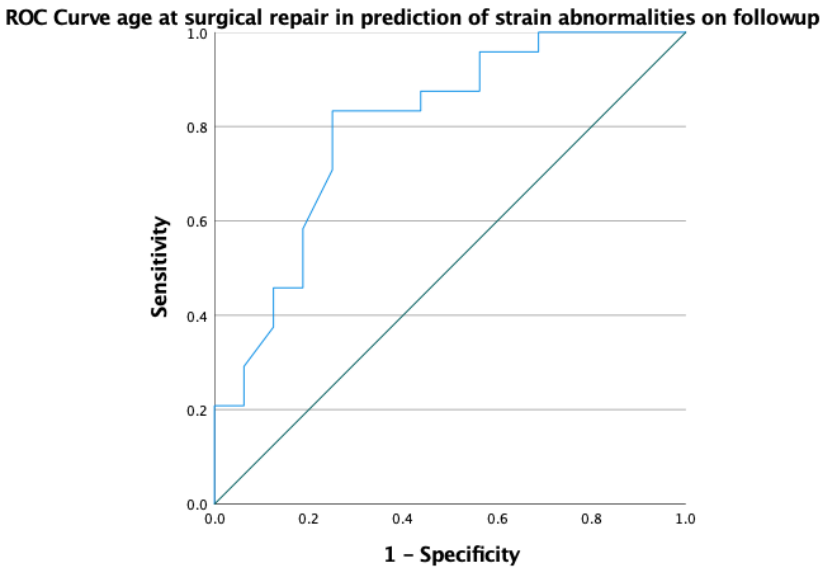


Fig.27: ROC curve for estimation of age cut off for surgical repair in prediction of strain abnormalities.

Based on the cut off obtained from this ROC curve, we divided the patients with post operative ALCAPA who had normal ejection fraction into two groups as group 1 (patients who underwent early repair that is before 7.8 months of life) with 21 patients and group 2 (patients who underwent surgery after 7.8 months of life) with 18 patients.

The ventricular function at presentation was significantly worse (ejection fraction 33.8 vs 54; p <0.05) for the group who presented early (group 1), but both groups had comparable ejection fraction (EF) (67.6 vs 65.6, p=0.94) at latest follow up. In the repeated ANOVA to depict the effect of surgical repair on ejection fraction, the improvement in EF within each group (p <0.001) and between the two groups (p = 0.002) were statistically significant.

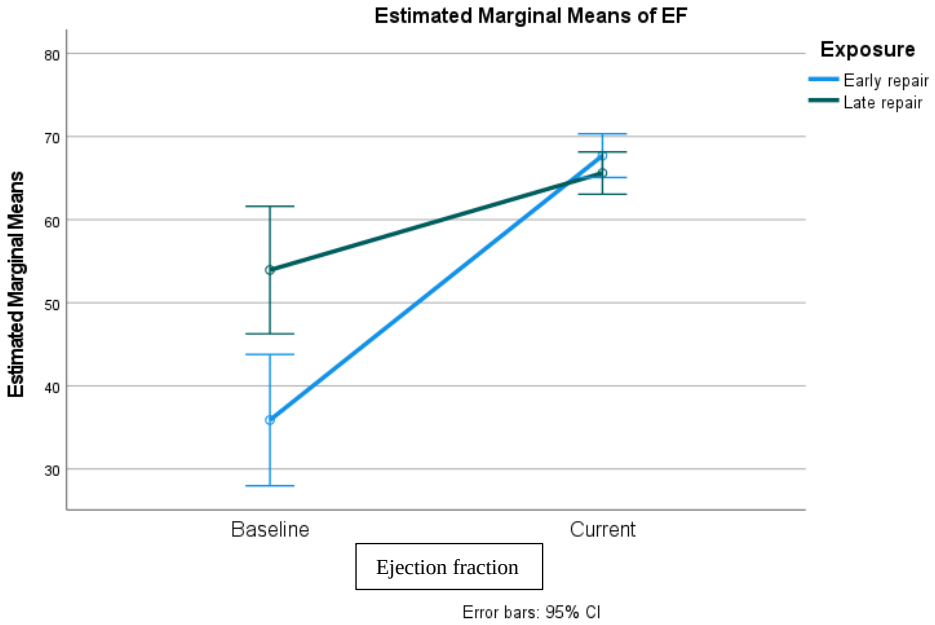


Fig.28: Repeated measure ANOVA to see the interaction between age of repair and change in ejection fraction (EF).

We compared the differences between two groups with respect to regional, arterial territorial strain and global longitudinal and global circumferential strain. Abnormal GLS-LV was seen in 19%(n=4) in early repair group whereas in late repair group abnormal GLS-LV was seen in 67%(n=12).

Table.15: comparison of strain values between early repair and late repair groups

	Group 1 (n=21) Early repair group	**Group 2 (n=18) Late repair group**	**P value**
Abnormal Global longitudinal strain (n, %)	4 (19%)	12 (67%)	**0.004**
Abnormal Global Circumferential strain (n, %)	0	1(6%)	**0.43**
Regional strain abnormalities LCA territory (Any severity)	21 (100%)	18 (100%)	**1.0**
Regional strain abnormalities LCA territory (severe)	9 (43%)	11 (60%)	**0.34**
Regional strain abnormalities RCA territory(any severity)	**3 (14%)**	**6 (33%)**	**0.26**

Along with strain abnormalities seen in left coronary territory, we also observed strain abnormalities in RCA territory of varying severity in 22 patients (37%). 9 patients who had normal LV function also exhibited RCA strain abnormalities.

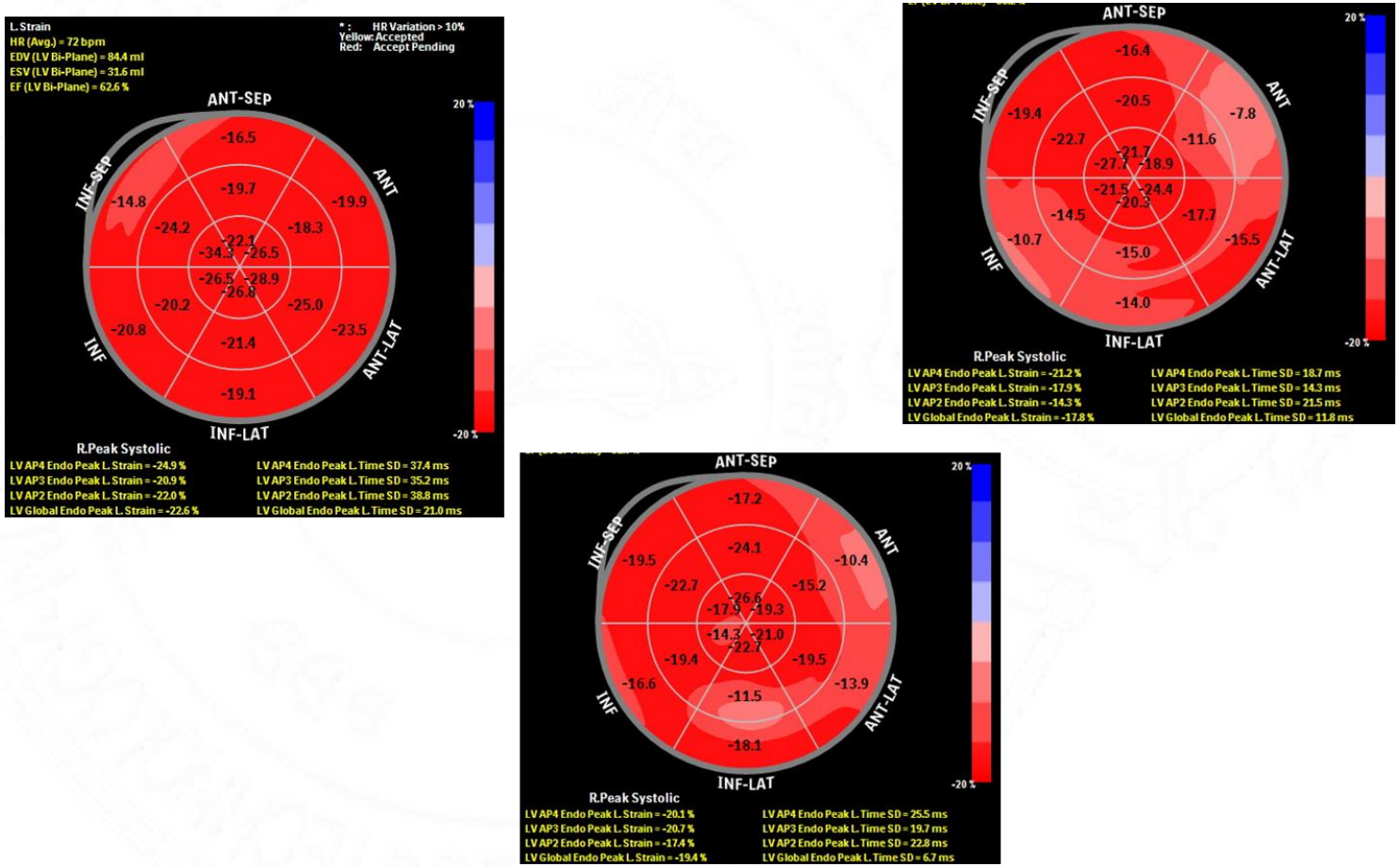


Fig.29: Bulls eye plot of three different patients showing varying degrees of severity in RCA territory strain abnormalities from mild to severe involvement.

4 DISCUSSION

Our study is one of the largest single-center analyses showing the strain abnormalities in post-operative ALCAPA patients. It is the only study reported so far from the Indian subcontinent.

Females predominated in this study, unlike in other studies where males were predominantly affected. ALCAPA was diagnosed in 37% of the total cohort. Still, 63% of the infants are misdiagnosed as other diseases and referred, reiterating the significant knowledge gap in suspecting and diagnosing this rare, life-threatening entity.

Atrial fibrillation was seen in 5% of the cohort. All were adult patients. None of the cases had normal ECG at presentation. LVH was seen in 64% of patients, whereas prevalence reported in prior studies ranged from 28 to 48%. Q waves were seen in 95% of cases.

Associated mitral valve abnormalities like mitral valve prolapse were seen in 16% of our cohort, whose prevalence reported in other studies ranged from 10% to as high as 59% (36).

None of our patients had coronary ostial narrowing documented from echocardiography. The median time for normalisation of EF is 4.8 months, which is in concordance with previous studies.

Mitral regurgitation post-operatively worsened in only one patient (1.6%) who underwent surgery at the age of 4 years needing intervention by MV replacement. This

indirectly indicates that MR improves in most infants with time. Those patients who had severe MR preoperatively, presenting at a later age, may benefit from repair done at index surgery. These findings correlate with the existing studies (46).

Most patients underwent direct coronary implantation, which is most physiological, as seen in prior studies (21).

Strain imaging showed a mean GLS-LV of 18.6 +/-5.05. Strain abnormalities are seen in 50% of the postoperative ALCAPA patients. Longer translocation distance, coronary originating from the non-facing sinus, high total inotropic hours, and secondary outcomes were major predictors of abnormal GLS-LV.

40% of the patients with normal EF had documented LV dysfunction, which was in concordance with prior studies indicating the need for close follow-up and future reassessment of the strain for progression of abnormalities which in the case may warrant the additional imaging or coronary angiography to see for the patency of coronaries.

Very low longitudinal strain values (less than -15) had been mentioned in a previous study (31,32) to indicate the presence of coronary ostial narrowing. Inducible ischemia on exercise stress testing and a subendocardial scar on cardiac MRI was demonstrated in one of our patients with GLS <15. As there was no anatomic narrowing of the coronary ostium, he was continued on optimal medical management. The other two patients with GLS <-15 did not consent for exercise stress testing or additional imaging stating asymptomatic status. All our study cohort patients ha widely patent coronary ostia on echocardiography.

As expected, the global longitudinal strain GLS-LV was lower in 50% of the patients. The circumferential strain was consistently normal in 95% of the patients in our study as in previous studies (11,34–36). The preferential involvement of the longitudinal fibres, which were located subendocardially led to a preferential abnormality in global longitudinal strain (GLS-LV) with normal and preserved circumferential strain.

Most patients' presentation, course, and recovery pattern of infantile and adult type ALCAPA were vastly different. Though the infantile type of ALCAPA has worse baseline ventricular function, they recover much faster after repair than the patients with adult type ALCAPA (23,47). In our study, the overall ventricular function was better for the older age group before repair (mean ejection fraction 54% vs 34% in younger age group; $p<0.05$). This apparent paradox has been explained by a rapid recovery of function of hibernating myocardium in the infantile ALCAPA group (24,25).

Subtle functional abnormalities of the left ventricular myocardium after complete recovery of ventricular systolic function in repaired adult and infantile type ALCAPA have been reported in previous studies (24,28,31,35,44,48).

Global longitudinal strain abnormalities were found in two third patients of adult type ALCAPA in our study compared to only 19% in the younger age group($p=0.004$). In our study, the odds of normalisation of longitudinal strain on follow-up were higher (OR 11.3; 95% CI 2.4- 54.5) if surgery was done before 7.8 months of age (group1). Though the ventricular function was worse before surgery in the younger age group, they fared much better in normalising ventricular strain. The persistent subclinical

dysfunction of the subendocardial myocardial fibres has been hypothesised to be partly due to competitive flow between the collateral circulation and the newly established antegrade flow in the left coronary artery (LCA) (47). This could imply that persistent or recurrent subendocardial ischemia may be more in patients with better collateral circulation, that is, the older age group. The collateral flow provided by the RCA in the adult type of ALCAPA may be inadequate to compensate for the longer duration of myocardial ischemia as it may not prevent the ongoing subendocardial ischemia. As time passes, the profuse collateral flow may also cause coronary steal from the right and left the coronary system to the pulmonary circulation (47). The development of coronary abnormalities due to the collateral circulation like aneurysm or stenosis may also result in inadequate antegrade flow in LCA after coronary reimplantation. The development of good collateral circulation may thus provide an initial survival advantage but may not necessarily translate to better functional outcomes on follow-up.

Even in our favourable cohort of patients with good ventricular function at baseline and with no more than moderate mitral regurgitation, we found that regional strain abnormalities of the left coronary artery territory were universal, albeit mild. As described in previous studies, apical segments were spared, though the reason for apical sparing is not clear (44,49). In a few patients in both groups, the strain abnormalities in a few segments of the LCA territory were severe. Identifying the clinical impact of this finding is difficult, as no event happened to any of the patients in both groups. Longer follow-up with additional investigations like exercise stress testing and Holter may bring to light the risk for arrhythmias or inducible ischemia in the subset with severely reduced regional strain values.

The presence of strain abnormalities in RCA territory in both groups was somewhat unexpected, though this has been described previously in a previous study by Kugacka et al (35). The more frequent occurrence of RCA territory strain abnormality in the older repair group suggests that this may be related to coronary steal by the well-developed collateral circulation to the pulmonary artery. In some patients, ischemia may also explain RCA territory strain abnormality to the inferior segments supplied by dominant or codominant left coronary circulation.

Table.16: Comparison of index study with previous studies

Author, Year Country	N patients	Normal values of strain imaging	Study	Findings
DiSalvoet al Saudi Arabia (2001)	13	33 Age & sex matched controls	STE GLS & Radial strains of RV & LV	• Median age – 0.4 years; • Mean follow up : 7.5 yrs • RV regional LS : normal in both pts & controls • LV Radial function: normal in both pts & controls • LV GLS & regional deformation : reduced in patients
Cabrera et al (2014);Texas, USA	34	Age based reference values	Outcome and STE 2D vs TSE	• Median age – 5months , Median followup : 6yrs • Reinterventions : 15% (n=5), • LVEDD(Z score): pre 6 →post 4 →longterm0.9 • LVEF% : pre 21 → post 41 →longterm 60 • EF : normalised in all by the end of followup • STE: GLS: low GLS and CPS in 79% (n=11 out of 14) • Normal GLS & increased CPS (n=2):14% • Increased GLS & normal CPS (n=1) :7%
DiSalvoet al Saudi Arabia (2015)	30	16 Age & sex matched controls	2D (Systolic & Diastolic Function) vs STE 1yr of repair in LVEF>50%	• Median age – 5 years; • LVEF : (63.6% vs. 64.1%)(pts Vs controls) • Avg E/é : 11.9 vs. 6.6 , • GLS in Pts vs controls (–17.6 ± 3.5% vs. –23.4 ± 3.1%) • LV torsion (9.1 ± 4.9° vs. 11.9 ± 3.3°)
Castaldi etal 2016 N.Y USA	10	20 Age and sex matched controls	Comparison Of STE: GLS,RS,CPS & CMRI Correlating with CAG	• Median age – 188days , • Mean follow up : 8.7 +/- 4.7 yrs • GLS & CPS : reduced in LCA Vs RCA territory • MRI : LCA stenosis in 3/10 pts, CAG confirmed • have lowest GLS in LCA territories • (–11.7, –14.7 & –14.8%). • Radial strain : preserved • circumferential strain : mildly depressed • (–23.5 ± 3.8 vs. –20.3 ± 2.0%, $p < 0.05$).

Author, Year Country	N patientts	Normal values of strain imaging	Study	Findings
Kugacka et al Poland, Italy (2019)	18	18 Age & sex matched controls	2DE; STE GLS & Radial strains of RV & LV RCA Vs LCA Clinical outcome	• Mean age – 16.8 years; • Median follow up : 17 yrs • Mean LVEF:55% • LV GLS: -15.8±3.3% vs -21.9±1.7%; • RV GLS: -20.6±3.9% vs -24.9±4.6%; • (E/E'): 8.1±2.6 vs 5.8±1.3 • Mean GLS RCA :-19.0± 4.4%, • LCA : -13.8± 7.3%
Index study	59	Historical controls Metanalysis from Levy etal.	STE- GLS-LV And outcome Comparison between normal and abnormal GLS-LV in patients with good LV function	• Median age of presentation: 5 yrs (IQR:23.5) • Median f/u : 7.4 yrs (IQR: 10.19) • Median time of diagnosis to surgery :0.5hrs (IQR:8.75) • Abnormal GLS-LV seen in 50% of the postoperative ALCAPA patients • GLS-LV was abnormal in 40% of patients despite normal LV function and no RWMA. • No significant correlation between strain abnormality and secondary outcomes • RCA territory strain abnormalities do exist in varying severity in post operative ALCAPA patients. • Early age of repair reduces the incidence of strain abnormalities on follow up.

Limitations:

1. No age and sex-matched controls were used in the study
2. Validation with cardiac MRI or stress exercise testing may be needed to substantiate these findings.
3. A coronary angiogram or cardiac CT may be needed to look for coronary ostial narrowing in cases with severe global or regional strain abnormalities.
4. The small number of patients in the study (due to the rarity of the disease) and the lack of clinical correlation with the findings made it difficult to draw conclusions or to dictate further management of those with significant strain abnormalities.
5. Further prospective strain imaging can be performed in all ALCAPA patients who underwent repair despite normalisation of strain to foresee the occurrence of any subtle subclinical myocardial dysfunction.

5 SUMMARY AND IMPLICATIONS

1. Approximately 50% of the patients post-ALCAPA repair do have strain abnormalities and 40% of the normal LV function do have lesser global longitudinal strain which indicate though the clinical improvement and 2d ECHO wise parameters normalised patients do have subclinical LV dysfunction which might improve in early repair subsets and may not improve in late repair individuals warranting the close follow-up of these individuals.
2. There is no significant correlation between strain abnormality and secondary outcomes which may be due to shorter duration of follow-up of 7.4 years and lesser number of events in the overall cohort which warrants more extensive duration of follow-up and needs Holter and exercise stress test for unmasking more events.
3. GLS-LV improved over the follow-up period in the patients who underwent corrective repair early in life.
4. RCA territory strain abnormalities do exist in varying severity in post operative ALCAPA patients which may signifies the extensive strain abnormalities causing ischemia over the RCA territory or dominant left system associated and have PDA supplying the inferior territory.
5. Early surgical repair before 7.8 months of age conferred 85% probability of normal ventricular strain on follow up.

6. Though ventricular function was better in the older age group prior to repair when compared to the younger age group, global and regional strain abnormalities persisted more in the older age group after repair.

6 CONCLUSIONS

7. Abnormal GLS-LV was seen in 50% of the postoperative ALCAPA patients
8. GLS-LV was abnormal in 40% of patients despite normal LV function and no wall motion abnormality on conventional 2D echocardiography.
9. There is no significant correlation between strain abnormality and secondary outcomes.
10. GLS-LV improved over the follow-up period.
11. RCA territory strain abnormalities do exist in varying severity in post-operative ALCAPA patients.
12. Early age of repair reduces the incidence of strain abnormalities on follow-up.
13. Surgical repair before 7.8 months of age conferred an 85% probability of normal ventricular strain on follow-up.
14. Though ventricular function was better in the older age group before repair when compared to the younger age group, global and regional strain abnormalities persisted more in the older age group after repair.
15. Future research with concurrent imaging with cardiac MRI may throw light in pathophysiological aspects.

7 REFERENCES

1. Farouk A, Zahka K, Siwik E, Golden A, Karimi M, Uddin M, et al. Anomalous origin of the left coronary artery from the right pulmonary artery. J Card Surg. 2009 Feb;24(1):49–54.

2. Lange R, Vogt M, Hörer J, Cleuziou J, Menzel A, Holper K, et al. Long-Term Results of Repair of Anomalous Origin of the Left Coronary Artery From the Pulmonary Artery. Ann Thorac Surg. 2007 Apr;83(4):1463–71.

3. Alexi-Meskishvili V, Nasseri BA, Nordmeyer S, Schmitt B, Weng YG, Böttcher W, et al. Repair of anomalous origin of the left coronary artery from the pulmonary artery in infants and children. J Thorac Cardiovasc Surg. 2011 Oct;142(4):868–74.

4. Hoashi T, Kagisaki K, Okuda N, Shiraishi I, Yagihara T, Ichikawa H. Indication of Takeuchi technique for patients with anomalous origin of the left coronary artery from the pulmonary artery. Circ J Off J Jpn Circ Soc. 2013;77(5):1202–7.

5. Ling Y, Bhushan S, Fan Q, Tang M. Midterm outcome after surgical correction of anomalous left coronary artery from the pulmonary artery. J Cardiothorac Surg. 2016 Dec;11(1):137.

6. Naimo PS, Fricke TA, d'Udekem Y, Cochrane AD, Bullock A, Robertson T, et al. Surgical Intervention for Anomalous Origin of Left Coronary Artery From the Pulmonary Artery in Children: A Long-Term Follow-Up. Ann Thorac Surg. 2016 May;101(5):1842–8.

7. Kazmierczak PA, Ostrowska K, Dryzek P, Moll JA, Moll JJ. Repair of anomalous origin of the left coronary artery from the pulmonary artery in infants. Interact Cardiovasc Thorac Surg. 2013 Jun;16(6):797–801.

8. Ben Ali W, Metton O, Roubertie F, Pouard P, Sidi D, Raisky O, et al. Anomalous origin of the left coronary artery from the pulmonary artery: late results with special attention to the mitral valve. Eur J Cardio-Thorac Surg Off J Eur Assoc Cardio-Thorac Surg. 2009 Aug;36(2):244–8; discussion 248-249.

9. Cabrera AG, Chen DW, Pignatelli RH, Khan MS, Jeewa A, Mery CM, et al. Outcomes of Anomalous Left Coronary Artery From Pulmonary Artery Repair: Beyond Normal Function. Ann Thorac Surg. 2015 Apr;99(4):1342–7.

10. Prakash A, Powell AJ, Krishnamurthy R, Geva T. Magnetic resonance imaging evaluation of myocardial perfusion and viability in congenital and acquired pediatric heart disease. Am J Cardiol. 2004 Mar 1;93(5):657–61.

11. Di Salvo G, Eyskens B, Claus P, D'hooge J, Bijnens B, Suys B, et al. Late post-repair ventricular function in patients with origin of the left main coronary artery from the pulmonary trunk. Am J Cardiol. 2004 Feb 15;93(4):506–8.

12. Driscoll DJ, Garson A, McNamara DG. Anomalous origin of the left coronary artery from the right pulmonary artery associated with complex congenital heart disease. Cathet Cardiovasc Diagn. 1982;8(1):55–61.

13. Ismail M, Jijeh A, Alhuwaymil RM, Alahmari R, Alshahrani R, Almutairi R, et al. Long-Term Outcome of the Anomalous Origin of the Left Coronary Artery From the Pulmonary Artery (ALCAPA) in Children After Cardiac Surgery: A Single-Center Experience. Cureus [Internet]. 2020 Dec 1 [cited 2022 Jul 27];

Available from: https://www.cureus.com/articles/44985-long-term-outcome-of-the-anomalous-origin-of-the-left-coronary-artery-from-the-pulmonary-artery-alcapa-in-children-after-cardiac-surgery-a-single-center-experience

14. Peña E, Nguyen ET, Merchant N, Dennie C. ALCAPA Syndrome: Not Just a Pediatric Disease. RadioGraphics. 2009 Mar;29(2):553–65.

15. Schaper W, Flameng W, Winkler B, Wüsten B, Türschmann W, Neugebauer G, et al. Quantification of collateral resistance in acute and chronic experimental coronary occlusion in the dog. Circ Res. 1976 Sep;39(3):371–7.

16. Vilá Mollinedo LG, Jaime Uribe A, Aceves Chimal JL, Martínez-Rubio RP, Hernández-Romero KP. Case Report: ALCAPA syndrome: successful repair with an anatomical and physiological alternative surgical technique. F1000Research. 2016 Aug 3;5:1680.

17. Karolczak MA, Wieteska J, Bec L, Madry W. Anomalous origin of the left coronary artery (LCA) from pulmonary trunk (Bland-White-Garland syndrome) with systemic collateral supply to LCA. Med Sci Monit Int Med J Exp Clin Res. 2001 Aug;7(4):755–8.

18. Fuchs MM, Le RJ, Cullen MW, Maleszewski JJ, Ammash NM. Multimodal Imaging of Anomalous Left Coronary Artery from the Pulmonary Artery in a 75-Year-Old Woman. Tex Heart Inst J. 2017 Dec 1;44(6):395–8.

19. Shivalkar B, Borgers M, Daenen W, Gewillig M, Flameng W. ALCAPA syndrome: An example of chronic myocardial hypoperfusion? J Am Coll Cardiol. 1994 Mar;23(3):772–8.

20. Kubota H, Endo H, Ishii H, Tsuchiya H, Inaba Y, Terakawa K, et al. Adult ALCAPA: from histological picture to clinical features. J Cardiothorac Surg. 2020 Dec;15(1):14.

21. Kottayil BP, Jayakumar K, Dharan BS, Pillai VV, Ajitkumar V, Menon S, et al. Anomalous Origin of Left Coronary Artery From Pulmonary Artery in Older Children and Adults: Direct Aortic Implantation. Ann Thorac Surg. 2011 Feb;91(2):549–53.

22. Kanoh M, Inai K, Shinohara T, Tomimatsu H, Nakanishi T. Outcomes from anomalous origin of the left coronary artery from the pulmonary artery repair: Long-term complications in relation to residual myocardial abnormalities. J Cardiol. 2017 Nov;70(5):498–503.

23. Muzaffar T, Ahmad Ganie F, Gpoal Swamy S, Wani NUD. The surgical outcome of anomalous origin of the left coronary artery from the pulmonary artery. Int Cardiovasc Res J. 2014 Apr;8(2):57–60.

24. Mertens L, Weidemann F, Sutherland GR. Left ventricular function before and after repair of an anomalous left coronary artery arising from the pulmonary trunk. Cardiol Young. 2001 Jan;11(1):79–83.

25. Azakie A, Russell JL, McCrindle BW, Van Arsdell GS, Benson LN, Coles JG, et al. Anatomic repair of anomalous left coronary artery from the pulmonary artery by aortic reimplantation: early survival, patterns of ventricular recovery and late outcome. Ann Thorac Surg. 2003 May;75(5):1535–41.

26. El-Louali F, Lenoir M, Gran C, Allary C, Fouilloux V, Ovaert C. Early Presentation of Patients with Abnormal Origin of Left Coronary Artery from the

Pulmonary Artery is a Predictor of Poor Mid-term Outcomes. Pediatr Cardiol. 2022 Apr;43(4):719–25.

27. Kanoh M, Inai K, Shinohara T, Tomimatsu H, Nakanishi T. Outcomes from anomalous origin of the left coronary artery from the pulmonary artery repair: Long-term complications in relation to residual myocardial abnormalities. J Cardiol. 2017 Nov;70(5):498–503.

28. Cabrera AG, Chen DW, Pignatelli RH, Khan MS, Jeewa A, Mery CM, et al. Outcomes of Anomalous Left Coronary Artery From Pulmonary Artery Repair: Beyond Normal Function. Ann Thorac Surg. 2015 Apr;99(4):1342–7.

29. Johnson C, Kuyt K, Oxborough D, Stout M. Practical tips and tricks in measuring strain, strain rate and twist for the left and right ventricles. Echo Res Pract. 2019 Sep;6(3):R87–98.

30. Marwick TH, Leano RL, Brown J, Sun JP, Hoffmann R, Lysyansky P, et al. Myocardial Strain Measurement With 2-Dimensional Speckle-Tracking Echocardiography. JACC Cardiovasc Imaging. 2009 Jan;2(1):80–4.

31. Castaldi B, Vida V, Reffo E, Padalino M, Daniels Q, Stellin G, et al. Speckle Tracking in ALCAPA Patients After Surgical Repair as Predictor of Residual Coronary Disease. Pediatr Cardiol. 2017 Apr;38(4):794–800.

32. Iriart X, Jalal Z, Derval N, Latrabe V, Thambo JB. Two-dimensional strain as a marker of subclinical anterior ischaemia in anomaly of left coronary artery arising from pulmonary artery. Eur Heart J - Cardiovasc Imaging. 2009 Jul;10(5):732–5.

33. Fornwalt BK, Mahle WT, Fyfe DA. Resynchronization and Strain Recovery Following Reimplantation of Anomalous Coronary Artery: A Tissue Doppler and Three-dimensional Echocardiographic Study. Congenit Heart Dis. 2007 Jan;2(1):58–63.

34. Di Salvo G, Siblini G, Issa Z, Mohammed H, Abu Hazeem A, Pergola V, et al. Left Ventricular Mechanics in Patients with Abnormal Origin of the Left Main Coronary Artery from the Pulmonary Trunk Late after Successful Repair. Cardiology. 2017;136(2):71–6.

35. Dąbrowska-Kugacka A, Dorniak K, Meyer-Szary J, Rey AH, Lewicka E, Ostrowska K, et al. Myocardial function in patients with anomalous left coronary artery from the pulmonary artery syndrome: A long-term speckle tracking echocardiographic study. Cavarretta E, editor. PLOS ONE. 2019 Oct 15;14(10):e0223227.

36. Naqvi N, Babu-Narayan SV, Krupickova S, Muthialu N, Maiya S, Chandershekar P, et al. Myocardial Function Following Repair of Anomalous Origin of Left Coronary Artery from the Pulmonary Artery in Children. J Am Soc Echocardiogr. 2020 May;33(5):622–30.

37. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, et al. Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Eur Heart J – Cardiovasc Imaging. 2015 Mar;16(3):233–71.

38. Lancellotti P, Tribouilloy C, Hagendorff A, Popescu BA, Edvardsen T, Pierard LA, et al. Recommendations for the echocardiographic assessment of native valvular regurgitation: an executive summary from the European Association of Cardiovascular Imaging. Eur Heart J - Cardiovasc Imaging. 2013 Jul 1;14(7):611–44.

39. Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin JP, Gentile F, et al. 2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation [Internet]. 2021 Feb 2 [cited 2022 Jun 14];143(5). Available from: https://www.ahajournals.org/doi/10.1161/CIR.0000000000000932

40. Vahanian A, Beyersdorf F, Praz F, Milojevic M, Baldus S, Bauersachs J, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. Eur Heart J. 2022 Feb 12;43(7):561–632.

41. Marcus KA, Mavinkurve-Groothuis AMC, Barends M, van Dijk A, Feuth T, de Korte C, et al. Reference Values for Myocardial Two-Dimensional Strain Echocardiography in a Healthy Pediatric and Young Adult Cohort. J Am Soc Echocardiogr. 2011 Jun;24(6):625–36.

42. Levy PT, Machefsky A, Sanchez AA, Patel MD, Rogal S, Fowler S, et al. Reference Ranges of Left Ventricular Strain Measures by Two-Dimensional Speckle-Tracking Echocardiography in Children: A Systematic Review and Meta-Analysis. J Am Soc Echocardiogr. 2016 Mar;29(3):209-225.e6.

43. Sun JP, Lee APW, Wu C, Lam YY, Hung MJ, Chen L, et al. Quantification of left ventricular regional myocardial function using two-dimensional speckle tracking echocardiography in healthy volunteers — A multi-center study. Int J Cardiol. 2013 Jul;167(2):495–501.

44. Di Salvo G, Bulbul ZA, Issa Z, Fadel B, Al-Sehly A, Pergola V, et al. Left ventricular mechanics after arterial switch operation: a speckle-tracking echocardiography study. J Cardiovasc Med. 2016 Mar;17(3):217–24.

45. Yagmur J, Sener S, Acikgoz N, Cansel M, Ermis N, Karincaoglu Y, et al. Subclinical left ventricular dysfunction in Behcet's disease assessed by two-dimensional speckle tracking echocardiography. Eur J Echocardiogr. 2011 Jul 1;12(7):536–41.

46. Sasikumar D, Dharan BS, Arunakumar P, Gopalakrishnan A, Sivasankaran S, Krishnamoorthy KM. The outcome of mitral regurgitation after the repair of anomalous left coronary artery from the pulmonary artery in infants and older children. Interact Cardiovasc Thorac Surg. 2018 Aug 1;27(2):238–42.

47. Kanoh M, Inai K, Shinohara T, Tomimatsu H, Nakanishi T. Outcomes from anomalous origin of the left coronary artery from the pulmonary artery repair: Long-term complications in relation to residual myocardial abnormalities. J Cardiol. 2017 Nov;70(5):498–503.

48. Schmitt B, Bauer S, Kutty S, Nordmeyer S, Nasseri B, Berger F, et al. Myocardial Perfusion, Scarring, and Function in Anomalous Left Coronary Artery From the Pulmonary Artery Syndrome: A Long-Term Analysis Using Magnetic Resonance Imaging. Ann Thorac Surg. 2014 Oct;98(4):1425–36.

49. Secinaro A, Ntsinjana H, Tann O, Schuler PK, Muthurangu V, Hughes M, et al. Cardiovascular magnetic resonance findings in repaired anomalous left coronary artery to pulmonary artery connection (ALCAPA). J Cardiovasc Magn Reson. 2011 Dec;13(1):27.

ANNEXURES

List of publications from Thesis
Curriculum Vitae
Appendices
APPENDIX A – ETHICS COMMITTEE APPROVAL
APPENDIX B – PROFORMA
APPENDIX C - PUBLICATIONS
APPENDIX D – PLAGIARISM CHECK REPORT

List of publications from thesis

1. Kakarla S, Sasikumar D, Varma R P, Kurup HKN, Nair M, Gopalakrishnan A, Krishnamoorthy KM, Influence of age at surgery on left ventricular strain in patients with anomalous origin of left coronary artery from pulmonary artery (ALCAPA), European journal of cardiothoracic surgery, under review for publication.

APPENDIX – A: ETHICS COMMITTEE APPROVAL LETTER

श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेंद्रम - 695 011, केरल, भारत
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY
TRIVANDRUM - 695 011, KERALA, INDIA
(एक राष्ट्रीय महत्व का संस्थान, विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार)
(An Institution of National Importance, Department of Science and Technology, Government of India)
टेलीफॉन नं./Telephone No.: 0471-2443152 फैक्स/Fax: 0471-2446433, 2550728
ई-मेल/E-mail: sct@sctimst.ac.in वेबसाइट/Website: www.sctimst.ac.in

Institutional Ethics Committee

(IEC Regn No. ECR/189/Inst/KL/2013/RR-16)

SCT/IEC/1552 /OCTOBER/ 2020 30.10.2020

Dr. Kakarla Saikiran
DM Resident
Department of Cardiology
SCTIMST, Thiruvananthapuram

Dear Dr. Kakarla Saikiran,

The Institutional Ethics Committee reviewed and discussed your application to conduct the study entitled "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS** (IEC/1552)**"** on August 3- 21, 2020.

The following documents were reviewed:

Original submission

1. *Checklist for IEC*	9. *CV of Dr.Saikiran Kakarla with APMC registration number*
2. *Study proposal*	10. *CV of Dr.KM Krishnamoorthy with TCMC registration number*
3. *IEC Application form duly filled*	11. *CV of Dr.Krishna Kumar Mohanan Nair with TCMC registration number*
4. *Covering letter dated 10/07/2020 and endorsed by HOD on 13/07/2020*	12. *CV of Dr.Arun Gopalakrishnan with TCMC registration number*
5. *Proforma*	13. *CV of Dr.Baiju S Dharan with TCMC registration number*
6. *Approval from TAC-Clinical Studies without TAC revisions*	14. *Copy of cover letter endorsed by HOD on 13/07/2020*
7. *Patient information sheet and consent form/Assent form in English*	
8. *Patient information sheet and consent form/Assent form in Malayalam*	

Revised submission on 25/09/2020

1. Revised checklist	14. New Consent form for adult patients for controls in Malayalam
2. Revised study proposal	15. New Assent form for patients for cases (aged 13-17) in English
3. Revised IEC application form	16. New Assent form for patients for cases (aged 13-17) in Malayalam
4. Forwarding letter from HOD dated 10/07/2020	17. New Assent form for patients for controls (aged 13-17) in English
5. Proforma	18. New Assent form for patients for controls (aged 13-17) in Malayalam
6. TAC clearance letter dated 07/07/2020	19. Parental consent form for patients (aged <12 years) for cases in English
7. Patient information sheet for cases (English)	20. Parental consent form for patients (aged <12 years) for cases in Malayalam
8. Patient information sheet for cases (Malayalam)	21. Parental consent form for patients (aged <12 years) for controls in English
9. New Patient information sheet for controls(English)	22. Parental consent form for patients (aged <12 years) for controls in Malayalam
10. New Patient information sheet for controls (Malayalaym)	23. CV of PI Dr.Karkala Saikiran with APMC registration number
11. Consent form for adult patients for cases in English	24. CV of Co-PI Dr.KM Krishnamoorthy with TCMC registration number
12. Consent form for adult patients for cases in Malayalam	25. CV of Co-PI Dr.Krishna Kumar Mohanan Nair with TCMC registration number
13. New Consent form for adult patients for controls in English	26. CV of Co-PI Dr.Arun Gopalakrishnan with TCMC registration number

The following members of the Students Sub-Committee of the Institutional Ethics Committee participated in the discussions held between August 3-21, 2020 at the offices and residences of the members

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Dr. R V G Menon	M Tech, PhD	Male	Lay Person (Chairman)	No
2.	Dr. Harikrishnan S	MD, DM (Cardiology) DNB (Cardiology)	Male	Clinician	Yes
3.	Dr. Kala Kesavan. P	MBBS, MD	Female	Basic Medical Scientist	No
4.	Smt. Sathi Nair	MA (English Literature)	Female	Lay Person	No
5.	Dr. Rema M. N	MD	Female	Basic Medical Scientist	No
6.	Dr. Christina George	MD Psychiatry	Female	Clinician	No
7.	Dr. Mala Ramanathan	PhD	Female	Social Scientist (Member Secretary)	Yes

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:
The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely,

Mala Ramanathan
Member Secretary, IEC

APPENDIX -B: PROFORMA

PROFORMA

Subject ID No: Name:

Age: Sex: Age of presentation: Age at diagnosis:

Address: Mobile no:

Weight: Height: BSA: BMI:

Referral Diagnosis:

Presenting Complaint:	Duration of symptoms:
h/o Dyspnea	
h/o resuscitated SCD	
Examination Findings	+/-
JVP, CE, S3 , Murmurs	

NYHA /ROSS class at admission	

ECG

Rate		Rhythm	
QRSd & Axis,		PR	
ST segment		T waves	
Looping		impression	

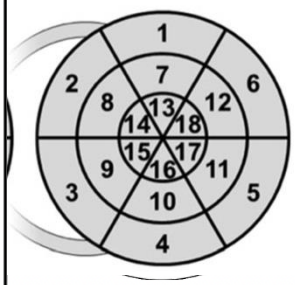
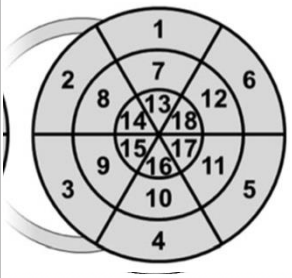
Chest Xray	**Findings +/-**
CE, CTR:	
PVH: grade	
PAH	

Date of Intervention	
Intervention underwent	
Mechanical Ventilation time	
Use of Inotropes	
Length of hospital stay	
Operative Variables: 1. CPB time, 2. Aortic Cross Clamp time 3. Type of ALCAPA repair, 4. Graft used: if any 5. Mitral Valve intervention, 6. additional surgical procedures performed, 7. duration of Mechanical Ventilation, 8. duration of hospital /ICU stay, 9. postoperative complications,	

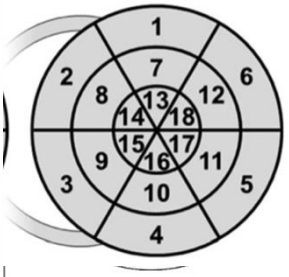
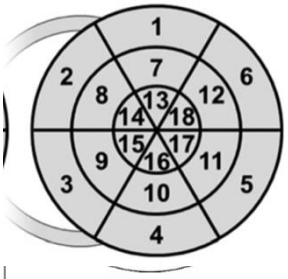
CURRENT STATUS:

1. Symptoms, Duration	
2.NYHA class / ROSS class	
3.Clinical examination findings	
4. Medications (if Any) Duration	

2D ECHO:

2D ECHO Parameters:	Pre-operative	Post-operative
• LVDd (Z score), • LVDs (Z score), • FS%: • EF % • By Teichholz formula: • By Simpsons method: • MR & its severity (Gr. 0 - 4) • RCA (in mm and Z score), • LCA (in mm and Z score), • Flow Reversal in LCA • LV Endocardial Fibro Elastosis (LV EFE) • Papillary Muscle FE • MVP • Lateral Mitral annular E/é		
• RWMA +/- • If present type and distribution • Coronary Artery Territory		
Serial 2D ECHO if present: Trend of MR and above parameters		

SPECKLE TRACKING ECHOCARDIOGRAPHY:

IMAGING PARAMETER	PATIENT VALUE	NORMAL AGE & SEX MATCHED CONTROL VALUE
1. Segmental Strain:		
Mean RCA region Strain:		
Mean LCA region Strain:		
2. GLS – LV (%)		
3. GLS – APLAX (%)		
4. GLS – A4C		
5. GLS – A2C		
6. LV-- CPS(Circumferential Peak strain)		
7. LV -RS (Radial Strain)		
8. Atrio-Ventricular Synchrony		
9. Interventricular Synchrony		
10. LV Intra Ventricular Synchrony		

APPENDIX-C: CONSENT FORMS

PATIENT INFORMATION SHEET: ENGLISH

SREE CHITRA THIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
PATIENT INFORMATION SHEET

Study Title: SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA) PATIENTS

Name of the Investigators:
Dr. Kakarla Saikiran, Dr. K.M. Krishnamoorthy, Dr. Krishna Kumar.M,
Dr. Arun Gopalakrishnan, Dr. Baiju S Dharan

Dear Subject,
We welcome you and thank you for your interest in this research project titled **"Speckle Tracking Echocardiography in post-surgical repair of Anomalous origin of the Left Coronary Artery from the Pulmonary Artery (ALCAPA)"**. Before you participate in this study, it is important for you to understand why this research is being carried out. This form will provide you all the relevant details of this research. It will explain the nature, the purpose, the benefits, the risks, the discomforts, the precautions and the information about how this project will be carried out. It is important that you read and understand the contents of the form carefully. This form may contain certain scientific terms and hence, if you have any doubts or if you want more information, you are free to ask the study personnel or the contact person mentioned below before you give your consent and also at any time during the entire course of the project.

What is Speckle tracking Echocardiography (STE)?
STE is a routine Echocardiographic procedure, after acquiring Echo images they will be specially analyzed for it with an existing software in the Echo machine itself.

What is the Study about?
To assess LV function and outcomes in post ALCAPA repair patients by LV - STE.

If you take part what will you have to do?
You need to tell us about symptoms of your disease, allow us to collect your data (History, Clinical and ECHO reports) from electronic medical records. You need to undergo 2D ECHO & strain imaging.

How long does it take?
During your OPD visit assessment will take 15 minutes & 2D ECHO will take 15 to 30 minutes.

Will you have to pay for above tests?
These tests are part of your routine care and amount paid for the tests would be the amount decided by hospital as for all general patients at that time.

Is there any risk or benefit for this study?
There are no risks involved in the study, echocardiography is safe non-invasive procedure. If on evaluation any reports are abnormal you will receive treatment according to the standard operating procedure of the hospital for which you have to pay for the hospital and this is not part of the study.

Can you withdraw from this study after it starts?
Your participation in this study is entirely voluntary and you are also free to decide to withdraw permission to participate in this study. If you do so, this will not affect your usual treatment.

What happens after the study is over?
2D Echo report will be available for your use and it will be stored in EMR in your Hospital I.D. Strain values obtained from STE data will be used to analyse the LV function and outcomes.

Will participants be compensated for participation in this trial?

You will not be paid for participation in the study.

Will your personal details be kept confidential?
The results of this study will be published in a medical journal but you will not be identified by name in any publication or presentation of results. However, your medical notes may be reviewed by people associated with the study.

If you have any further questions, please ask Dr. Kakarla Saikiran, Senior Resident, Department of Cardiology, SCTIMST (Tel: 8019672629) or
email: kakarla63@gmail.com or
Saikirankakarla@sctimst.ac.in

For any clarifications regarding the study's ethics clearance you may contact the Member Secretary of the SCTIMST-IEC. The phone number is: 91-471-2524-234 and the email id is iec.mem.sec@sctimst.ac.in

==========

PATIENT INFORMATION SHEET: MALAYALAM

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

രോഗികൾക്കുള്ള കാര്യവിവരണപത്രം

പഠന ശീർഷകം: പൾമനറി ആർട്ടറിയിൽനിന്നും, ഇടത് കൊറോണറി ആർട്ടറിയുടെ അസാധാരണമായ ആരംഭമുള്ള (അൽകാപ്പ) രോഗികളിൽ ശസ്ത്രക്രിയാനന്തരമുള്ള സ്പെക്കിൾ ട്രാക്കിംഗ് എക്കോകാർഡിയോഗ്രഫി.

ഗവേഷകരുടെ പേര്

ഡോ. കാകർള സായികിരൺ, ഡോ. കെ എം കൃഷ്ണമൂർത്തി, ഡോ. കൃഷ്ണകുമാർ എം, ഡോ. അരുൺ ഗോപാലകൃഷ്ണൻ, ഡോ. ബൈജു എസ് ധരൻ

പ്രിയ സുഹൃത്തേ,

പൾമനറി ആർട്ടറിയിൽനിന്നും, ഇടത് കൊറോണറി ആർട്ടറിയുടെ അസാധാരണമായ ആരംഭമുള്ള (അൽകാപ്പ) രോഗികളിൽ ശസ്ത്രക്രിയാനന്തരമുള്ള സ്പെക്കിൾ ട്രാക്കിംഗ് എക്കോകാർഡിയോഗ്രഫി എന്ന ഗവേഷണ പഠനത്തിലേയ്ക്ക് താങ്കളെ സ്വാഗതം ചെയ്യുകയും താങ്കൾ പ്രകടിപ്പിച്ച താത്പര്യത്തിന് നന്ദി പറയുകയും ചെയ്യുന്നു.

താങ്കൾ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതിനു മുമ്പ് ഈ ഗവേഷണം എന്തിന് നടത്തുന്നു എന്ന് താങ്കൾ മനസ്സിലാക്കേണ്ടത് പ്രധാനമാണ്. ഈ ഗവേഷണത്തെപ്പറ്റിയുള്ള പ്രസക്തമായ എല്ലാ വിശദാംശങ്ങളും ഈ കാര്യവിവരണപത്രത്തിൽ നൽകിയിട്ടുണ്ട്. ഗവേഷണത്തിന്റെ സ്വഭാവം, ഉദ്ദേശം, നേട്ടങ്ങൾ, അപായ സാദ്ധ്യതകൾ, അസ്വസ്ഥതകൾ, മുൻകരുതലുകൾ ഈ പദ്ധതി എങ്ങിനെ നടപ്പാക്കും എന്നതിന്റെ വിവരങ്ങൾ എന്നിവ ഈ കാര്യവിവരണപത്രം വിശദീകരിക്കും. ഇതിന്റെ ഉള്ളടക്കം ശ്രദ്ധാപൂർവ്വം താങ്കൾ വായിക്കുകയും മനസ്സിലാക്കുകയും ചെയ്യേണ്ടുന്നത് പ്രധാനമാണ്. ഈ കാര്യവിവരണപത്രികയിൽ ചില ശാസ്ത്രീയ പദങ്ങൾ അടങ്ങിയിട്ടുണ്ട് എന്നതിനാൽ താങ്കൾക്കെന്തെങ്കിലും സംശയമോ കൂടുതലായെന്തെങ്കിലും വിവരങ്ങൾ വേണമെങ്കിലോ, പഠനത്തിന് സമ്മതം നൽകുന്നതിനു മുൻപും, പഠനകാലയളവിൽ എതു സമയത്തും പഠനം നടത്തുന്നവരോടോ ബന്ധപ്പെടുന്നതിനായി അറിയിച്ചിട്ടുള്ളവരോടോ ചോദിക്കാൻ താങ്കൾക്ക് സ്വാതന്ത്ര്യമുണ്ട്.

സ്പെക്കിൾ ട്രാക്കിംഗ് എക്കോകാർഡിയോഗ്രഫി (എസ്റ്റിഇ)എന്നാലെന്ത്?

ഒരു പതിവ് എക്കോകാർഡിയോഗ്രഫി നടപടിയാണ് എസ്റ്റിഇ, ഇമേജുകൾ ശേഖരിച്ചശേഷം എക്കോ യന്ത്രത്തിൽ തന്നെ നിലവിലുള്ള ഒരു സോഫ്റ്റ്വെയറുപയോഗിച്ച് അതിനായി പ്രത്യേകം വിശകലനം ചെയ്യും.

ഈ പഠനം എന്തിനെപ്പറ്റിയാണ്?

അൽകാപ്പ രോഗികളിൽ ശസ്ത്രക്രിയയ്ക്ക് ശേഷം ഇടത് വെൻട്രിക്കിളിന്റെ പ്രവർത്തനവും നേട്ടവും ഇടതു വെൻട്രിക്കിൾ എസ്റ്റിഇയിലുടെ വിലയിരുത്തുക.

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

പങ്കെടുക്കുകയാണെങ്കിൽ താങ്കൾ എന്തു ചെയ്യണം?
താങ്കളുടെ രോഗ ലക്ഷണങ്ങളെപ്പറ്റി ഞങ്ങളോട് പറയുക, താങ്കളുടെ വിവരങ്ങൾ (ക്ലിനിക്കൽ, എക്കോ റിപ്പോർട്ടുകളുടെ ചരിത്രം) ഇലക്ട്രോണിക്ക് ചികിത്സാരേഖകളിൽ നിന്നും ശേഖരിക്കാനുള്ള അനുവാദം നൽകുക. താങ്കൾ 2ഡി എക്കോയ്ക്കും സ്ട്രെയിൻ ഇമേജിംഗിനും വിധേയമാകണം.

ഇതിന് എത്ര സമയം എടുക്കും?
താങ്കളുടെ തുടർചികിത്സാ സന്ദർശന സമയത്ത് വിലയിരുത്തലിന് 15 മിനിട്ടും 2 ഡി എക്കോയ്ക്ക് 15 മുതൽ 30 മിനിട്ടും എടുക്കും.

മുകളിൽ പറഞ്ഞ പരിശോധനകൾക്ക് താങ്കൾ പണം നൽകണോ?
ഈ പരിശോധനകൾ താങ്കളുടെ തുടർചികിത്സയ്ക്കുള്ള പതിവ് പരിശോധനകളുടെ ഭാഗമാണ്. എസ്റ്റിഇ (STE)ക്കോ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതിനോ താങ്കൾക്ക് കൂടുതലായി ചിലവുണ്ടാകില്ല..

ഈ പഠനത്തിൽ എന്തെങ്കിലും അപായമോ നേട്ടമോ ഉണ്ടോ?
ഈ പഠനത്തിൽ അപായമൊന്നുമില്ല, എക്കോ കാർഡിയോഗ്രഫി ശരീരത്തിൽ കടക്കാതെയുള്ള നടപടിയാണ്. വിലയിരുത്തൽ റിപ്പോർട്ടിൽ അസാധാരണത്വം കണ്ടാൽ അതിനനുസരിച്ചുള്ള ചികിത്സ താങ്കൾക്ക് ലഭിക്കും, അതിന് താങ്കൾ പണം നൽകണം, അത് പഠനത്തിന്റെ ഭാഗമല്ല.

പഠനം അരംഭിച്ചശേഷം താങ്കൾക്ക് പഠനത്തിൽ നിന്നും പിൻമാറാനാകുമോ?
ഈ പഠനത്തിലെ താങ്കളുടെ പങ്കാളിത്തം തികച്ചും സ്വമേധയായും എതു സമയത്തും പിൻമാറാൻ സ്വാതന്ത്ര്യമുള്ളതുമാണ്. താങ്കളങ്ങനെ ചെയ്താലും താങ്കളുടെ പതിവ് ചികിത്സയെ അത് ബാധിക്കില്ല.

പഠനം അവസാനിച്ചശേഷം എന്തു സംഭവിക്കും?
2ഡി എക്കോ റിപ്പോർട്ട് താങ്കളുടെ ഉപയോഗത്തിനായി താങ്കളുടെ ആശുപത്രി ഐഡിയിൽ ഇലക്ട്രോണിക്ക് മെഡിക്കൽ റെക്കാഡായി സൂക്ഷിക്കും. എസ്റ്റിഇ വിവരങ്ങളിൽനിന്നുള്ള സ്ട്രെയിൻ മൂല്യങ്ങൾ ഇടത് വെൻട്രിക്കിളിന്റെ പ്രവർത്തനവും നേട്ടവും വിലയിരുത്താൻ ഉപയോഗിക്കും.

പഠനത്തിൽ പങ്കെടുക്കുന്നവർക്ക് പ്രതിഫലം നൽകുമോ?
ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതിന് താങ്കൾക്ക് പ്രതിഫലം നൽകില്ല.

താങ്കളുടെ വ്യക്തിപരമായ വിവരങ്ങൾ രഹസ്യമായിരിക്കുമോ?
ഈ പഠനത്തിന്റെ ഫലങ്ങൾ ഒരു വൈദ്യശാസ്ത്ര ജേർണലിൽ പ്രസിദ്ധീകരിച്ചേക്കാം പക്ഷേ താങ്കളെ പേരുകൊണ്ട് പ്രസിദ്ധീകരണത്തിലോ പ്രദർശനത്തിലോ തിരിച്ചറിയാനാകില്ല. എന്നാലും

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിച്ചാൽ താങ്കളുടെ ചികിത്സാരേഖകൾ പഠനവുമായി ബന്ധപ്പെട്ടയാളുകൾ താങ്കളുടെ അധികമായ സമ്മതമില്ലാതെ അവലോകനം ചെയ്തേക്കാം.

താങ്കൾക്ക് കൂടുതൽ ചോദ്യങ്ങളുണ്ടെങ്കിൽ ദയവായി ബന്ധപ്പെടുക
ഡോ. കാകർള സായികിരൺ, സീനിയർ റസിഡന്റ്, ഡിപ്പാർട്ടമെന്റ് ഓഫ് കാർഡിയോളജി, SCTIMST (ഫോൺ: 8019672629) അല്ലെങ്കിൽ ഇമെയിൽkakarla63@gmail.com അല്ലെങ്കിൽ Saikirankakarla@sctimst.ac.in

പഠനത്തിന്റെ നൈതിക അനുവാദവുമായി ബന്ധപ്പെട്ട സംശയങ്ങൾക്ക് SCTIMST-IEC മെമ്പർസെക്രട്ടറി, മാല രാമനാഥൻ (ഫോൺ. 91-0471-2524234) ഇമെയിൽ iec.mem.sec@sctimst.ac.in

CONSENT FORM FOR ADULTS >18 YRS : ENGLISH

SREE CHITRA THIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
DEPARTMENT OF CARDIOLOGY

CONSENT FORM FOR ADULT PATIENTS (FOR AGE ≥ 18 YRS)

Participant's name:_____Age:_____Y_____M; Sex: M / F

I (Name of Participant)_____aged _____(in years) son/daughter of _____(Please tick boxes).

[ ] I declare that I have read the above information provided to me regarding the study: "SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST SURGICAL REPAIR OF ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA)" and agree to participate in the study.

[ ] 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 any time without affecting my usual treatment or my legal rights.

[ ] I understand that the study staff and institutional ethics committee members may not need my permission to look at my health records even if I withdraw from the trial. I agree to this access.

[ ] I understand that my identity may not be revealed in any information released to third parties or published.

[ ] I voluntarily agree to take part in this study.

[ ] I received a copy of this signed consent form.

Name:	Name & Signature of witness:
Signature:	Relation to participant
Date:	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 benefits and risk 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:

Dr. Kakarla Sai kiran,
Date: Senior resident, Dept. of Cardiology, SCTIMST.

CONSENT FORM FOR ADULTS >18 YRS : MALAYALAM

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

പ്രായപൂർത്തിയായ രോഗികളുടെ സമ്മതപത്രം (18 വയസ്സിനു മുകളിൽ)

പങ്കെടുക്കുനനയാളുടെ പേര്: _____ വയസ്സ്: _____വർഷം_____മാസം,

ലിംഗം: പുരുഷൻ/സ്ത്രീ

ഞാൻ.....(മകൻ/മകൾ) .....
.....
(കോളങ്ങളിൽ ശരിയടയാളമിടുക)

- ഞാൻ പ്രഖ്യപിക്കുന്നതെന്തെന്നാൽ ''പൾമനറി ആർട്ടറിയിൽനിന്നും, ഇടത് കൊറോണറി ആർട്ടറിയുടെ അസാധാരണമായ ആരംഭമുള്ള (അൽകാപ്പ) രോഗികളിൽ ശസ്ത്രക്രിയാനന്തരമുള്ള സ്പെക്കിൾ ട്രാക്കിംഗ് എക്കോകാർഡിയോഗ്രഫി'' എന്ന പഠനസംബന്ധമായി എനിക്കുനൽകിയ വിവരങ്ങൾ വായിക്കുകയും പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിക്കുകയും ചെയ്യുന്നു. [ ]
- എന്റെ പങ്കാളിത്തം സ്വമേധയായാണെന്നും, എന്റെ പതിവ് ചികിത്സയെയോ നിയമപരമായ അവകാശങ്ങളോയോ ബാധിക്കാതെ ഏതു സമയത്തും പങ്കെടുക്കുനനതിനുള്ള എന്റെ അനുവാദം പിൻവലിക്കാമെന്നും ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- പഠനത്തിൽനിന്നും ഞാൻ പിൻമാറിയാലും ഈ പഠനവുമായി ബന്ധപ്പെട്ട ആരോഗ്യരേഖകൾ പഠനസംഘത്തിനും നൈതീക കമ്മിറ്റി അംഗങ്ങൾക്കും എന്റെ അനുവാദം കൂടാതെ പരിശോധിക്കാമെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. അതിന് ഞാൻ സമ്മതിക്കുന്നു. [ ]
- എന്റെ വ്യക്തിപരമായവിവരങ്ങൾ മുന്നാം കക്ഷികൾക്കോ പ്രസിദ്ധികരണത്തിനോ നൽകില്ലെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- ഞാൻ സ്വമേധയാ ഈ പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിക്കുന്നു. [ ]
- സമ്മതപത്രത്തിന്റെ ഒപ്പിട്ട ഒരു പ്രതി എനിക്ക് ലഭിച്ചു. [ ]

പേര്

ഒപ്പ്

തീയതി

സാക്ഷിയുടെ പേര്

രോഗിയുമായുള്ള ബന്ധം

ഒപ്പ്

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

സമ്മതപത്രം വാങ്ങുന്ന ആൾ

മെഡിക്കൽ റിസർച്ച്പ്രോജക്ടിനാവശ്യമായ സമ്മതപത്രത്തിനു വേണ്ടുന്ന എല്ലാ ഘടകങ്ങളും തൃപ്തികരമായി നിർവഹിച്ചിരിക്കുന്നുവെന്ന് ഞാൻ ബോധ്യപ്പെടുത്തുന്നു. പഠനപങ്കാളിയുമായി ഗവേഷണ പദ്ധതിയെപ്പറ്റി സാങ്കേതികേതര പദങ്ങളുപയോഗിച്ച് എല്ലാ വിവരങ്ങളെപ്പറ്റിയും ചർച്ച നടത്തുകയും പ്രതീക്ഷിക്കാവുന്ന അപകടസാധ്യതകളും പാർശ്വഫലങ്ങളും വിശദീകരിക്കുകയും ചെയ്തു. പങ്കാളിയെ ചോദ്യങ്ങൾ ചോദിക്കാൻ പ്രേരിപ്പിക്കുകയും എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം നൽകുകയും ചെയ്തു എന്നും ഞാൻ സാക്ഷ്യപ്പെടുത്തുന്നു.

സമ്മതപത്രംവാങ്ങുന്ന ആളുടെ പേര്

ഒപ്പ് തീയതി

പ്രധാന ഗവേഷകൻ

ഡോ. കാക്കർള സായികിരൺ,

സീനിയർ റസിഡന്റ്, ഡിപ്പാർട്ടമെന്റ് ഓഫ് കാർഡിയോളജി, SCTIMST

സാക്ഷിയുടെ പേര്

PARENTAL ASSENT FORM: 13-17 YRS : ENGLISH

SREE CHITRA THIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

DEPARTMENT OF CARDIOLOGY

STUDY ASSENT FORM FOR PATIENTS (13 – 17 yrs.)

Participant's name:_____Age:_____Y_____M; Sex: M / F

I_____Father/ Mother / Legal Guardian of_____ (Please tick boxes below).

[ ] I declare that I have read the above information provided to me regarding the study: "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST SURGICAL REPAIR OF ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA)"** and agree to participate in the study.

[ ] I also understand that participation of my child in this study is entirely voluntary and that I am free to withdraw permission to continue to participate at any time without affecting my usual treatment or my legal rights.

[ ] I understand that the study staff and institutional ethics committee members may not need my permission to look at my health records even if I withdraw from the trial. I agree to this access.

[ ] I understand that my child's identity may not be revealed in any information released to third parties or published.

[ ] I voluntarily agree for my child to take part in this study.

[ ] I received a copy of this signed form.

Name:	Name & Signature of witness:
Signature:	Relation to participant
Date:	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 benefits and risk 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:

Dr. Kakarla Sai kiran,

Date:

Senior resident, Dept. of Cardiology, SCTIMST.

PARENTAL ASSENT FORM: 13-17 YRS: MALAYALAM

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

പഠനത്തിനുള്ള രോഗിയുടെ സമ്മതപത്രം (13 മുതൽ 17 വയസ്സുവരെ)

പങ്കെടുക്കുനനയാളുടെ പേര്: _____ വയസ്സ്: _____വർഷം_____മാസം,

ലിംഗം: പുരുഷൻ/സ്ത്രീ

ഞാൻ..... (അച്ഛൻ/അമ്മ/നിയമപരമായ രക്ഷകർത്താവ്)

(കോളങ്ങളിൽ ശരിയടയാളമിടുക)

- ഞാൻ പ്രഖ്യപിക്കുന്നതെന്തെന്നാൽ ''പൾമനറി ആർട്ടറിയിൽനിന്നും, ഇടത് കൊറോണറി ആർട്ടറിയുടെ അസാധാരണമായ ആരംഭമുള്ള (അൽകാപ്പ) രോഗികളിൽ ശസ്ത്രക്രിയാനന്തരമുള്ള സ്പെക്കിൾ ട്രാക്കിംഗ് എക്കോകാർഡിയോഗ്രഫി'' എന്ന പഠനസംബന്ധമായി എനിക്കുനൽകിയ വിവരങ്ങൾ വായിക്കുകയും പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിക്കുകയും ചെയ്യുന്നു. [ ]
- എന്റെ കുട്ടിയുടെപങ്കാളിത്തം സ്വമേധയായാണെന്നും, എന്റെ കുട്ടിയുടെ പതിവ് ചികിത്സയെയോ നിയമപരമായ അവകാശങ്ങളോയോ ബാധിക്കാതെ ഏതു സമയത്തും പങ്കെടുക്കുനനതിനുള്ള എന്റെ അനുവാദം പിൻവലിക്കാമെന്നും ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- പഠനത്തിൽനിന്നും ഞാൻ പിൻമാറിയാലും ഈ പഠനവുമായി ബന്ധപ്പെട്ട ആരോഗ്യരേഖകൾ പഠനസംഘത്തിനും നൈതീക കമ്മിറ്റി അംഗങ്ങൾക്കും എന്റെ അനുവാദം കൂടാതെ പരിശോധിക്കാമെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. അതിന് ഞാൻ സമ്മതിക്കുന്നു. [ ]
- എന്റെ കുട്ടിയുടെ വ്യക്തിപരമായവിവരങ്ങൾ മുന്നാം കക്ഷികൾക്കോ പ്രസിദ്ധികരണത്തിനോ നൽകില്ലെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- എന്റെ കുട്ടി ഈ പഠനത്തിൽ പങ്കെടുക്കാൻ ഞാൻ സ്വമേധയാ സമ്മതിക്കുന്നു. [ ]
- സമ്മതപത്രത്തിന്റെ ഒപ്പിട്ട ഒരു പ്രതി എനിക്ക് ലഭിച്ചു. [ ]

പേര്

ഒപ്പ്

തീയതി

സാക്ഷിയുടെ പേര്

രോഗിയുമായുള്ള ബന്ധം

ഒപ്പ്

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

സമ്മതപത്രം വാങ്ങുന്ന ആൾ

മെഡിക്കൽ റിസർച്ച്പ്രോജക്ടിനാവശ്യമായ സമ്മതപത്രത്തിനു വേണ്ടുന്ന എല്ലാ ഘടകങ്ങളും തൃപ്തികരമായി നിർവഹിച്ചിരിക്കുന്നുവെന്ന് ഞാൻ ബോധ്യപ്പെടുത്തുന്നു. പഠനപങ്കാളിയുമായി ഗവേഷണ പദ്ധതിയെപ്പറ്റി സാങ്കേതികേതര പദങ്ങളുപയോഗിച്ച് എല്ലാ വിവരങ്ങളെപ്പറ്റിയും ചർച്ച നടത്തുകയും പ്രതീക്ഷിക്കാവുന്ന അപകടസാധ്യതകളും പാർശ്വഫലങ്ങളും വിശദീകരിക്കുകയും ചെയ്തു. പങ്കാളിയെ ചോദ്യങ്ങൾ ചോദിക്കാൻ പ്രേരിപ്പിക്കുകയും എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം നൽകുകയും ചെയ്തു എന്നും ഞാൻ സാക്ഷ്യപ്പെടുത്തുന്നു.

സമ്മതപത്രംവാങ്ങുന്ന ആളുടെ പേര്

ഒപ്പ് തീയതി

പ്രധാന ഗവേഷകൻ

ഡോ. കാക്കർള സായികിരൺ,

സീനിയർ റസിഡന്റ്, ഡിപ്പാർട്ടമെന്റ് ഓഫ് കാർഡിയോളജി, SCTIMST

സാക്ഷിയുടെ പേര്

PARENTAL CONSENT FORM ≤ 12 YRS : ENGLISH

SREE CHITRA THIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

DEPARTMENT OF CARDIOLOGY

PARENTAL CONSENT FORM FOR PATIENTS (≤ 12 yrs.)

Participant's name:_____Age:_____Y_____M; Sex: M / F

I_____Father/ Mother / Legal Guardian of_____ (Please tick boxes below).

[ ] I declare that I have read the above information provided to me regarding the study: "**SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST SURGICAL REPAIR OF ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY(ALCAPA)"** and agree to participate in the study.

[ ] I also understand that participation of my child in this study is entirely voluntary and that I am free to withdraw permission to continue to participate at any time without affecting my usual treatment or my legal rights.

[ ] I understand that the study staff and institutional ethics committee members may not need my permission to look at my health records even if I withdraw from the trial. I agree to this access.

[ ] I understand that my child's identity may not be revealed in any information released to third parties or published.

[ ] I voluntarily agree for my child to take part in this study.

[ ] I received a copy of this signed form.

Name:	Name & Signature of witness:
Signature:	Relation to participant
Date:	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 benefits and risk 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:

Dr. Kakarla Sai kiran,

Date: Senior resident, Dept. of Cardiology, SCTIMST.

PARENTAL CONSENT FORM ≤ 12 YRS: MALAYALAM

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

പ്രായപൂർത്തിയാകാത്ത രോഗികളുടെ രക്ഷകർത്താവിന്റെ സമ്മതപത്രം

(12 വയസ്സിൽ താഴെ)

പങ്കെടുക്കുനനയാളുടെ പേര്: _____ വയസ്സ്:

_____വർഷം_____മാസം,

ലിംഗം: പുരുഷൻ/സ്ത്രീ

ഞാൻ.....(അച്ഛൻ/അമ്മ/ നിയമപരമായ രക്ഷകർത്താവ്) ....

(കോളങ്ങളിൽ ശരിയടയാളമിടുക)

- ഞാൻ പ്രഖ്യപിക്കുന്നതെന്തെന്നാൽ "പൾമനറി ആർട്ടറിയിൽനിന്നും, ഇടത് കൊറോണറി ആർട്ടറിയുടെ അസാധാരണമായ ആരംഭമുള്ള (അൽകാപ്പ) രോഗികളിൽ ശസ്ത്രക്രിയാനന്തരമുള്ള സ്പെക്കിൾ ട്രാക്കിംഗ് എക്കോകാർഡിയോഗ്രഫി" എന്ന പഠനസംബന്ധമായി എനിക്കുനൽകിയ വിവരങ്ങൾ വായിക്കുകയും പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിക്കുകയും ചെയ്യുന്നു. [ ]
- എന്റെ കുട്ടിയുടെ പങ്കാളിത്തം സ്വമേധയായാണെന്നും, എന്റെ കുട്ടിയുടെപതിവ് ചികിത്സയെയോ നിയമപരമായ അവകാശങ്ങളോയോ ബാധിക്കാതെ ഏതു സമയത്തും പങ്കെടുക്കുനനതിനുള്ള എന്റെ അനുവാദം പിൻവലിക്കാമെന്നും ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- പഠനത്തിൽനിന്നും ഞാൻ പിൻമാറിയാലും ഈ പഠനവുമായി ബന്ധപ്പെട്ട ആരോഗ്യരേഖകൾ പഠനസംഘത്തിനും നൈതീക കമ്മിറ്റി അംഗങ്ങൾക്കും എന്റെ അനുവാദം കൂടാതെ പരിശോധിക്കാമെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. അതിന് ഞാൻ സമ്മതിക്കുന്നു. [ ]
- എന്റെ കുട്ടിയുടെ വ്യക്തിപരമായവിവരങ്ങൾ മുന്നാം കക്ഷികൾക്കോ പ്രസിദ്ധികരണത്തിനോ നൽകില്ലെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- എന്റെ കുട്ടി ഈ പഠനത്തിൽ പങ്കെടുക്കാൻ ഞാൻ സ്വമേധയാ സമ്മതിക്കുന്നു. [ ]
- സമ്മതപത്രത്തിന്റെ ഒപ്പിട്ട ഒരു പ്രതി എനിക്ക് ലഭിച്ചു. [ ]

പേര്

ഒപ്പ്

തീയതി

സാക്ഷിയുടെ പേര്

രോഗിയുമായുള്ള ബന്ധം

ഒപ്പ്

ശ്രീ ചിത്ര തിരുനാൾ ഇൻസ്റ്റിറ്റ്യൂട്ട് ഫോർ മെഡിക്കൽ സയൻസസ് ആന്റ് ടെക്നോളജി, തിരുവനന്തപുരം

സമ്മതപത്രം വാങ്ങുന്ന ആൾ

മെഡിക്കൽ റിസർച്ച്പ്രോജക്ടിനാവശ്യമായ സമ്മതപത്രത്തിനു വേണ്ടുന്ന എല്ലാ ഘടകങ്ങളും തൃപ്തികരമായി നിർവഹിച്ചിരിക്കുന്നുവെന്ന് ഞാൻ ബോധ്യപ്പെടുത്തുന്നു. പഠനപങ്കാളിയുമായി ഗവേഷണ പദ്ധതിയെപ്പറ്റി സാങ്കേതികേതര പദങ്ങളുപയോഗിച്ച് എല്ലാ വിവരങ്ങളെപ്പറ്റിയും ചർച്ച നടത്തുകയും പ്രതീക്ഷിക്കാവുന്ന അപകടസാധ്യതകളും പാർശ്വഫലങ്ങളും വിശദീകരിക്കുകയും ചെയ്തു. പങ്കാളിയെ ചോദ്യങ്ങൾ ചോദിക്കാൻ പ്രേരിപ്പിക്കുകയും എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം നൽകുകയും ചെയ്തു എന്നും ഞാൻ സാക്ഷ്യപ്പെടുത്തുന്നു.

സമ്മതപത്രംവാങ്ങുന്ന ആളുടെ പേര്

ഒപ്പ് തീയതി

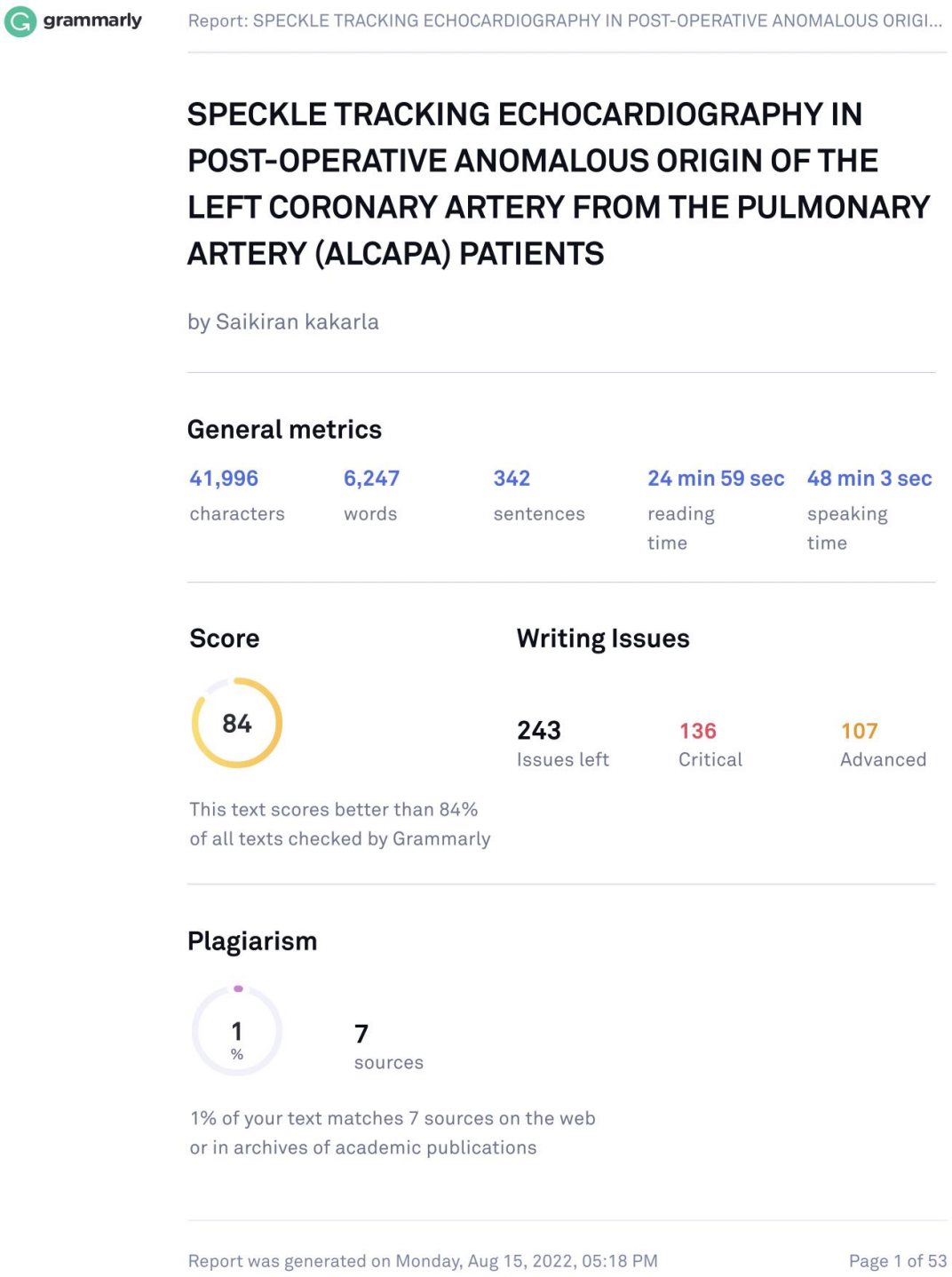
പ്രധാന ഗവേഷകൻ

ഡോ. കാക്കർള സായികിരൺ,

സീനിയർ റസിഡന്റ്, ഡിപ്പാർട്ടമെന്റ് ഓഫ് കാർഡിയോളജി, SCTIMST

സാക്ഷിയുടെ പേര്

APPENDIX :D : PLAGIARISM REPORT



grammarly

Report: SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST-OPERATIVE ANOMALOUS ORIGI...

SPECKLE TRACKING ECHOCARDIOGRAPHY IN POST-OPERATIVE ANOMALOUS ORIGIN OF THE LEFT CORONARY ARTERY FROM THE PULMONARY ARTERY (ALCAPA) PATIENTS

by Saikiran kakarla

General metrics

41,996	6,247	342	24 min 59 sec	48 min 3 sec
characters	words	sentences	reading time	speaking time

Score

84

This text scores better than 84% of all texts checked by Grammarly

Writing Issues

243	136	107
Issues left	Critical	Advanced

Plagiarism

1 %

7 sources

1% of your text matches 7 sources on the web or in archives of academic publications

Report was generated on Monday, Aug 15, 2022, 05:18 PM

Page 1 of 53

CURRICULUM VITAE

LAST NAME	FIRST NAME	MIDDLE NAME
KAKARLA	**SAI KIRAN**	
Date of Birth (dd/mm/yy)- 23/02/1993	Sex- Male	
Study Site Affiliation: **PRINCIPAL INVESTIGATOR**		
Professional Mailing Address (Include Institution name)	Study Site Address (Include Institution name)	
Dr. KAKARLA SAIKIRAN, Room No. 28, Old PG Quarters, Sree Chitra Staff Quarters, SCTIMST, Kumarapuram, Trivandrum- 695011	Department of Cardiology, SCTIMST	
Telephone (Office):	Mobile Number: 8019672629; 8328106051	
Telephone (Residence):	Email: 1. Kakarla63@gmail.com 2. kakarla63@sctimst.ac.in	

Academic Qualifications (Most recent qualification first)		
Degree/Certificate	Year	Institution, Country
MD (GENERAL MEDICINE)	2019	KURNOOL MEDICAL COLLEGE, INDIA
MBBS	2016	KURNOOL MEDICAL COLLEGE, INDIA

Details of professional registration: (MCI/State Registration/Bar Council/DCI/etc. including Registration Number and Year of Registration:
APMC (ANDHRA PRADESH MEDICALCOUNCIL) 97454; 01/02/2017

Current and previous positions (most recent position first)		
Month and Year	Title	Institution/Company, Country
From 1/1/2020	Senior Resident, Department of cardiology	SCTIMST, INDIA
29/05/2015 to 28/05/2018	Resident, Department of General Medicine	KURNOOL MEDICAL COLLEGE, INDIA

Brief summary of relevant research experience:

1. An interesting case of Systemic Lupus erythematosus -Rowell's syndrome; J NTR Univ Health Sci 2017; 6:60-3.
2. An observational clinical study of assessing the utility of PSS (poison Severity score) and GCS (Glasgow Coma Scale) scoring systems in predicting Severity and clinical outcomes in op poisoning; J. Evid. Based Med. Healthc., pISSN- 2349-2562, eISSN- 2349-2570/Vol. 4/Issue 36/May 04, 2017

Current project/s at hand:

Signature: 	Date: 15/05/2020 Place: Trivandrum