LONG TERM OUTCOME OF CARDIAC PACEMAKER IMPLANTATION IN PEDIATRIC POPULATION

Deepanjan Bhattacharya

DM(CARDIOLOGY) THESIS

2022

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM

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A THESIS SUBMITTED BY

Deepanjan Bhattacharya

TO

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

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF

DM (CARDIOLOGY)

2022

DECLARATION BY THE STUDENT

CERTIFICATE

I,DEEPANJAN BHATTACHRYA hereby certify that I had personally carried out the work depicted in the thesis titled, " **LONG TERM OUTCOME OF CARDIAC PACEMAKER IMPLANTATION IN PEDIATRIC POPULATION".**

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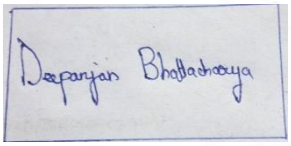

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The thesis entitled, "**LONG TERM OUTCOME OF CARDIAC PACEMAKER IMPLANTATION IN PEDIATRIC POPULATION**" was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

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

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APPROVAL OF THE THESIS

The thesis entitled

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Submitted by

DEEPANJAN BHATTACHARYA

for the degree of

DM (CARDIOLOGY)

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LIST OF ABBREVIATIONS (Optional)

S No	Abbreviation	Full Form
	CHB	Complete Heart Block
	CHD	Congenital Heart Disease
	PPI	Permanent Pacemaker Implantation
	AV	Atrioventricular
	TOF	Tetralogy of Fallot
	TGA	Transposition of Great Arteries
	CCTGA	Congenitally Corrected Transposition of Great Arteries
	VSD	Ventricular Septal Defect
	ASD	Atrial Septa Defect
	PDA	Patent Ductus Arteriosus
	CCHB	Congenital Complete Heart Block
	SAN	Sino-atrial node
	SND	Sinus Node Dysfunction
	AVCD	Atrio-ventricular Canal Defect
	DORV	Double outlet right ventricle

SYNOPSIS

LONG TERM OUTCOME OF CARDIAC PACEMAKER IMPLANTATION IN PEDIATRIC POPULATION

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SYNOPSIS

Children (<18 years of age) account for less than 1% of patients requiring permanent pacemaker implantation (PPI), but form a complex subset of population due to technical difficulties, higher prevalence of structural abnormalities and higher rates of reinterventions. Moreover, there is lack of long-term outcomes of PPI in this population.

We retrospectively analyzed the long-term outcomes of PPI in children below 18 years of age, with respect to indications, techniques, need for reinterventions and complications.

Total of 235 children with M:F ratio being 1.1, and median of implantation of 7 years. 43.4% underwent epicardial PPI, and the commonest indication being congenital complete heart block (50.2%) followed by post-operative CHB (28.1%). 65.5% underwent VVI pacemaker implantation. 41.3% had associated congenital heart disease out of which ventricular septal defect was commonest (20.6%) followed by atrial septal defect (18.6%). Over a median follow-up of 8 years, mean percentage of pacing was 82.1±29.2, with stable lead thresholds. 23.8% patients underwent PG change at median duration 97 months for battery depletion, 3.4% underwent lead change for lead dysfunction at median duration 52 months while 4.3% patients had surgical site infection at median duration of 2 months. 6.38% had post implantation ventricular dysfunction at a median duration of 83 months, major predictors being younger age at implantation, maternal ANA positivity, presence of

post-operative CHB, associated congenital heart disease and epicardial PPI. Overall mortality was 2.9%, with major predictors being age at implantation below 28 days, maternal lupus antibodies, congenital heart disease and post-implantation ventricular dysfunction.

Permanent pacemaker implantation in children has favourable outcomes with age at implantation below 28 days, maternal lupus antibodies, congenital heart disease and post-implantation ventricular dysfunction being predictors of adverse outcomes.

1 INTRODUCTION

Children form a very small proportion of the population who require pacemaker implantation, accounting for less than 1% of all cases, with the procedure being done in very few centres around the globe [1].

The recommendations for pacemaker implantation in children as per the American College of Cardiology/American Heart Association/Heart Rhythm Society (ACC/AHA/HRS) 2008 guidelines [2], include:

Class I (Recommended)

- Advanced second- or third-degree AV block associated with symptomatic bradycardia, ventricular dysfunction, or low cardiac output
- Sinus Node Dysfunction with correlation of symptoms during age-inappropriate bradycardia
- Postoperative advanced second- or third-degree AV block that is not expected to resolve or that persists at least 7 days after cardiac surgery
- Congenital third-degree AV block with a wide QRS escape rhythm, complex ventricular ectopy, or ventricular dysfunction
- Congenital third-degree AV block in the infant with a ventricular rate <55 bpm or with congenital heart disease and a ventricular rate <70 bpm

Class IIA (Reasonable)

- Patients with congenital heart disease and sinus bradycardia (intrinsic or antiarrhythmic induced) for the prevention of recurrent episodes of intra-atrial reentrant tachycardia
- Congenital third-degree AV block beyond the first year of life with an average heart rate <50 bpm, abrupt pauses in ventricular rate that are two or three times the basic cycle length, or associated with symptoms due to chronotropic incompetence
- Sinus bradycardia with complex congenital heart disease with a resting heart rate <40 bpm or pauses in ventricular rate longer than 3 s
- Patients with congenital heart disease and impaired hemodynamics due to sinus bradycardia or loss of AV synchrony
- Unexplained syncope in the patient with prior congenital heart surgery complicated by transient complete heart block with residual fascicular block after a careful evaluation to exclude other causes of syncope

Class IIB (May be considered)

- Transient postoperative third-degree AV block that reverts to sinus rhythm with residual bifascicular block because of the long-term risk for development of AV block
- Congenital third-degree AV block in asymptomatic children or adolescents with an acceptable rate, a narrow QRS complex, and normal ventricular function

- Asymptomatic sinus bradycardia after biventricular repair of congenital heart disease with a resting heart rate <40 bpm or pauses in ventricular rate longer than 3 s

Class III (Not recommended)

- Transient postoperative AV block with return of normal AV conduction in the otherwise asymptomatic patient
- Asymptomatic bifascicular block with or without first-degree AV block after surgery for congenital heart disease in the absence of prior transient complete AV block
- Asymptomatic type I second-degree AV block
- Asymptomatic sinus bradycardia with the longest relative risk interval <3 seconds and a minimum heart rate more than 40 bpm

The recommendations for pacemaker implantation in children as per the recent PACES 2021 guidelines [3], include:

In Sinus Node Dysfunction [SND]

Class I

- Permanent atrial or dual-chamber pacemaker implantation is indicated for SND when there is correlation of symptoms with age-inappropriate bradycardia
- Permanent pacemaker implantation is indicated in patients with symptomatic SND secondary to chronic medical therapy for which there is no alternative treatment

Class IIA

- Permanent pacemaker implantation (with rate-responsive programming) is reasonable in patients with symptoms temporally associated with observed chronotropic incompetence

Class IIB

- Permanent pacemaker implantation may be considered in patients with SND and symptoms that are likely attributable to bradycardia or prolonged pauses without conclusive evidence correlating the symptoms with bradycardia following a thorough investigation

Class III

- Permanent pacemaker implantation is not indicated in patients with asymptomatic SND
- Permanent pacemaker implantation is not indicated in patients with symptomatic SND due to a reversible cause

In Congenital Complete Heart Block

Class I

- Permanent pacemaker implantation is indicated for patients with CCHB with symptomatic bradycardia
- Permanent pacemaker implantation is indicated for patients with CCHB with a wide QRS escape rhythm, complex ventricular ectopy, or ventricular dysfunction
- Permanent pacemaker implantation is indicated for CCHB in asymptomatic neonates or infants when the mean ventricular rate is ≤50 bpm. Ventricular

rate alone should not be used as implant criteria, as symptoms due to low cardiac output may occur at faster heart rates.

Class IIA

- Permanent pacemaker implantation is reasonable for asymptomatic CCHB beyond the first year of life when the mean ventricular rate is <50 bpm or there are prolonged pauses in ventricular rate
- Permanent pacemaker implantation is reasonable for CCHB with left ventricular dilation (*z* score ≥3) associated with significant mitral insufficiency or systolic dysfunction

Class IIB

- Permanent pacemaker implantation may be considered for CCHB in asymptomatic adolescents with an acceptable ventricular rate, a narrow QRS complex, and normal ventricular function, based on an individualized consideration of the risk/benefit ratio

In Post-operative Complete Heart Block

Class I

- Permanent pacemaker implantation is indicated for postoperative advanced second- or third-degree AV block that persists for at least 7–10 days after cardiac surgery
- Permanent pacemaker implantation is indicated for late-onset advanced second- or third-degree AV block especially when there is a prior history of transient postoperative AV block

Class IIB

- Permanent pacemaker implantation may be considered for unexplained syncope in patients with a history of transient postoperative advanced second- or third-degree AV block
- Permanent pacemaker implantation may be considered at <7 postoperative days when advanced second- or third-degree AV block is not expected to resolve due to extensive injury to the cardiac conduction system
- Permanent pacemaker implantation may be considered in select patients with transient postoperative advanced second- or third-degree AV block who are predisposed to progressive conduction abnormalities

In Congenital heart disease

Class I

- Permanent pacemaker implantation is indicated for CCHB in neonates or infants with complex CHD when bradycardia is associated with hemodynamic compromise or when the mean ventricular rate is <60–70 bpm

Class IIA

- Permanent pacemaker implantation with atrial antitachycardia pacing is reasonable for patients with CHD and recurrent episodes of intra-atrial re-entrant tachycardia when catheter ablation or medication are ineffective or not acceptable treatments
- Permanent atrial or dual-chamber pacemaker implantation is reasonable for patients with CHD and impaired hemodynamics due to sinus bradycardia or loss of AV synchrony

- Permanent atrial or dual-chamber pacing is reasonable for patients with tachy-brady syndrome and symptoms attributable to pauses due to sudden-onset bradycardia
- Permanent pacemaker implantation is reasonable for sinus or junctional bradycardia with *complex* CHD when the mean awake resting heart rate is <40 bpm or when there are prolonged pauses in the ventricular rate

Miscellaneous causes of AV block

Class I

- Permanent pacemaker implantation is indicated in patients with clinically significant ventricular tachycardia (VT) that is pause dependent or associated with severe bradycardia; ICD implantation may be considered as a reasonable alternative
- Permanent pacing is indicated in *symptomatic* patients with idiopathic advanced second- or third-degree AV block not attributable to reversible causes

Class IIA

- Permanent pacemaker implantation is reasonable for any degree of AV block that progresses to advanced second- or third-degree with exercise in the absence of reversible causes

Class IIB

- Permanent pacemaker implantation may be considered for patients with intermittent advanced second- or third-degree AV block not attributable to

reversible causes and associated with minimal symptoms that are otherwise unexplained

Class III

- Permanent pacemaker implantation is not indicated for asymptomatic first-degree AV block or asymptomatic second-degree Mobitz type I

The mode of pacing and placement of leads is different and technically challenging as compared to procedures in adults as:

- Many children requiring pacemaker implantation have anatomical defects or artificially created shunts, creating problems for endovascular techniques and choosing sites for lead placement
- Small size of veins preclude the passage of leads, especially in those less than 3 kilograms of weight or less than 10 years of age, or if cross-sectional area of lead is more than 6 mm2/m2 of body surface area. In these patients, placement of epicardial leads is preferred [4].

As regard to complications, the Kids' Inpatient database reported a prevalence of 2.2% for pneumothorax, 3.3% for hematoma, 1.1% of endocarditis, 2.4% for surgical infection and 1.7% mortality rate, during the period 1997-2006 [5].

SCOPE OF THE STUDY

There are limited studies regarding the long-term outcome of pacemaker implantation from developing countries, especially the Indian subcontinent. We propose this study to understand the indications of pacemaker implantation, complications encountered thereof, need for reintervention and long term follow-up of children who underwent pacemaker implantation.

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2 LITERATURE REVIEW

The first pediatric pacemaker implantation was performed in 1961by Lagergren in a 14-year old with myocarditis [6]. Ever since then, the rates of pediatric pacemaker implantation have been rising, with increased availability of advanced devices with smaller size, better longeivity and sensitivity as well as novel algorithms enabling physiologic pacing to a greater extent. The demand has also been mounting owing to increased survival following surgical correction or palliation of complex congenital heart diseases.

However, studies till date are from few centres in the Western world, due to lack of universal availability of pediatric implantation procedures, and cannot be extrapolated to the developing nations.

Benrey et al [7], followed up 24 children in Texas, USA, with complete AV block, out of which 13 (54%) resulted from surgical complications, 9 had congenital AV block, and 4 had associated congenital heart disease. 20 children had syncope/convulsions while 4 had CHF, which led to pacemaker implantation in them. Mean age of the population at implantation was 9.7 years, and they were followed up for 1-12 years (average 5 years). Mortality rate was 25%, and seen in children with associated congenital heart defects, Pacemaker malfunction was seen 28 times in 12 patients, the leading cause being failure of PG, whereas wire fractures led to 12.5% of pacemaker failure.

Donahoo et al [8] followed up 13 children in Baltimore, USA, with 27 pacemaker implantation, at a mean age of 6.8 years. Surgical induced CHB was seen in 11, while congenital CHB was seen in 2. Over an average period of 5 years (1-12 years), mortality rate 15%, and pacemaker was removed in 2 children, without any complication.

Cohen et al [9], from Philadelphia, USA, evaluated 267 children with 385 pacemaker implantation (224 epicardial and 161 endocardial), implantation done at age of 8.4±6.2 years, following them up for a median of 29.4 months. Pacemaker infections were in seen in 30 patients (7.8%), majority being superficial infections, followed by pocket infections. Median time from implantation to infection was 16 days (range 2 days – 5 years). Multivariate analyses revealed trisomy 21 (RR – 3.9) and pacemaker revisions (RR – 2.5) as predictors of pacemaker infections.

Silvetti et al [10], from Rome Italy, reported 292 children, with mean age 8 years (range: 1 day – 18 years), who underwent pacemaker implantation. Endocardial leads were placed in 56.5%, and mean period of followup was 5 years. Pacing threshold was lower with endocardial leads as compared to epicardial leads (0.5±0.3V vs 1.2±0.5V, $p<0.05$). 15 deaths were noted but none were related to pacing failure. Pacing upgradation was done to DDD in 6.5% patients, commonest indication being LV dysfunction (EF<40%) in VVI(n=10), followed by symptomatic AV block in AAI (n=4). Early complications (<3 months) included hemothorax (3.5%), infection (1-2%), lead dislodgments (5%), while late complications (>3 months) included infection (2%), lead failure (21.5%). There was no difference between lead type, except for lead failure which was higher in epicardial leads.

Aellig et al [11] analysed 22 infants who underwent PPI at a median age of 35 days over a median follow-up of 4.6 years. He demonstrated stable lead thresholds and impedances, with 3 lead failures and 7 PG replacements.

Samir et al [12], from Egypt, published a series of 32 children with mean age 5.7±3.8 years, out of whom 78.1% had congenital heart disease. Endocardial lead implantation was seen in 65.6%, and VVIR was the commonest mode used (62.5%), followed by VVI (25%) and DDD (12.5%). Reintervention was required in 43.7% patients, and suboptimal pacing parameters were seen in 37.5%, of which lower age, weight and body surface area were important predictors. No difference in battery or lead survival was seen between epicardial or endocardial lead placement.

Wilhelm et al [13], from Pennsylvania USA, reviewed 73 children, with mean age 6.7 years at pacemaker implantation, followed up for an average of 7.9 years. Overall mortality was 11%, and was seen exclusively with endocardial leads. 95 pacemaker revisions were undertaken, leading cause of which was generator failure, followed by lead dislocation and failure. Subclavian venous thrombosis was seen in 11 cases, out which 9 were asymptomatic. Risk factors for venous thrombosis were age less than 1 year, weight less than 15 kg, female sex, cardiomyopathy and single chamber system.

Silvetti et al [14], from Rome Italy, analysed 287 children with median age of 5 years, undergoing pacemaker implantation, with a median followup of 5 years. Pacing system failure was higher in epicardial leads ($p<0.00001$), lower age at implantation and greater number of leads placed.

Cho et al [15] reported 44 children from Korea who underwent PPI at a median age of 101 days. 52.3% had post-operative CHB while 36.3% had CCHB. Over a mean follow-up of 9 years, 15 had lead failure and 11 underwent PG replacement.

Konta et al [16] followed up 37 infants, median age 6.7 months (1 day – 3 years) and median weight 4.6kg (2.7 – 10) with transvenous pacing, for a median period of 17.2 (range, 11.2–27.4) years. Ventricular lead revision was required in 75% of cases, while subclavian ven thrombosis was the major complication seen in 35.7%. Mortality rate was 10.8%, limited to the peri-implantation period.

Zhang et al [17], from China, followed up 35 children with congenital heart disease who underwent epicardial pacing (single lead VVI mode) following corrective surgery at a mean age of 26.9±23.2 months, for a period of 46.8±33.8 months. During followup, a significant decrease of LVEF (65.6 ± 5.3 % vs. 59.6 ± 7.6 %, p = 0.03), and increase of LVEDD (25.5 ± 8.4 mm vs. 33.3 ± 9.6 mm, p = 0.005) was observed. Re-intervention rate was 11.4% due to battery depletion, and 20% children experienced MACE with complex CHD being the major risk factor.

Eliasson et al [18], from Sweden, reviewed 127 children less than 15 years of age with complete AV block, and underwent pacemaker implantation at a median age of 3.2 years. Endocardial lead placement was done in 57%, and 76% leads were steroid eluting. Epicardial lead placement was done in younger age group as compared to endocardial leads (1.6± 2.2 vs. 7.2± 5.6 years; P< 0.0001). 74% of children with VVI/VDD were upgraded to DDD, while 1 required CRT in view of heart failure, and 31% required switching of pacing lead, mostly epicardial to endocardial. Reintervention rate was higher in those implanted below 1 month of age (HR-3.4,

p<0.001) and initial procedure being done before 2002 (HR-1.68, p<0.001), and was independent of pacing lead placement or pacing mode used. Complication rate was 24%, half of which were related to lead dysfunction or fracture, followed by infection (24%). Mortality rate was 3% during the study period.

Kwak et al[19] reported 48 children from Korea who underwent PPI at a mean age of 66.5 days. Half had CCHB, while 47.9% had post-operative CHB. Mean duration of follow-up was 8.5±7.9 years, during which 18 had lead failure and 11 underwent PG replacement.

Wildbolz et al [20] analysed 52 children from Switzerland, who underwent PPI at a median age of 90 days. 34.7% had CCHB, while 65.3% had post-operative CHB. At a median follow-up duration of 40 months, 3 case of lead dysfunction was documented while 10 underwent PG replacement. No mortality was seen.

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3 MATERIALS AND METHODS

3.1 AIM OF THE STUDY

To assess the long term outcome of pacemaker implantation in children less than 18 years of age

3.2 OBJECTIVES

1. To study the indication of Permanent Pacemaker Implantation in children less than 18 years of age, along with types of leads and pacing mode used
2. To study various pacemaker parameters (impedance, amplitude, lead thresholds) and their trends during followup
3. To study about any re-interventions or upgradation required in pacing mode in follow-up

3.3 METHODOLOGY

Study Design: Retrospective Non-interventional study

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

Inclusion criteria

Cases were be enrolled if they fulfil all of the following inclusion criteria:

1. Children who underwent permanent pacemaker implantation at SCTIMST
2. Patients who were less than 18 years of age at the time of pacemaker implantation
3. Patients being followed up in Cardiology OPD since implantation

Exclusion criteria

1. Those who underwent permanent pacemaker implantation in other hospitals

All consecutive patients, who underwent pacemaker implantation in SCTIMST, the age of implantation being less than 18 years of age, were included in the study. Details regarding indication of pacemaker implantation, technique involved, hardware used, initial mode of pacing and immediate post-procedural complications were collected from Electronic Medical Records (EMR).

Consent was taken from the legal guardians prior to enrolment.

During followup, details regarding pacemaker programming parameters and complications (if any) was recorded in a pre-designed proforma.

Pacemaker interrogation was performed using manufacturer provided Device Interrogator, and the following parameters were noted:

- Pacing Mode
- Impedance of leads, including trend (in ohms)
- Pacing threshold (in volts)
- Pulse amplitude (in volts)

PRIMARY OUTCOME –

1. Re-intervention during follow-up (including lead change, upgradation or pulse generator change)
2. Ventricular dysfunction
3. Mortality

SECONDARY OUTCOMES –

1. Complications during the post implantation period
2. Pacing system failure

Ventricular dysfunction was defined as the reduction of ejection fraction to below 50%, while pacing system failure was defined as need for implantation of a new pacemaker system.

Statistical analysis: Statistical analysis was done using SPSS version 21. Quantitative variables wasreported as mean (SD), median and inter-quartile range for

skewed data and qualitative variables are reported as proportions. Comparisons will be made by using student t test, Mann-Whitney U test and chi square test, as appropriate. Kaplan Meier survival curve was used to study freedom from MACE and re-intervention, while logistic regression was done to find out independent predictors. A p value of <0.05 was considered significant.

3.4 ETHICAL JUSTIFICATION

The present study entails the long term outcome of children who have undergone pacemaker implantation, including functional class, pacemaker parameters, complication and need for re-intervention. There is dearth of data in this field from the Indian subcontinent, and this study will help immensely in upgrading the quality of care currently available to them.

All patients who have undergone pacemaker implantation are assessed regularly and routine in PACE clinic in SCTIMST for interrogation and optimisation of pacing parameters, so no extra visit or cost was borne by the patient or his/her relatives. No intervention or invasive test was performed.

This study was approved by the Institutional Ethics Committee, SCTIMST Trivandrum.

4 RESULTS

Out of 235 patients included in the study, 53.2% were male, with median age of implantation being 7 years (IQR 1.2 – 13). 43.4% underwent epicardial pacemaker implantation, and VVI was the commonest (65.5%), followed by dual chamber(30.2%) and AAI (4.3%).

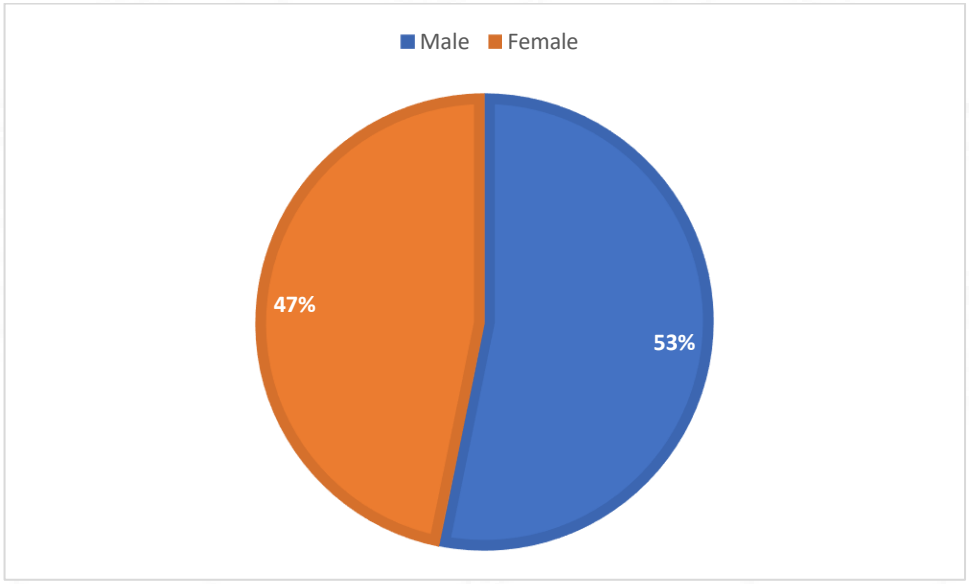

Fig 1: Pie chart showing distribution of population according to gender

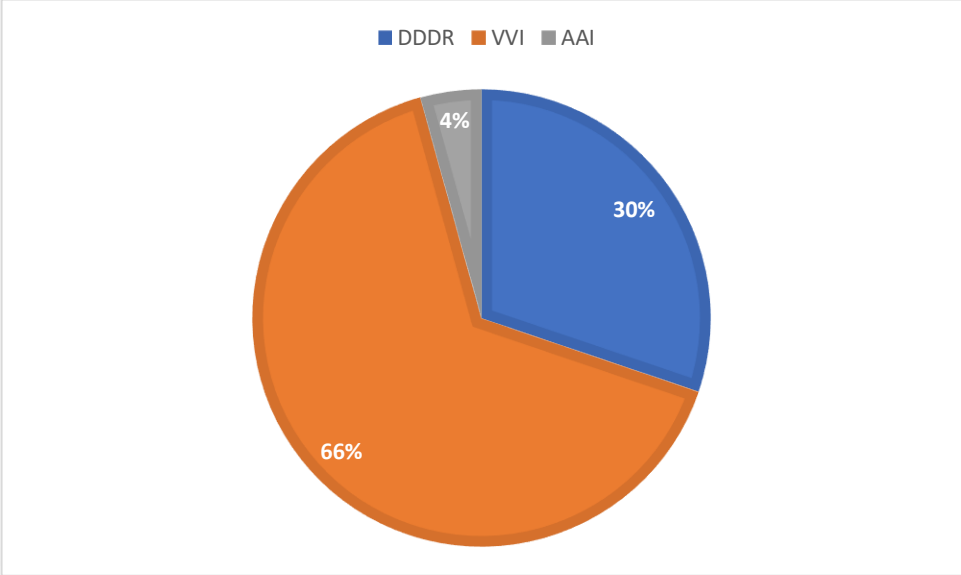

Fig 2: Pie chart showing distribution of population as per type of pacemaker implanted

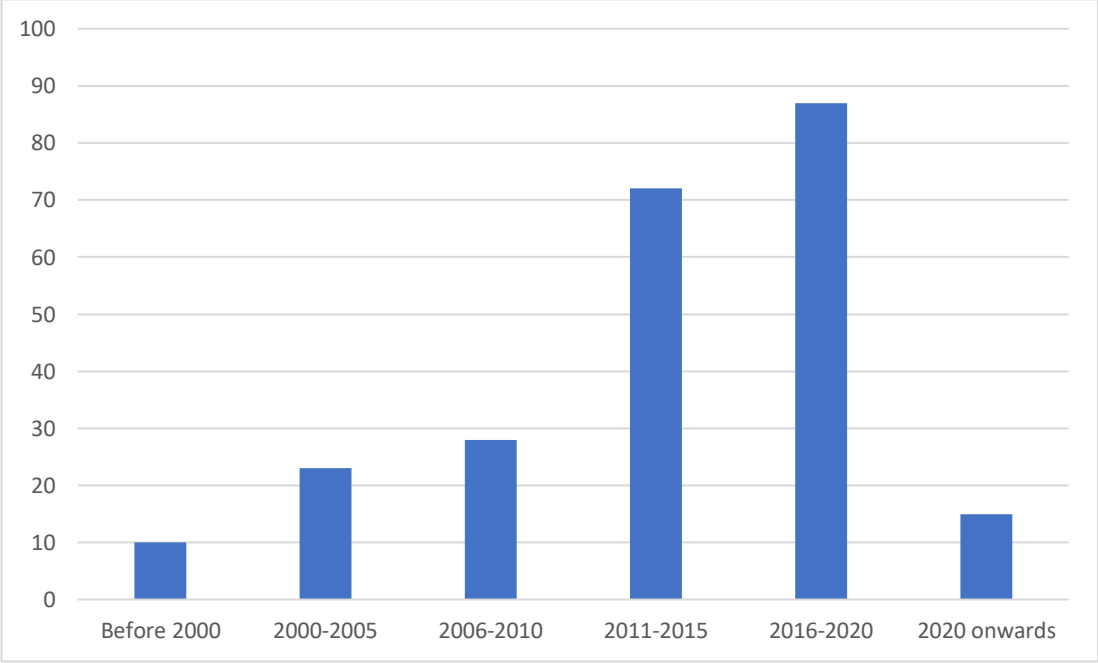

Fig 3: Column chart showing year-wise number of PPI in children

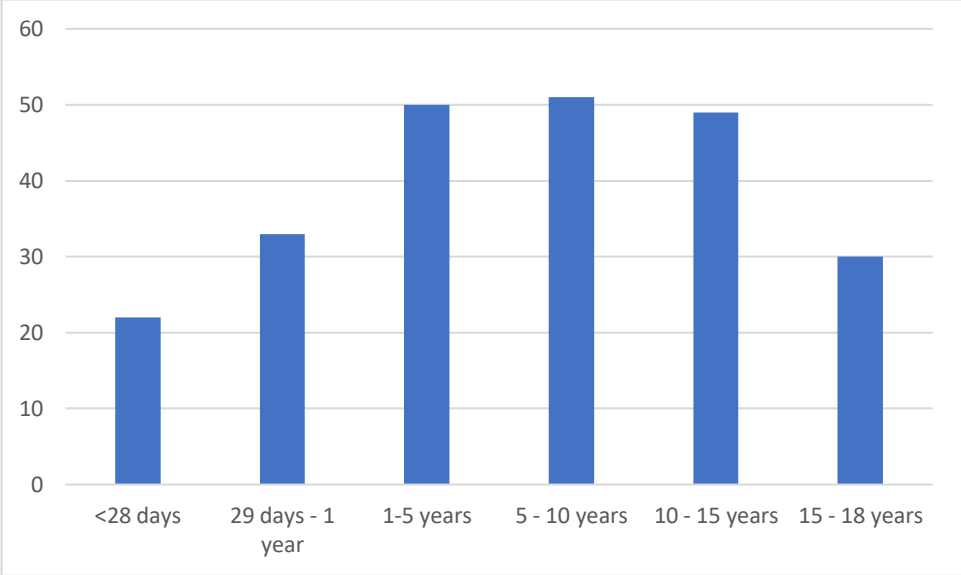

Fig 4: Column chart showing age at implantation of PPI in children

Congenital complete heart block was the commonest indication in half of the patients (50.2%), followed by post-operative complete heart block (28.1%), sinus node dysfunction (11.5%) and long QT syndrome (4.2%). Non-surgery related acquired complete heart block was seen in 10 patients (4.2%).

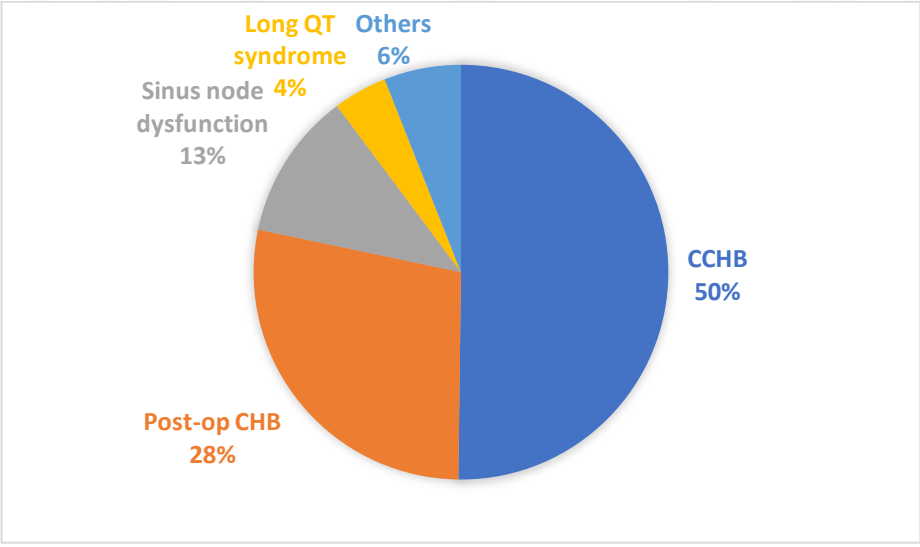

Fig 5: Pie chart showing indication for PPI in our population(n=235)

Congenital heart disease (CHD) was seen in 41.3%, out of which ventricular septal defect was commonest (20.6%) followed by atrial septal defect (18.6%). Congenitally corrected transposition of great arteries (13.4%), double outlet right ventricle (10.3%) and atrioventricular canal defect (7.5%) were the other common defects observed.

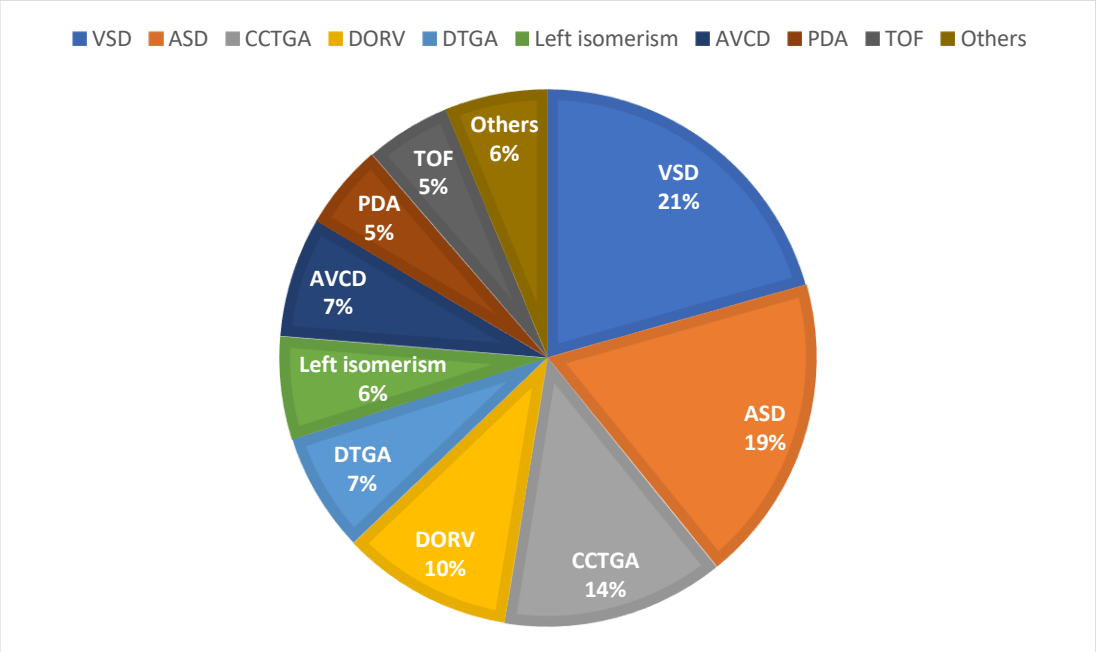

Fig 6: Pie chart showing distribution of study population based on associated congenital heart disease

Over a median follow-up of 8 years, mean percentage of pacing was 82.1±29.2%(median – 98% [IQR 79.6 – 99.9]), with a average threshold of 1.2 ± 0.7V and impedance of 562 ± 130 ohms. 56 (23.8%) patients underwent PG change

at median duration 97 months (72-126) for battery depletion, while 8 (3.4%) underwent lead change for lead dysfunction at median duration 52 months (IQR 5-97). 10 (4.3%) patients had surgical site infection at median duration of 2 months (1.25-5.1), while 15 (6.38%) had post implantation ventricular dysfunction at a median duration of 83 months, out of which 5 required hospitalisation for heart failure (2.1%). During the entire follow-up period, 7 patients died with an overall mortality of 2.9%.

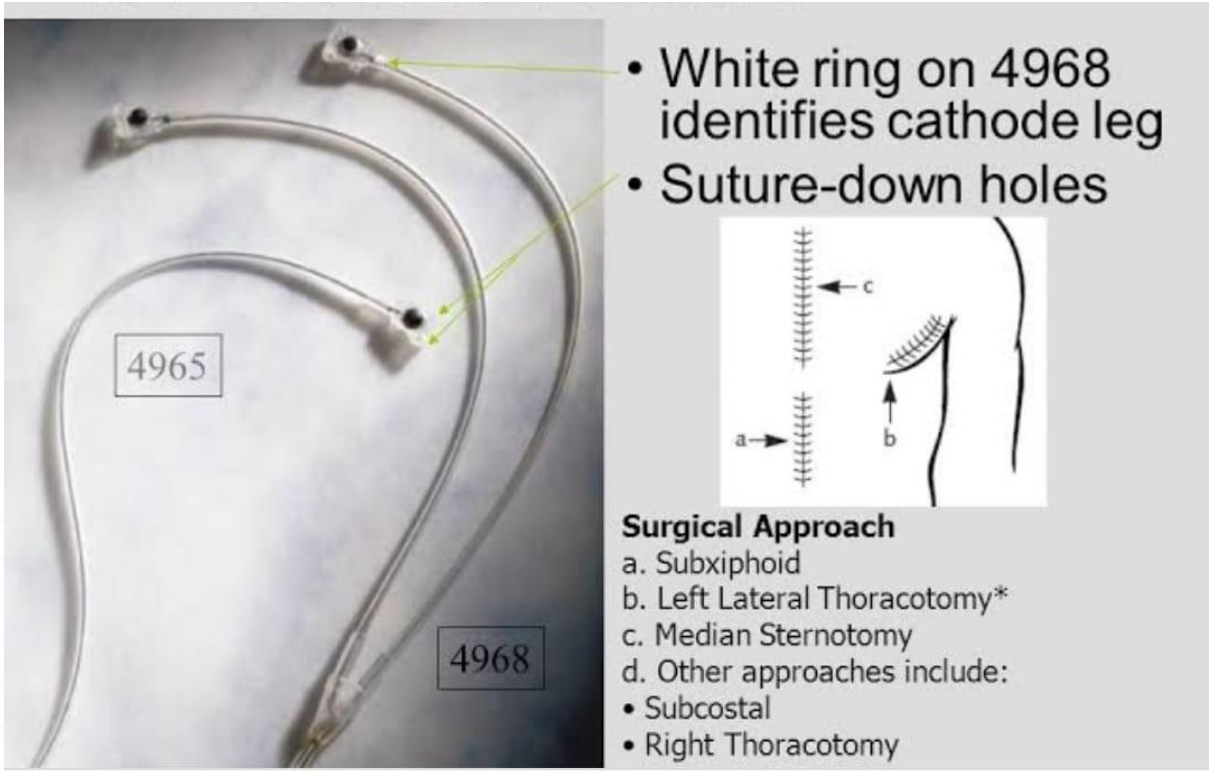

Fig 7: Steroid eluting epicardial pacemaker leads (Medtronic Capsure 4968, Minneapolis MN)

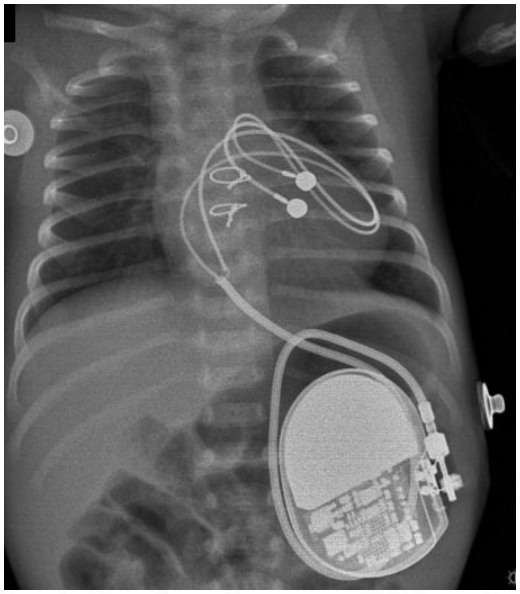

Fig 8: X ray showing implanted epicardial pacemaker (left) and endocardial pacemaker (right)

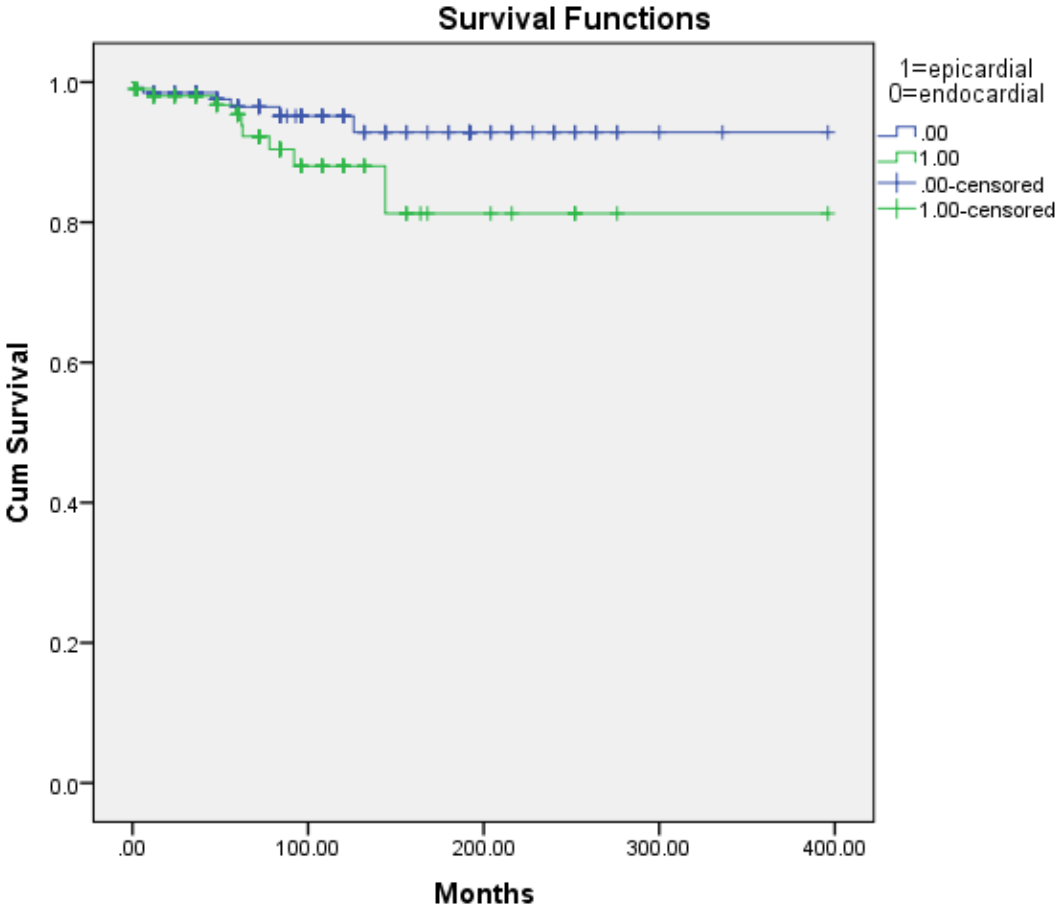

Fig 9: Kaplan Meier curve showing survival of epicardial vs endocardial leads (p=0.117)

Among 102 patients with epicardial pacemaker, 86 (84.3%) underwent steroid eluting lead implantation. There was no significant difference between lead survival between two groups (p=0.214) as well as no difference in overall survival (p=0.174).

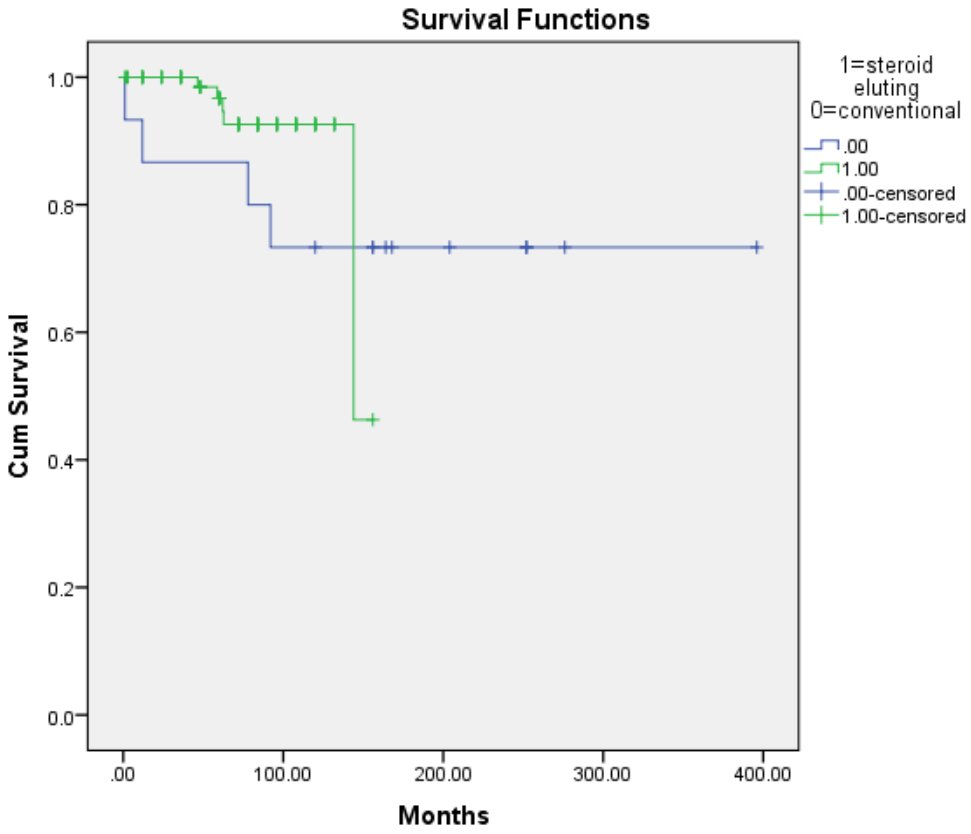

Fig 10: Kaplan Meier curve showing lead survival of steroid eluting vs conventional epicardial (p=0.214)

OUTCOMES IN NEONATES (AGE <28 DAYS AT IMPLANTATION)

Total of 22 children underwent PPI below 28 days of age, out of which 19 were CCHB ad 3 were post-operative CHB; 2 had undergone PDA ligation and 1 underwent VSD closure. Median age at implantation was 2 days (IQR 1-6 days), and average weight at implantation was 3.0±0.6 kg. Maternal ANA was positive in 8(36.4%) patients, while 11(50.0%) had associated congenital heart disease, ASD

being the commonest (31.8%) followed by VSD (9.1%). VVI pacemaker was implanted in 19, while 3 underwent dual chamber pacemaker.

Median duration of follow-up was 46 months (IQR 2-133 months), during which 7 patients underwent PG change for battery depletion. Average ventricular pacing percentage, lead threshold and lead impedance were 87.5±24.9%, 1.4±0.7V and 604.4±98.4 ohms. Ventricular systolic dysfunction was seen in 13.6%, and 2 underwent upgradation to CRT. 1 underwent lead revision due to elevated threshold, while 1 underwent upgradation to endocardial PPI.

Overall mortality was 13.6%, with major identifiable predictors.

Table 1: Parameters in neonates (<28 days old) who underwent PPI who died and survived

Parameter	**Died (n=3)**	**Survived (N=19)**	**P value**
Age at implantation, median (IQR)	3 (1-26)	2(1-8)	0.69
VVI PPI implantation, n(%)	3 (100)	16(84.2)	0.46
Structurally normal heart, n(%)	1(33.3)	10(52.6)	0.53
Maternal ANA positivity, n(%)	2(66.7)	6(31.6)	0.24

Ventricular dysfunction on follow-up, n(%)	1(33.3)	2(10.5)	0.28
CVA, n(%)	0	1(5.3)	0.68

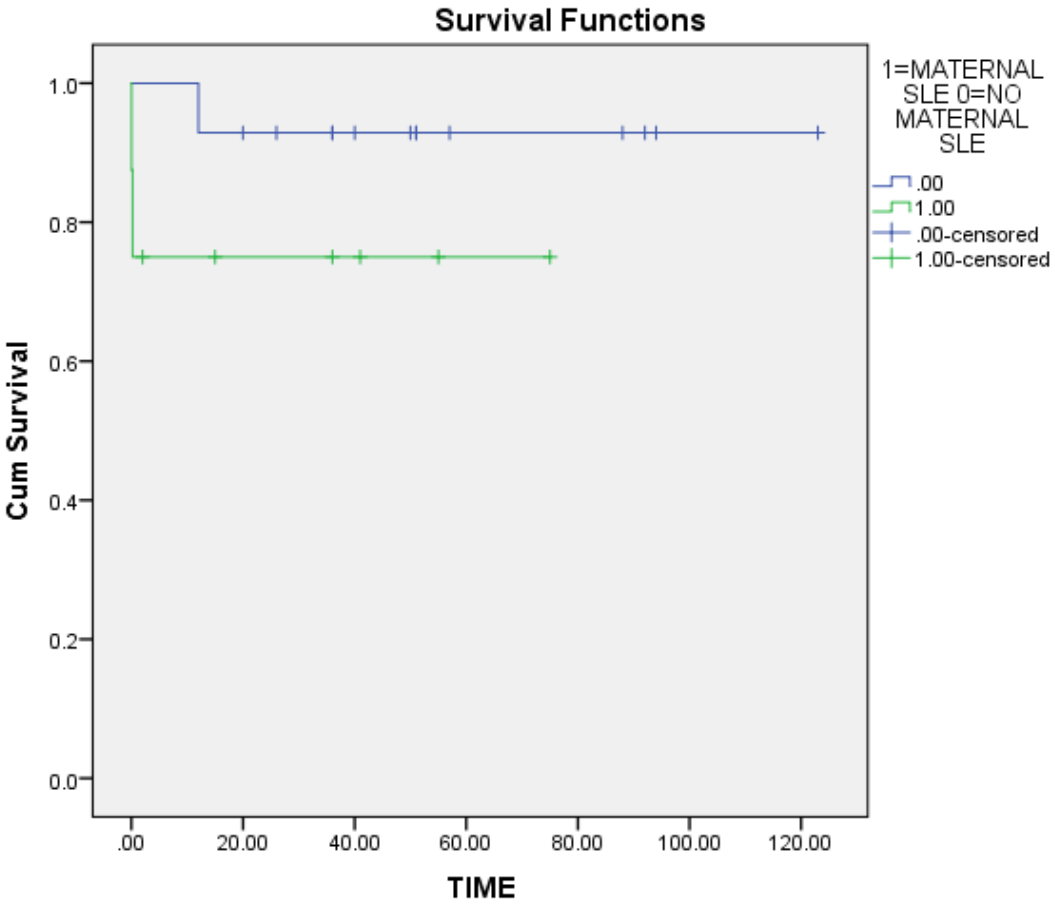

Fig 11: Kaplan Meier curve showing effect of maternal ANA on survival of neonates with PPI (P=0.196)

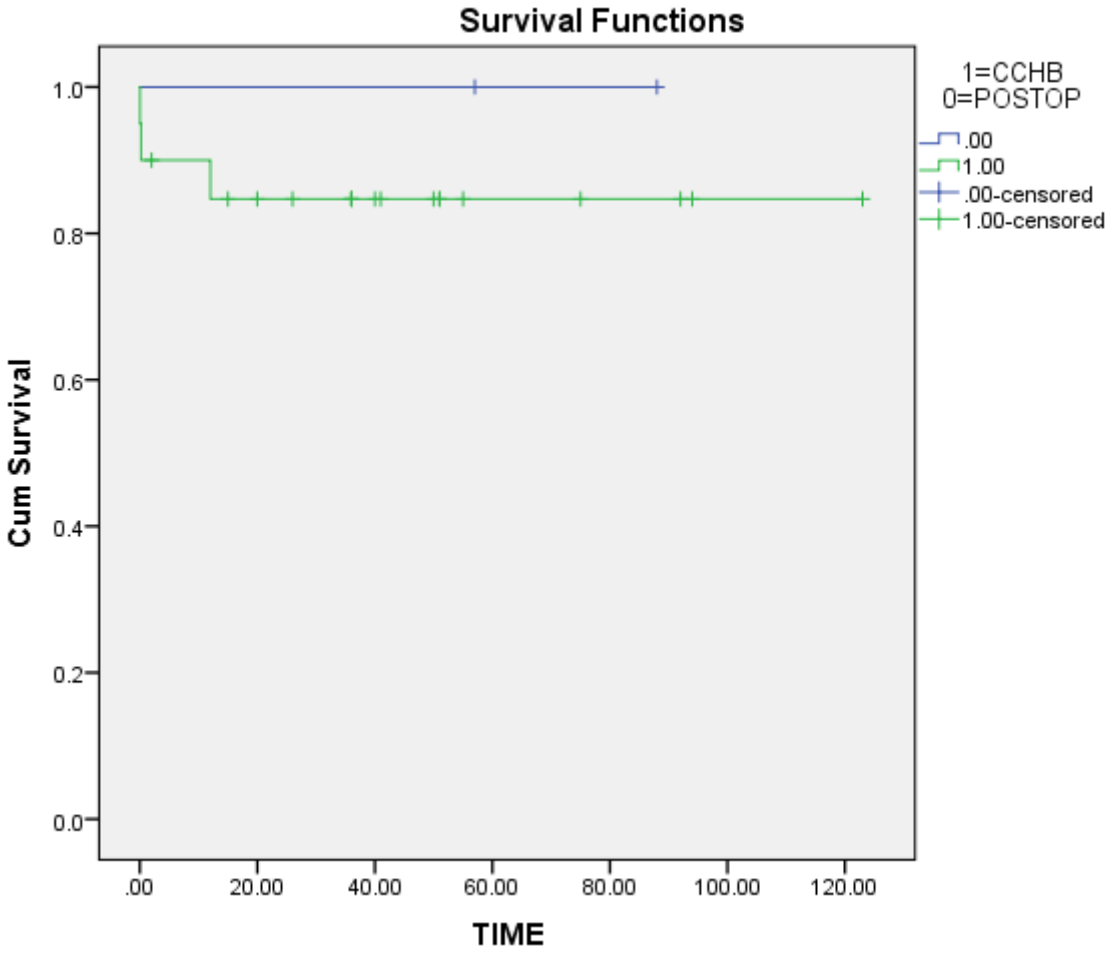

Fig 12: Kaplan Meier curve showing difference in survival of neonates undergoing PPI for CCHB or post-operative CHB (P=0.570)

OUTCOMES IN INFANTS (AGE <12 MONTHS AT IMPLANTATION)

Total of 55 children underwent PPI below 12 months of age, out of which 36 were CCHB and 19 were post-operative CHB. Median age at implantation was 2.4 months (IQR 1-6 months), and weight at implantation was 3.9±1.7 kg. Maternal lupus antibodies were positive in 8(22.2%) patients, while 36 (65.4%) had associated

congenital heart disease, PDA (10.9%) and DORV (10.9%) being the commonest, followed by VSD (9.1%), CCTGA (3.6%), DTGA (3.6%), TOF (5.4%) and left isomerism (3.6%)VVI pacemaker was implanted in 47, while 8 underwent dual chamber pacemaker.

Median duration of follow-up was 54 months (IQR 2-256 months), during which 13 patients underwent PG change for battery depletion. Median ventricular pacing percentage was 99.9% [IQR 96.3 – 100], while average lead threshold and lead impedance were 1.5±0.8V and 596.6±98.1 ohms. Ventricular systolic dysfunction was seen in 9.1% at a mean duration of 29 months, and 2 underwent upgradation to CRT at a mean follow-up of 21 months. 2 underwent lead revision due to elevated threshold, while 3 underwent upgradation to endocardial PPI.

Overall mortality was 7.3%, with major predictors being younger age at implantation, maternal lupus antibodies and systemic ventricular dysfunction.

Table 2: Parameters of infants who underwent PPI for CCHB and post-operative CHB

Parameter	**CCHB (n=36)**	**Post op CHB (N=19)**	**P value**
Age at implantation, median (IQR)	0.23±0.33	0.56±0.33	**<0.01**
Male, n(%)	14 (38.9)	12 (63.2)	0.09
VVI pacing, n(%)	31 (86.1)	16 (84.2)	0.85
Structurally normal heart, n(%)	25 (69.4)	0 (0)	**<0.01**

Lead threshold (in V), mean±SD	1.34±0.64	1.69±0.99	0.12
Median percentage of pacing (%) [IQR]	99.6 (96.1 – 100)	99.9 (97.1 – 100)	0.71
Impedance (in ohms), mean±SD	603±111	583±99.2	0.51
Lead failure, n(%)	3 (8.3)	4 (21.0)	0.18
Endo PPI upgradation, n(%)	0 (0.0)	3 (15.7)	**0.01**
Lead revision, n(%)	2 (5.6)	0 (0.0)	0.29
PG change, n(%)	9 (25.0)	4 (21.1)	0.74
Ventricular dysfunction on follow-up, n(%)	2 (5.6)	2 (10.5)	0.50
CVA, n(%)	1 (2.8)	0 (0.0)	0.68
Death, n(%)	2 (5.6)	2 (10.5)	0.21
SSI, n(%)	3 (8.3)	1 (5.3)	0.68

Table 3:Parameters of infants with PPI who died and survived

Parameter	**Died (n=4)**	**Survived (N=51)**	**P value**
Age at implantation(in days), median (IQR)	3.6 (2.1-164)	76 (3.6-211)	**<0.01**

Weight at implantation (in kg)	3.3±1.9	3.8±1.9	0.24
VVI pacing, n(%)	3 (75.0)	44(86.3)	0.53
Structurally normal heart, n(%)	1(33.3)	24(47.0)	0.10
Maternal lupus antibodies, n(%)	2(50.0)	6(11.8)	**0.03**
CCHB, n(%)	2(50.0)	34(66.7)	0.68

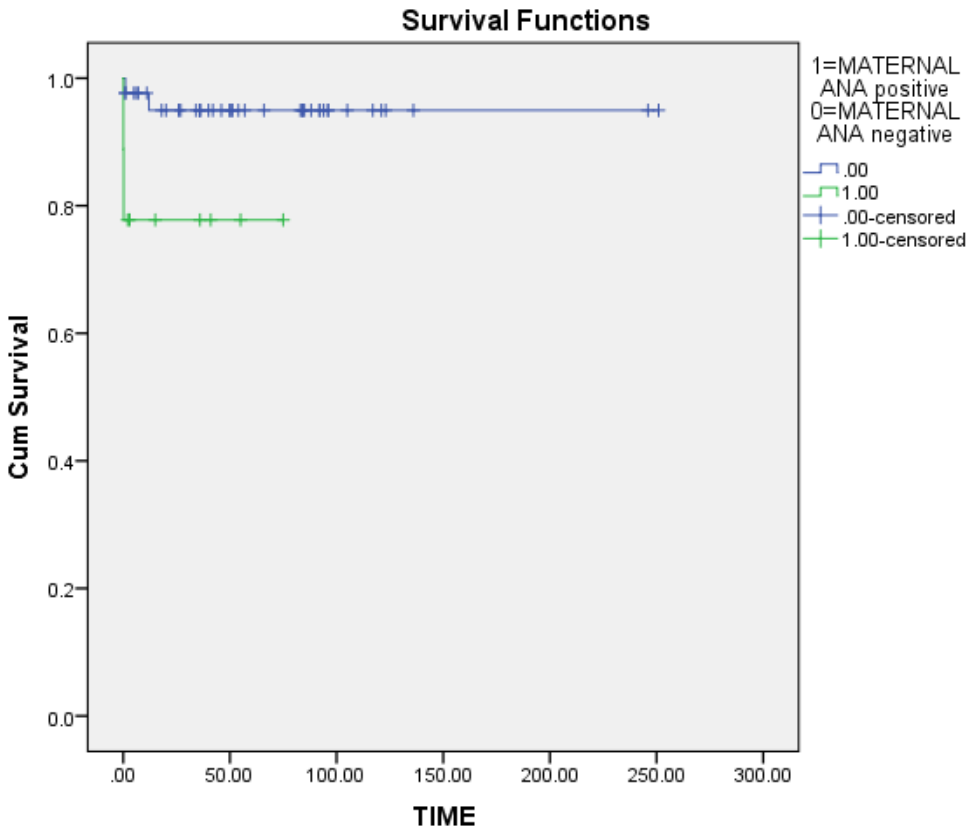

Fig 13: Kaplan Meier curve showing effect of maternal ANA on survival in infants who underwent PPI (p=0.047)

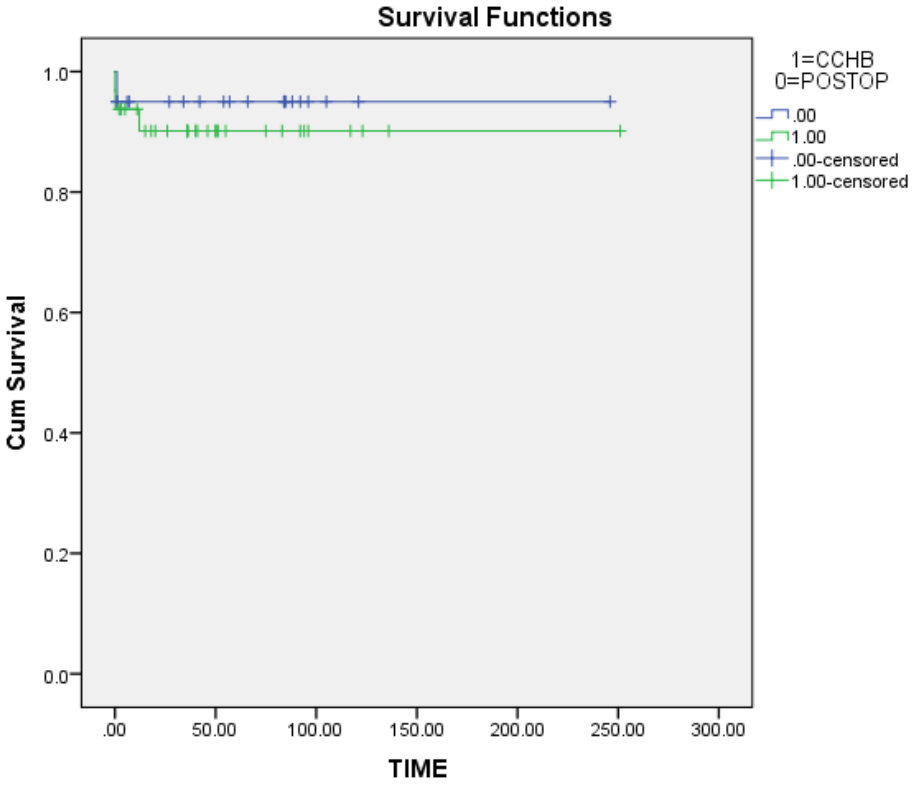

Fig 14: Kaplan Meier curve showing survival difference between CCHB and post-operative CHB(p=0.577)

EPICARDIAL VS ENDOCARDIAL PACEMAKER IMPLANTATION

102 patients underwent epicardial PPI, as compared to 133 who underwent endocardial PPI. They were younger (median age 0.9 years vs 12 years), with higher prevalence of congenital heart disease (77.4% vs 36.8%, $p<0.001$) and post-operative CHB (43.1% vs 16.5%, $p<0.001$). Percentage of ventricular pacing, pacing threshold and impedance were significantly higher than the patients who underwent endocardial PPI. Post-implantation systemic ventricular dysfunction was also higher in the epicardial PPI group (10.7% vs 0.7%, $p<0.01$).

Table 4:Parameters of patients who underwent epicardial vs endocardial PPI

	Epicardial (N=102)	Endocardial (N=133)	P value
Age (in years), median (IQR)	0.91 (0.17 – 3.0)	12 (8-15)	**<0.01**
Male sex, n(%)	53 (52.0)	72 (54.1)	0.74
Etiology			**<0.01**
CCHB, n(%)	50 (49.0)	68 (51.1)	
Post op, n(%)	44 (43.1)	22 (16.5)	
LQTS, n(%)	3 (2.9)	8 (6.0)	
SAN dysfunction, n(%)	4 (3.9)	23(17.3)	
CHD, n(%)	61 (59.8)	36 (27.1)	**<0.01**
ASD, n(%)	15 (14.7)	3 (2.2)	
PDA, n(%)	5 (4.9)	0 (0)	
CCTGA, n(%)	7 (6.9)	6 (4.5)	
AVCD, n(%)	7 (6.9)	0 (0.0)	
VSD, n(%)	13 (12.7)	7(5.3)	
DORV, n(%)	8 (7.8)	2(1.5)	
D-TGA, n(%)	6 (5.9)	1(0.75)	
TOF, n(%)	2 (2.0)	3 (2.3)	
Type			0.68

Dual chamber, n(%) VVI, n(%) AAI, n(%)	28 (27.5) 70 (68.6) 4 (3.9)	43 (32.3) 84 (63.2) 6 (4.5)	
Followup (in years), median (IQR)	7 (5-10.5)	8 (4.7 – 16)	0.11
V-pacing (in %), median [IQR]	99.6 [90.7 – 100]	95.3 [74.0 – 99.4]	**0.02**
Threshold (in V), mean±SD	1.46±0.94	0.99±0.37	**<0.01**
Impedance (in ohms), mean±SD	605.4±112.8	530±133	**<0.01**
PG change, n(%) Lead change, n(%) SSI, n(%) SV dysfunction, n(%)	22 (21.6) 3 (2.9) 4 (3.9) 12 (11.7)	34 (25.6) 5 (3.8) 6 (4.5) 3 (2.2)	0.48 0.73 0.82 **<0.01**
Mortality, n(%)	5 (4.9)	2 (1.5)	0.13

OUTCOMES IN CONGENITAL COMPLETE HEART BLOCK VS POST-OPERATIVE COMPLETE HEART BLOCK

118 patients underwent PPI for CCHB, while 66 for post-operative CHB. Use of endocardial PPI was more common in patients with CCHB, while epicardial PPI was

more prevalent in the post-operative CHB group. During follow-up, although percentage of ventricular pacing was similar between both groups, threshold was significantly higher in the post-operative group (1.07±0.46V vs 1.45±1.11, p<0.01). Ventricular dysfunction was much more common in the post-operative CHB group (12.1% vs 4.2%, p=0.04), although there was no significant difference in mortality.

Table 5:Parameters of patients with CCHB vs post-operative CHB

	CCHB (N=118)	Post-operative CHB (N=66)	P value
Age (in years), median (IQR)	5.3 (0.9 – 12.0)	3 (0.9 – 12.0)	0.43
Male sex, n(%)	56(47.4)	36 (54.5)	0.36
CHD, n(%)	31 (26.2)	66 (100.0)	**<0.01**
ASD, n(%)	8(6.8)	10 (15.2)	
PDA, n(%)	3 (2.5)	2 (3.0)	
CCTGA, n(%)	8 (6.7)	5 (7.6)	
AVCD, n(%)	1 (0.8)	6 (9.1)	
VSD, n(%)	1 (0.8)	19 (28.8)	
DORV, n(%)	1 (0.8)	9 (13.6)	
D-TGA, n(%)	0 (0)	7 (10.6)	
TOF, n(%)	0 (0)	5 (7.6)	
Type			

Endocardial, n(%)	68 (57.6)	21 (31.8)	**<0.01**
Epicardial, n(%)	50 (42.4)	45 (68.2)	
Dual chamber, n(%)	35 (28.8)	16 (24.2)	0.43
VVI, n(%)	83 (70.3)	50 (75.8)	
Followup (in years), median (IQR)	8 (5-12)	9 (5.3 – 14.7)	0.45
V-pacing (in %), mean±SD	99.0[91.9 – 99.9]	97.6 [90.1 – 99]	0.15
Threshold (in V), mean±SD	1.07±0.46	1.45±1.11	**<0.01**
Impedance (in ohms), mean±SD	563±132	583±135	0.33
PG change, n(%)	31 (26.3)	17 (25.8)	0.93
Lead change, n(%)	5 (4.2)	3 (4.5)	0.92
SSI, n(%)	5 (4.2)	3 (4.5)	0.92
Ventricular dysfunction, n(%)	5 (4.2)	9(13.6)	**0.03**
Mortality, n(%)	2 (1.7)	4 (6.1)	0.10

OUTCOMES IN SINUS NODE DYSFUNCTION

26 patients underwent PPI for Sino-atrial node (SAN) dysfunction, out of which 3 were post-operative. Mean age at implantation was 13.4±4.1 yrs, and 69.2% were male. 88% had endocardial PPI, and majority received VVI pacemaker (57.6%), followed by dual chamber (30.8%) and AAI (11.6%).

Median duration of follow-up was 10 years (IQR 4 – 16.7 years). Mean pacing percentage was 59.8±32.2%, while average lead threshold and impedance were 1.2±0.4V and 549±132 ohms. 9 underwent PG change for battery depletion, while 1 underwent lead revision for lead dysfunction. Overall mortality was 3.8%.

VENTRICULAR DYSFUNCTION

15 (6.38%) patients developed ventricular dysfunction at a median follow-up duration of 83 months, while 5 (2.1%) required hospitalization for heart failure.Younger age at implantation, maternal ANA positivity, presence of post-operative CHB, associated congenital heart disease and epicardial PPI was associated with higher incidence of ventricular dysfunction.

Patients developing ventricular dysfunction had a higher incidence of mortality.

Table 6: Table showing difference in parameters of patients with and without ventricular dysfunction post PPI

	Ventricular dysfunction	No ventricular dysfunction	P value

	(N=15)	(N=220)	
Age (in years), median (IQR)	3.25 (0.14 – 8.0)	7.2 (1.5-13)	**0.05**
Male sex, n(%)	9 (60.0)	116(52.7)	0.58
Etiology			**0.016**
CCHB, n(%)	6 (40.0)	68 (51.1)	
Post op, n(%)	8 (53.3)	22 (16.5)	
LQTS, n(%)	0 (0)	8 (6.0)	
SAN dysfunction, n(%)	1 (6.7)	23(17.3)	
Maternal ANA positivity, n(%)	3 (20.0)	12 (5.5)	**0.02**
CHD, n(%)	12 (86.7)	85(38.6)	**<0.01**
ASD, n(%)	2 (14.7)	16 (2.2)	
PDA, n(%)	0 (4.9)	5 (0)	
CCTGA, n(%)	1 (6.9)	12 (4.5)	
AVCD, n(%)	1 (6.9)	6(0.0)	
VSD, n(%)	3 (12.7)	17(5.3)	
DORV, n(%)	2 (7.8)	8(1.5)	
D-TGA, n(%)	2 (5.9)	5(0.75)	
TOF, n(%)	1 (2.0)	4(2.3)	
Type			0.38

Dual chamber, n(%)	3 (20.0)	43 (32.3)	
VVI, n(%)	12 (80.0)	84 (63.2)	
AAI, n(%)	0 (3.9)	6 (4.5)	
Epicardial, n(%)	11 (73.3)	91	**0.016**
Endocardial, n(%)	4 (26.7)	129	
Followup (in years), median (IQR)	9.5 (6.25-15.5)	7 (5 – 12)	0.25
V-pacing (in %), median [IQR]	99.7 [93.8 – 99.9]	97.8 [78.9 – 99.9]	0.25
Threshold (in V), mean±SD	1.06±0.40	1.20±0.70	0.44
Impedance (in ohms), mean±SD	594.4±85.5	560±132	0.33
PG change, n(%)	5 (33.3)	51 (25.6)	0.50
Lead change, n(%)	1 (6.7)	7 (3.8)	0.47
SSI, n(%)	2 (13.3)	8 (4.5)	0.07
Mortality, n(%)	6 (40.0)	1 (1.5)	<**0.01**

MATERNAL ANA POSITIVITY

15 (12.7%)patients with congenital CHB had documented maternal ANA positivity. Only 2 had associated CHD, and 9 underwent VVI implantation. Median age at

implantation was 1 month (IQR 3 days – 7.7 years), and 11 had epicardial pacemaker implantation. Median pacing percentage was 99% [IQR 92.4 – 100], and average threshold was 1.04±0.3 ohms and impedance being 591±147 ohms. Incidence of ventricular dysfunction was 20%, and mortality was 13.3%.

MORTALITY ANALYSIS

Seven patients died during the follow-up period, with an overall mortality of 2.98%. Systemic ventricular dysfunction was the cause seen universally preterminally. Major predictors of death by univariate analysis include age at implantation below 28 days, congenital heart disease, maternal ANA positivity and systemic ventricular dysfunction.

Table 7:Parameters among patients who died and survived

	Died (N=7)	Survived (N=228)	P value
Age (in years), median (IQR)	4.4 (0.9 – 13.0)	7 (1.4 – 13.0)	0.36
Age <28 days, n(%)	3 (42.9)	19 (8.3)	**<0.01**
Male sex, n(%)	4 (57.1)	121 (53.1)	0.83
Maternal ANA positivity, n(%)	3 (42.8)	14 (6.1)	**<0.01**
CHD, n(%)	7(100)	90 (39.4)	**<0.01**
ASD, n(%)	1(14.3)	17 (7.4)	

PDA, n(%)	1 (14.3)	4 (1.8)	
CCTGA, n(%)	1	12 (5.3)	
AVCD, n(%)	0	7(3.1)	
VSD, n(%)	1(14.3)	19(8.3)	
DORV, n(%)	0	10(4.4)	
D-TGA, n(%)	1(14.3)	6(2.6)	
TOF, n(%)	1(14.3)	4(1.8)	
Type			
Endocardial, n(%)	2 (28.6)	131(57.4)	0.13
Epicardial, n(%)	5 (71.4)	97(42.5)	
Dual chamber, n(%)	1 (14.3)	70 (30.7)	0.51
VVI, n(%)	6 (85.7)	148 (64.9)	
AAI, n(%)	0 (0.0)	10 (4.4)	
Followup (in years), median (IQR)	11 (5.7-17.7)	7 (5 - 12)	0.45
V-pacing (in %), median [IQR]	99.0 [97.1 – 99.9]	98.0 [80. – 99.9]	0.53
Threshold (in V), mean±SD	0.78±0.44	1.19±0.72	0.13
Impedance (in ohms), mean±SD	543±103	562±130	0.33
PG change, n(%)	2 (28.6)	54(23.7)	0.76
		8(3.5)	0.61

Lead change, n(%)	0	10(4.3)	0.54
SSI, n(%)	0	6(2.6)	**<0.01**
SV dysfunction, n(%)	7 (100.0)		

On multivariate analysis, age at implantation below 28 days, maternal lupus antibodies, congenital heart disease and post-implantation ventricular dysfunction were significant predictors of mortality.

Table 8: Predictors of mortality (Multivariate analysis)

	Hazard ratio	95% CI	P value
Maternal ANA positivity	11.5	2.3 – 56.3	**<0.01**
Age at implantation <28 days	8.4	1.7 – 40.4	**<0.01**
Post implantation ventricular dysfunction	513.0	26.4 – 9979	**<0.01**
Congenital heart disease	22.9	1.29 – 406.9	**0.030**

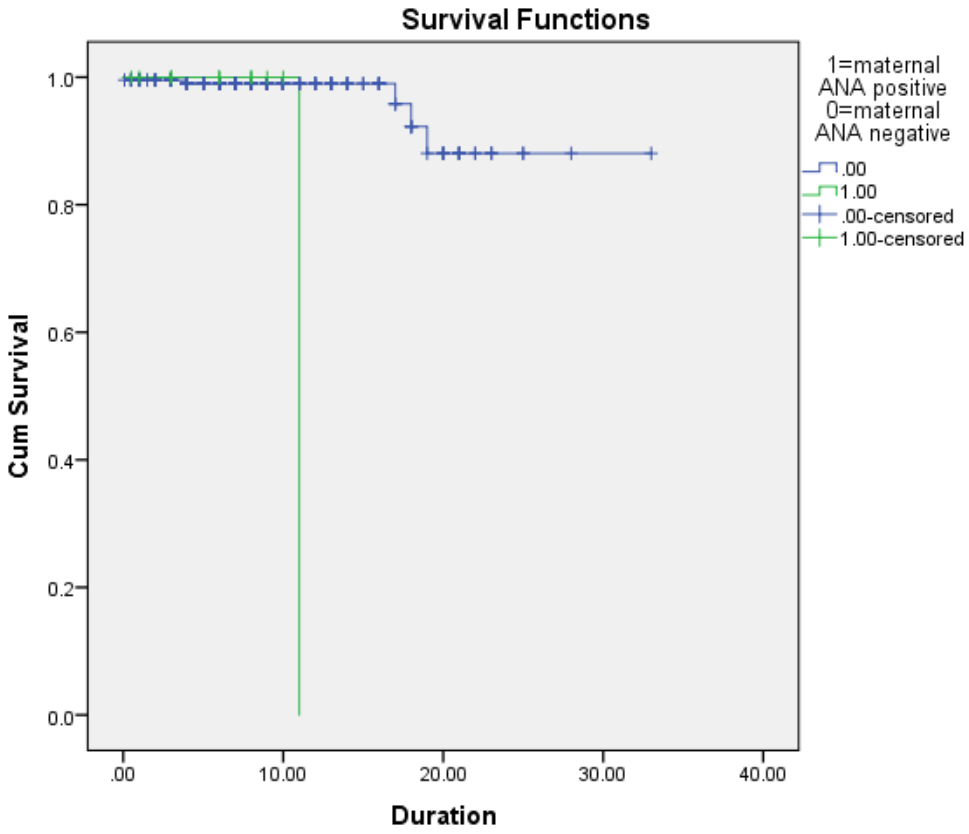

Fig 15: Kaplan Meier curve showing effect of maternal ANA positivity on mortality (p=0.01)

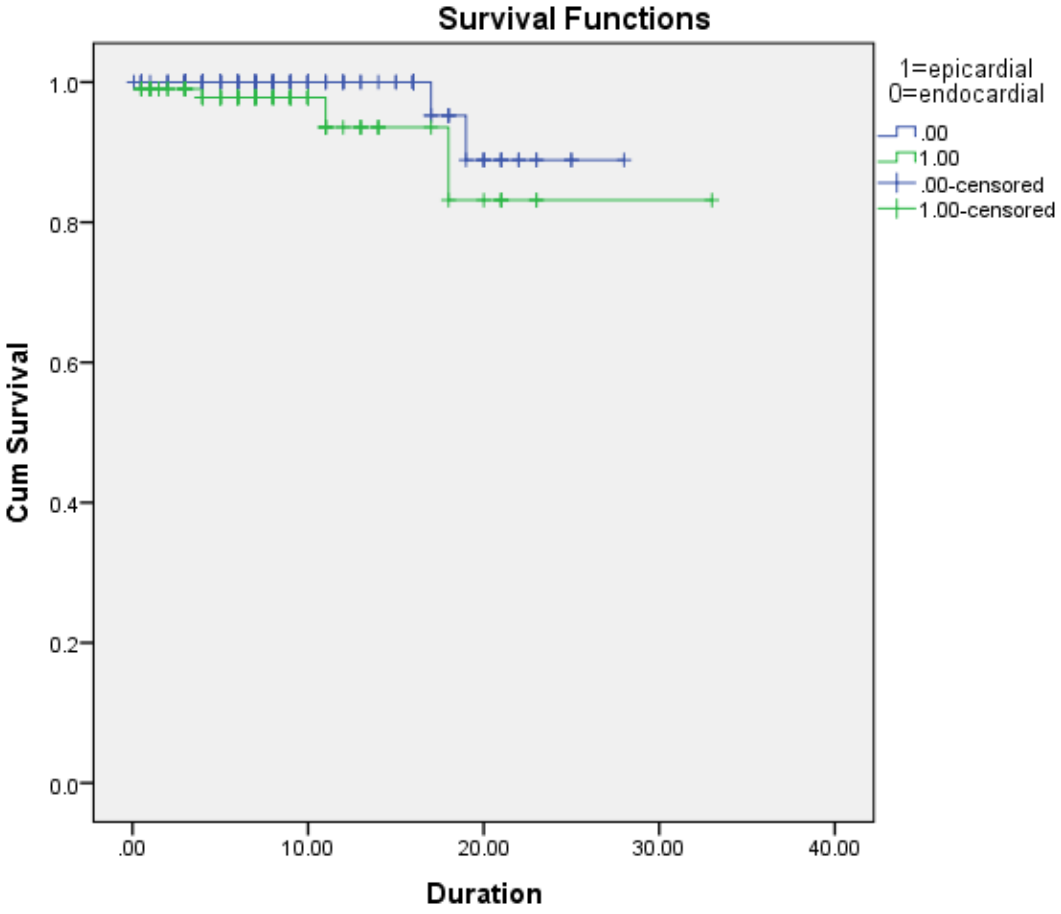

Fig 16: Kaplan Meier curve showing difference between endocardial and epicardial PPI on survival (p=0.12)

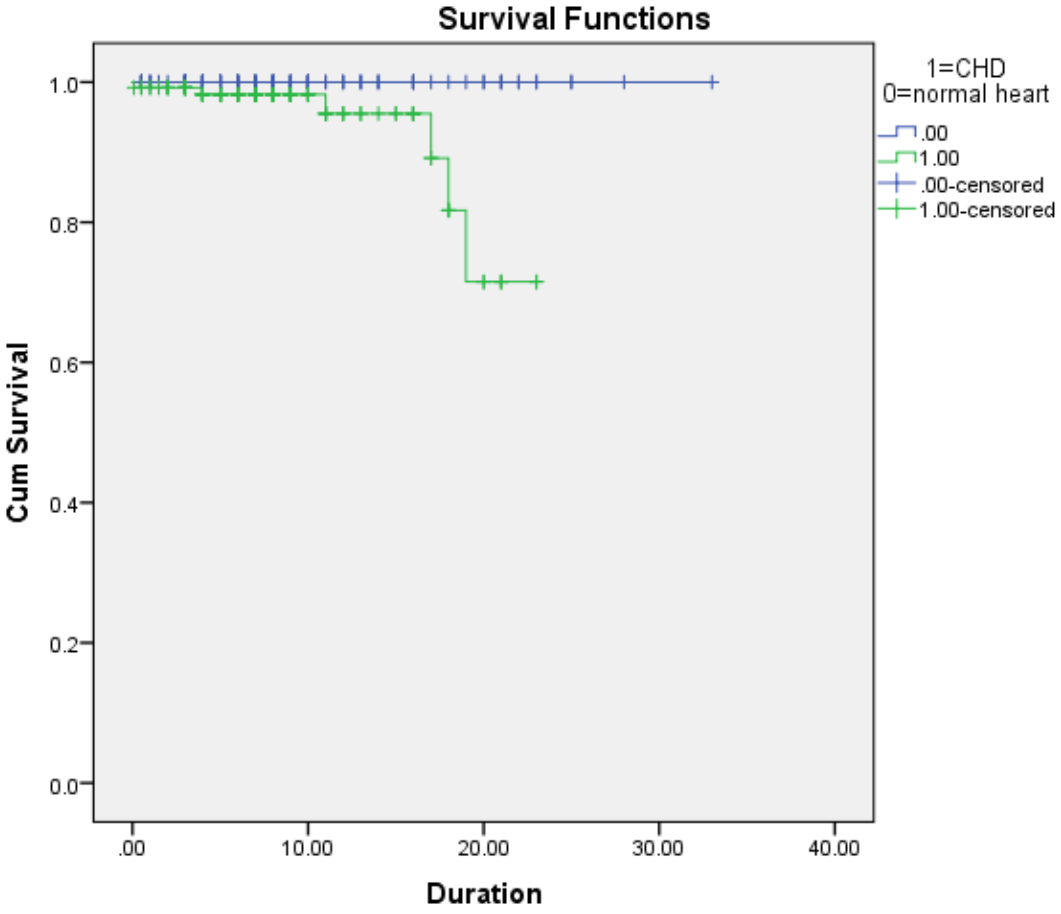

Fig 17: Kaplan Meier curve showing effect of congenital heart disease on survival (p=0.011)

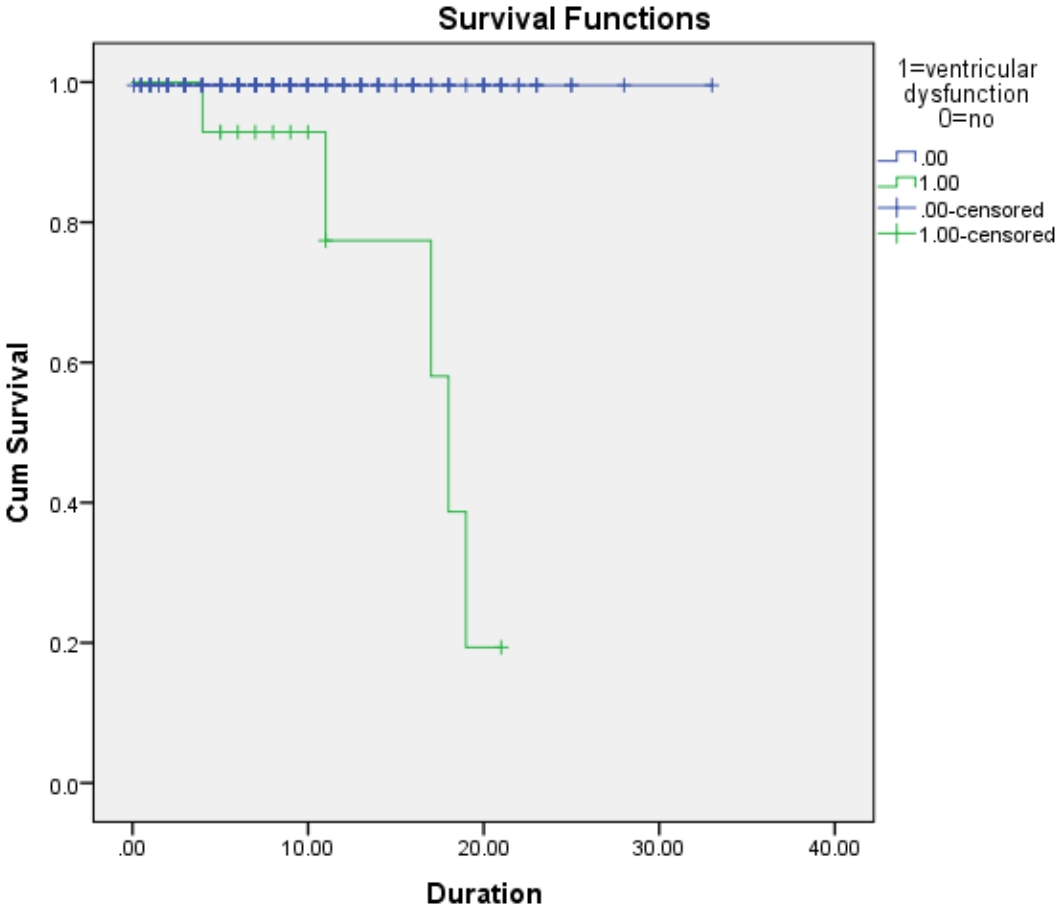

Fig 18: Kaplan Meier curve showing effect of ventricular dysfunction on survival (p<0.001)

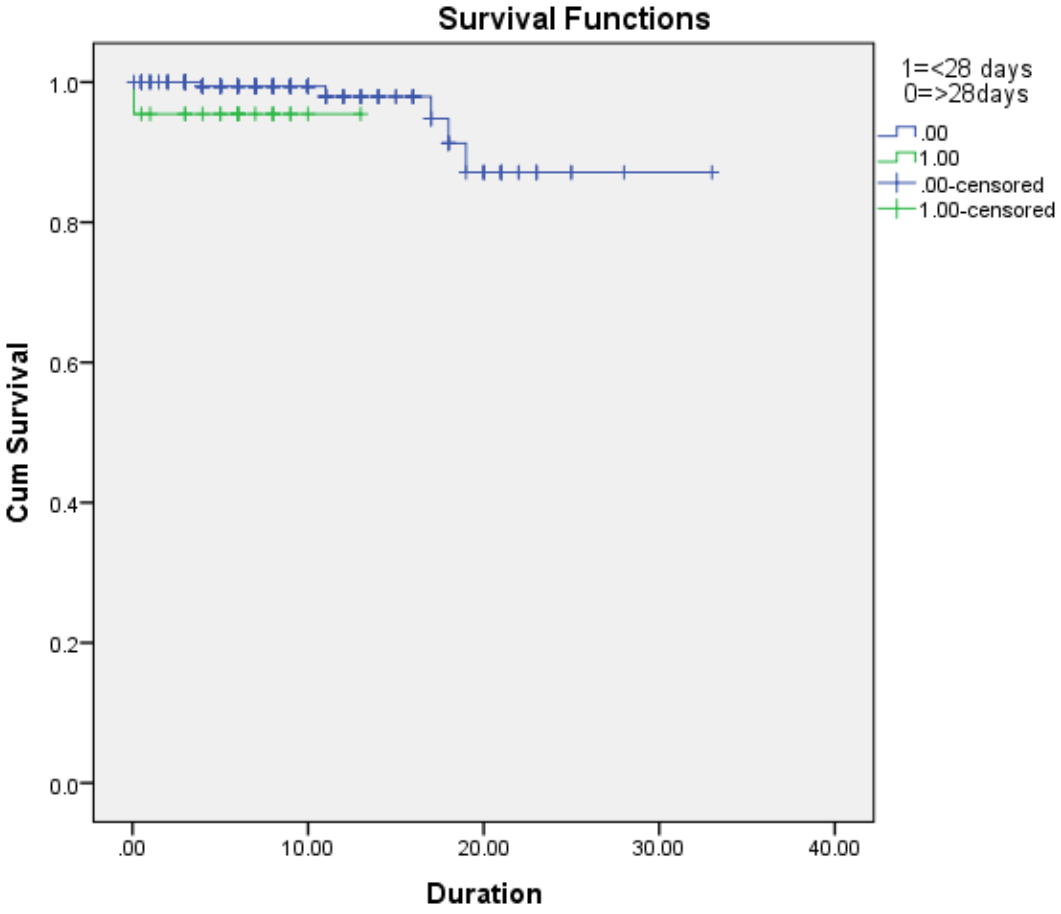

Fig 19: Kaplan Meier curve showing effect of age at implantation (<28 days vs >28 days) on survival (p=0.050)

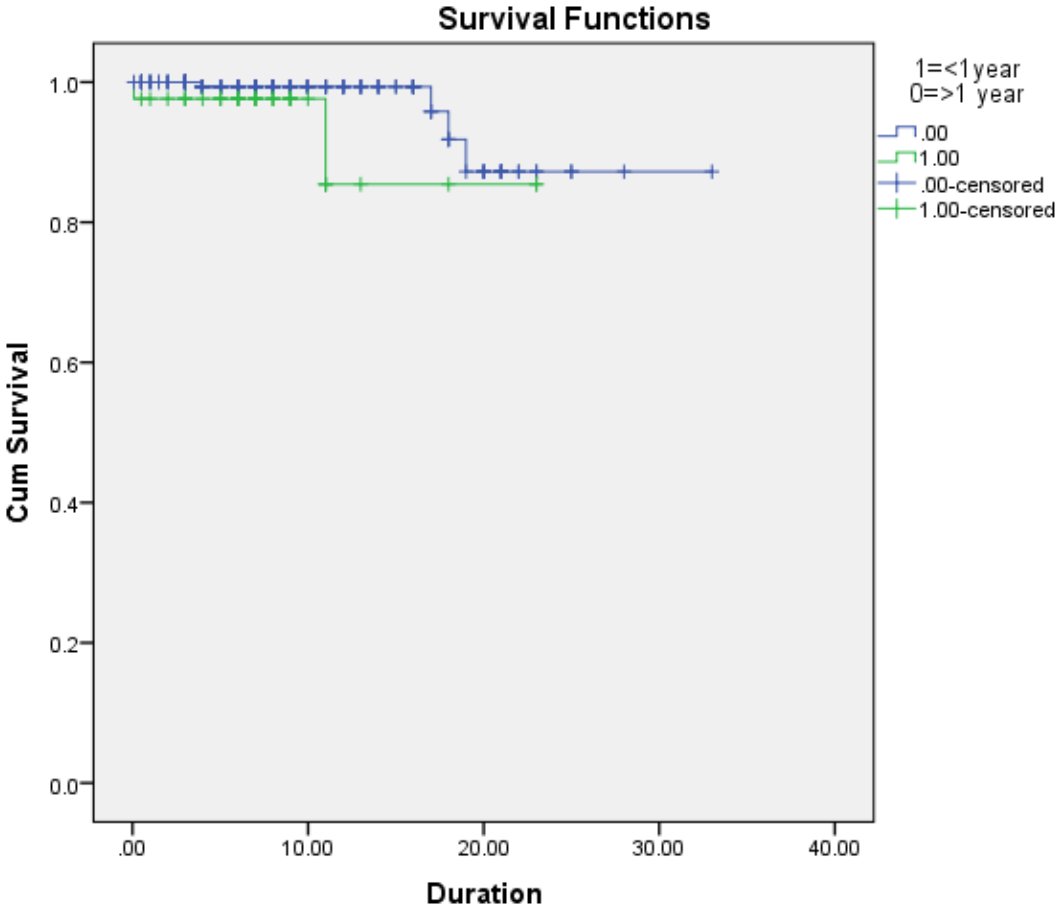

Fig 20: Kaplan Meier curve showing effect of age at implantation (<12 months vs >12 months) on survival (p=0.137)

5 DISCUSSION

Ours is one of the largest studies to report on the outcome of children below 18 years of age who underwent permanent pacemaker implantation (2162 patient years). Majority of the patients underwent PPI because of CCHB (50.2%), while post-operative CHB accounted for only 28%. This is in contrast to the previous studies where post-operative CHB has been the leading etiology.

Associated congenital heart disease was seen in 41.3% with ventricular septal defects being the commonest (20.6%), followed by atrial septal defect (18.6%). It was less than the data published by Wildbolz et al (84.6%) [20], Samir et al (78.1%) [12] and Aellig et al (77.3%) [11]. However it was higher in infants (65.4%) and neonates (50%) who underwent PPI.

Epicardial PPI was done only in 43.4% of the cohort, with this population being younger at the age of implantation with higher prevalence of CHD. Although they had numerically higher pacing requirements, lead thresholds and impedance on follow-up, the need for reintervention was quite low and comparable to the population with endocardial PPI. This exemplifies the utility of steroid using bipolar leads which was used predominantly in our cohort (84.3%). They had more frequent ventricular dysfunction, which was presumably due to younger age of implantation, higher pacing dependence and associated congenital heart disease. However, there was no corresponding increase in mortality.

Pacing lead dysfunction requiring replacement was seen in only 3.4% of the cohort with a median duration of 52 months from implantation. It was significantly less than

the data published by Konta et al (75%) [16], and similar between epicardial and endocardial leads, possibly due to the use of steroid eluting epicardial leads.

Need for PG replacement for battery depletion was seen in 23.8% of patients, at a median duration of 97 months post-implantation. This time interval was significantly shorter in infants (49 months) and neonates (47 months) probably due to higher pacing requirements and higher heart rates, although the proportion undergoing PG replacement were similar (23% and 31%) respectively).

Pacemaker site infections were seen in only 4.3% at a median duration of 2 months from date of implantation, which was significantly less than what reported by Eliasson et al (24%) [18] and Cohen et al (7.8%) [9], and comparable to the data from Silvetti et al (2%) [10].

Ventricular dysfunction was seen in 6.38% at a median follow-up of 83 months. Younger age at implantation, maternal ANA positivity, presence of post-operative CHB, associated congenital heart disease and epicardial PPI were the major predictors and associated mortality was 40%. This implies the significance of ventricular dysfunction in the long term outcome of these patients.

The overall mortality in our cohort was only 2.9% which is comparable to the data published by Eliasson et al [18] from Sweden (3%), and significantly less than the studies by Silvetti et al (5.1%) [10], Konta et al (10.8%) [16] and Wilhelm et al (11%) [13]. Major predictors in our cohort were age at implantation below 28 days, post-implantation ventricular dysfunction, associated congenital heart disease and maternal SLE. The mortality rates were higher among neonates (13.6%) and infants (7.3%), as compared to those implanted above 12 months of age (1.6%). It

Children with CCHB and maternal SLE have a mortality of 4-29%, which is highest in the initial 3 months (15%), which is predominantly due to diffuse myocardial fibrosis and resultant myocardial dysfunction [21][22]. In our cohort, we had 15 children with CCHB with maternal ANA positivity, with incidence of ventricular dysfunction being 20% and mortality being 13.3%.

Table 9: Comparison of our study with previously published series in literature

Author (Year)	**Country**	**Sample Size**	**Principle findings**
Benrey et al [7] (1976)	USA	24	54% post-operative CHB Mean age at implantation was 9.7 years, Mean follow-up duration of 5 years Pacemaker malfunction in 50%, lead dysfunction in 12.5% 25% mortality
Donahoo et al [8] (1976)	USA	13	84.6% post-operative CHB Mean age at implantation was 6.8 years Mean follow-up duration 5 years 15% mortality
Cohen et al [9] (2002)	USA	267	Mean age of implantation 8.4±6.2 years Median followup 29.4 months 7.8% had pacemaker site infections at a median of 16 days with major predictors being trisomy 21 and pacemaker revisions

Silvetti et al [10] (2007)	Italy	292	Mean age at implantation 8 years (56.5% endocardial, 43.5% epicardial) Mean duration of followup – 5 years Pacing threshold was lower with endocardial leads as compared to epicardial leads (0.5±0.3V vs 1.2±0.5V, $p<0.05$). Overall mortality – 5.1% Pacing upgradation to DDD in 6.5% patients Pacing site infection in 2%, LV dysfunction (3.7%) lead failure (21.5%)
Aellig et al [11] (2007)	Switzerland	22	Median age 35 days (1-300) 77.3% had CHD, 7 CCHB, 11 post operative Median follow-up 4.6 years – 7 PG change, 3 lead failure Stable lead thresholds and impedance Mortality – 18.2%
Samir et al [12] (2011)	Egypt	32	Mean age at implantation 5.7±3.8 years 78.1% had CHD Endocardial PPI in 65.6% VVI (87.5%), DDD (12.5%). Reintervention in 43.7%, suboptimal pacing parameters in 37.5%, Predictors - lower age, weight and body surface area

			No difference in battery or lead survival between epicardial or endocardial lead placement
Wilhelm at al [13] (2015)	USA	73	Mean age at implantation – 6.7 years Mean follow-up duration – 7.9 years. Mortality – 11% 95 pacemaker revisions Subclavian venous thrombosis in 11 cases
Silvetti et al [14] (2013)	Italy	287	Median age of implantation 5 years Median followup of 5 years 40.7% endocardial, 59.3% epicardial PPI failure was higher in epicardial leads, lower age at implantation and greater number of leads placed
Cho et al [15] (2015)	Korea	44	Mean age 101 days CCHB – 16, post op – 23 Mean follow-up 9.0±7.9 years – 11 PG change, 15 lead failure
Konta et al [16] (2016)	UK	37	Median age at implantation 6.7 months Median follow-up of 17.2 years Lead revision (75%), Subclavian vein thrombosis (35.7%) Mortality rate - 10.8%
Zhang et al [17] (2016)	China	35	Mean age at implantation 26.9 months Average follow-up 46.8 months Significant reduction of LVEF (65.6 ± 5.3 % vs.

			59.6 ± 7.6 %, p = 0.03) Re-intervention rate (11.4%), MACE (20%)
Eliasson et al [18] (2019)	Sweden	127	Median age at implantation 3.2 years Mean followup – 11 years Endocardial (57%), epicardial (43%) Epicardial in younger age group as compared to endocardial leads (1.6± 2.2 vs. 7.2± 5.6 years; P< 0.0001). 74% of children with VVI/VDD were upgraded to DDD, Reintervention rate higher in age at implantation <1 month and procedure before 2002 Lead dysfunction (12%), pacemaker site infection (24%) Mortality rate – 3%
Kwak et al [19] (2019)	Korea	48	Median age 66.5 days Mean follow-up 8.5±7.9 years – 11 PG change, 18 lead failure
Wildbolz et al [20] (2020)	Switzerland	52	Median age 90 days 84.6% had CHD, 12 CCHB, 34 post operative Median follow-up 40.4 months – 10 PG change, 3 lead dysfunction No mortality
Index Study	India	235	Mean age at implantation 7.4 years (43.4% epicardial)

			VVI (65.5%), DDD (30.2%) CCHB (50.2%), post-operative CHB (28.1%) CHD in 54.4% - ASD (20.4%), VSD (20.4%), PDA (18.3%) Mean followup duration – 9 years Average threshold and impedance higher in epicardial PPI 23.8% underwent PG change, 3.4% underwent lead change 4.3% had pacemaker site infection 5.5% had systemic ventricular dysfunction Overall mortality 2.9% (predictors – maternal SLE, SV dysfunction)

STRENGTHS OF OUR STUDY

It is a single centre study from a tertiary care centre with a dedicated pacemaker follow-up clinic, where all patients undergoing PPI are followed up comprehensively.

Sample size is large (n=235) as compared to the previous studies, with a relatively long duration of follow-up (2162 patient years)

LIMITATIONS

The number of permanent pacemaker implantations were less in 2020 owing to the COVID19 pandemic. Also the change in guidelines across the decade resulted in a paradigm shift in selection of patients for PPI.

6 SUMMARY AND CONCLUSIONS

- We followed up 235 patients (50.2% CCHB, 28.1% post-operative CHB, 11.5% sinus node dysfunction) for a median duration of 8 years (2162 patient years).
- Median age at implantation was 7 years, with 65.5% being VVI
- 43.4% underwent epicardial pacemaker implantation
- Congenital heart disease (CHD) was seen in 41.3% of patients, out of which ventricular septal defect was commonest (20.6%) followed by atrial septal defect (18.6%).
- 56 patients (23.8%) underwent PG change at median duration 97 months (72-126) for battery depletion, while 8 (3.4%) underwent lead change for lead dysfunction at median duration 52 months (IQR 5-97).
- Upgradation
- 15 patients (6.38%) had post implantation ventricular dysfunction at a median duration of 83 months, out of which 5 required hospitalisation for heart failure (2.1%). Major predictors were younger age at implantation, maternal ANA positivity, presence of post-operative CHB, associated congenital heart disease and epicardial PPI.
- During the entire follow-up period, 7 patients died with an overall mortality of 2.9%, with major predictors being age at implantation below 28 days, congenital heart disease, maternal ANA positivity and systemic ventricular dysfunction.

- Patients with epicardial PPI were younger, with higher prevalence of congenital heart disease and post-operative CHB. Percentage of ventricular pacing, pacing threshold and impedance were significantly higher along with higher incidence of post-implantation ventricular dysfunction. Mortality was similar to those with endocardial PPI.
- Patients with post-operative CHB had higher use of epicardial PPI, with higher pacing threshold and increased incidence of ventricular dysfunction with no difference in mortality.
- 10 patients (4.3%) had surgical site infection at median duration of 2 months (1.25-5.1)
- 22 children underwent PPI below 28 days of age, out of which 19 were CCHB, and half had congenital heart disease. Pacing induced ventricular systolic dysfunction was seen in 13.6% and overall mortality was 13.6%
- 55 children underwent PPI below 12 months of age, out of which 36 were CCHB and 19 were post-operative CHB. 65.4% had associated CHD, and overall mortality was 7.3%.
- 15 (12.7%)patients with congenital CHB had documented maternal ANA positivity, with median age of implantation being 1 month. Incidence of ventricular dysfunction was 20%, and mortality was 13.3%.

However, considering the median age at implantation being only 7 years, we need further follow-up to ascertain the further long term outcomes of these patients, and associated complications.

CONCLUSION

Outcome of permanent pacemaker implantation in children has a favourable outcome with acceptable rates of reinterventions. Risk of ventricular dysfunction and mortality was low, with major predictors being maternal ANA positivity, younger age of implantation and congenital heart disease.

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Academic Qualifications:

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Senior Residency	Dept of Pediatrics	PGIMER Chandigarh		Nov – Dec 2019	
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Housestaff—ship	Critical Care Unit	Medical College Kolkata		April 2016 – June 2016	
Bachelor Degree	MBBS	Medical College Kolkata	WBUHS	2010-2015	

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10th	ICSE	Calcutta Boys' School	CISCE	2007- 2008	96.4%

Additional Qualification / Achievements / Certifications:

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- ICSE School Topper with 96.4%
- Calcutta Boys' School Old Boys' Association Award for topping ICSE 2008
- Attended Vijyoshi Camp 2009 at Jawaharlal Nehru University, Delhi
- Calcutta Boys' School Merit award for scoring 95% in ISC 2010
- ***Gold Medal in Indian National Biology Olympiad*** 2010
- Selected for Orientation cum Selection Camp at HBCSE, Mumbai for International Biology Olympiad 2010
- ***Junior Class Assistant in Biochemistry***, Medical College 2011
- ***Certificate of Honours in Physiology***, Medical College 2011
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- ***Student of the Year*** in Microbiology & Pharmacology, Medical College 2012
- ***Gold Medal in ENT***, Dept of ENT, Medical College Kolkata 2013
- ***Awarded Indian Council of Medical Research STS Scholarship*** in 2013
- ***Dr. DB Chatterjee & Smt Sudha Rani Chatterjee Prize*** in Ophthalmology 2014
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- ***Dr. Manindra Nath Chatterjee and Rajlakshmi Devi Memorial Medal*** for ENT 2014

- ***Senior Class Assistant in Surgery***, Dept of Surgery, Medical College Kolkata 2014
- ***Gold Medal in Medicine,*** Dept of Medicine, Medical College Kolkata 2014
- ***Gold Medal in Surgery,*** Dept of Surgery, Medical College Kolkata 2014
- ***Gold Medal in Gynecology and Obstetrics,*** Dept of Gynecology and Obstetrics, Medical College Kolkata, 2014
- ***Dr. DP Basu Award 2016*** for Best Speaker in Junior Doctors' Symposium at Medical College Kolkata, organized by MCESA 2016
- ***3rd Prize in Poster Paper Presentation*** in PEDICON 2018, Nagpur
- ***Awarded Indian Council of Medical Research Thesis Grant 2017*** *for MD thesis*
- ***2nd Prize in Oral Paper Presentation*** in Annual Conference 2018, Indian Academy of Pediatrics, Chandigarh Branch, at Advanced Pediatrics Centre, PGIMER, Chandigarh
- ***Best Paper Award*** in *Cardiology Society of India Kerala (CSI Kerala) Annual National Conference 2020 (CSI Kerala 2020)*
- ***Winner of Pediatric Cardiology Society of India Research Grant 2020-21*** *for project titled "*Association and Impact of 22q11.2 deletion in Conotruncal Defects: A Prospective Observational Study"
- ***Special Appreciation Award*** in Indian College of Cardiology Kerala Chapter Virtual Annual Conference 2021
- ***Best Abstract in Electrophysiology Award*** in Pediatric Cardiac Society of India Annual Conference 2021
- ***Best Poster Award*** in Pediatric Cardiac Society of India Annual Conference 2021
- ***3rd Prize in E-Poster*** in Cardiology Society of India Annual Conference 2021
- ***Best case in Congenital Heart Disease category*** in Cardiology Society of India National Intervention Council Mid Term Meet, June 2022, Ahmedabad
- ***2nd Prize in Best Challenging Case Presentation*** in the field of Cardiology in Cardiology Society of India National Intervention Council Mid Term Meet, June 2022, Ahmedabad
- ***Member of American College of Physicians (2014-15)***

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- **Scholarships**
  - ***Kishore Vaigyanik Protsahan Yojana (KVPY) Scholarship*** **2008** awardee from Indian Institute of Science
  - ***Prof Anjali Chatterjee Scholarship*** **2010** for being most meritorious student passing out of Calcutta Boys' School who is admitted to any medical college in West Bengal
  - ***Indian Council of Medical Research (ICMR) STS Scholarship*** **2013** for "Changes in Retinal Nerve Fibre Layer thickness in patients suffering from Type II Diabetes Mellitus"
  - ***Indian Council of Medical Research (ICMR) MD Thesis Grant 2017*** for "A Randomized Control T*rial to assess the effect of early VS routine Iron Supplementation on iron store and growth in Term Small for Gestational Age and Appropriate for Gestational Age infants at 1 year"*
  - ***Pediatric Cardiology Society of India (PCSI) Research Grant 2020-21*** for "Association and Impact of 22q11.2 deletion in Conotruncal Defects: A Prospective Observational Study"

Papers Presented

UNDERGRADUATE

1. "Changes in Retinal Nerve Fibre Layer thickness in patients suffering from Type II Diabetes Mellitus" at ILLUMINATI 2014 at AFMC, Pune
2. "A Unique Case of Cysticercosis" at ILLUMINATI 2014 at AFMC, Pune

POSTGRADUATE

1. "Hemophagocytic Lymphohistiocytosis with Pulmonary Mucormycosis: A Rare Association" at PEDICON 2018, Nagpur
2. "Prolonged Unconjugated Hyperbilirubinemia in a newborn with Congenital Hypopituitarism" at PEDICON 2018, Nagpur
3. "Tear of Long Head of Biceps following Cardiopulmonary Resuscitation – A need for concern" at Annual Conference 2018 of Indian Academy of Pediatrics, Chandigarh Branch, at Advanced Pediatrics Centre, PGIMER, Chandigarh
4. "How well informed are our parents about Polio in today's communication rich environment?" at Annual Conference 2018 of Indian Academy of Pediatrics, Chandigarh Branch, at Advanced Pediatrics Centre, PGIMER, Chandigarh
5. "Right Internal Jugular Vein Phlebectasia: A Rare Cause of Neck Swelling" at PEDICON 2019, Mumbai
6. *"Clinical profile of severe dengue in children and its association with hemophagocytic lymphohistiocytosis: a case series"* at PEDICON 2019, Mumbai
7. *"Intraventricular hemorrhage and obstructive hydrocephalus in a term neonate: an uncommon presentation of Hemophilia B"* at PEDICON 2019, Mumbai
8. *"A toddler with bilateral non-tender parotidomegaly – a clue for underlying HIV infection and lymphocytic interstitial pneumonia"* at PEDICON 2019, Mumbai
9. *"Pertussis in early infancy: cases from a tertiary care centre in northern India"* at PEDICON 2019, Mumbai
10. *"Disseminated tuberculosis with tubercular otitis media in IL12βR deficiency: a rare presentation"* at PEDICON 2019, Mumbai

11. *"Tear of long head of biceps following cardiopulmonary resuscitation – a need for concern"* at PEDICON 2019, Mumbai
12. *"Scabies with acute postinfectious glomerulonephritis in a young boy"* at PEDICON 2019, Mumbai
13. *"Chylothorax in nephrotic syndrome: do not miss thrombosis"* at PEDICON 2019, Mumbai
14. *"Congenital hypoplasia of depressor anguli oris muscle (CHDAOM): an uncommon cause of asymmetric crying facies in childhood"* at PEDICON 2019, Mumbai
15. *"Hypertension with dilated cardiomyopathy: do not miss Takayasu Arteritis"* at PEDICON 2019, Mumbai
16. *"Chronic recurrent multifocal osteomyelitis: a case report"* at PEDICON 2019, Mumbai
17. *"Congenital nephrotic syndrome with acyanotic congenital heart disease: an uncommon association"* at PEDICON 2019, Mumbai
18. *"Diffuse lipomatosis of peritoneum, spinal epidural space and renal sinus: a rare complication of long term steroid therapy"* at PEDICON 2019, Mumbai
19. *"How well informed are our parents about polio in today's communication rich environment?"* at PEDICON 2019, Mumbai
20. *"How well informed are our pediatric trainees about polio when the world prepares for the End Game strategy?"* at PEDICON 2019, Mumbai

POSTDOCTORAL

1. *"Cardiac MRI in in Right Ventricular Outflow Tract (RVOT) Tachycardia: A Retrospective Analysis" at Indian Heart Rhythm Society Annual Conference 2020 (Virtual IHRS 2020)*
2. *"Long term outcome of patients with atrial standstill: a retrospective analysis" at Kerala Heart Rhythm Society (KHRS) Annual Conference 2020*
3. *"Cardiac MRI in in Right Ventricular Outflow Tract (RVOT) Tachycardia: A Retrospective Analysis" at Asia-Pacific Heart Rhythm Society Annual Conference 2020 (APHRS 2020)*

4. *"Short-term outcome of thoracic sympathetectomy in preschool children with Jervell and Lange-Nelsen Syndrome" at Asia-Pacific Heart Rhythm Society Annual Conference 2020 (APHRS 2020)*
5. *"Cardiac MRI in in Right Ventricular Outflow Tract (RVOT) Tachycardia: A Retrospective Analysis" at Cardiology Society of India Kerala Annual Conference 2020 (CSI Kerala 2020)*
6. *"Cardiac MRI in in Right Ventricular Outflow Tract (RVOT) Tachycardia: A Retrospective Analysis" at Cardiology Society of India Annual Conference 2020 (CSI 2020)*
7. *"Clinical outcome of Aortic Root Abscess from a Tertiary Care Center in South India" at Cardiology Society of India Annual National Conference 2020 (CSI 2020)*
8. *"Ventricular Septal Defect with Pulmonary Arterial Hypertension in an infant: is there something more than what meets the eye?" at Cardiology Society of India Annual National Conference 2020 (CSI 2020)*
9. *"Cardiac MRI in in Right Ventricular Outflow Tract (RVOT) Tachycardia: A Retrospective Analysis" at Taiwan Heart Rhythm Society Annual National Conference 2021 (THRS 2021)*
10. *"Outcome of Epicardial Permanent Pacemaker In Neonates: A Tertiary Care Experience from South India" at Indian College of Cardiology Kerala Chapter Annual Conference 2021*
11. *"An Octogenerian with Cyanosis and A Pacemaker" at Pediatric Cardiology Society of India Annual Conference 2021*
12. *"Isolated Mitral Regurgitation in an Adult: Is there an underlying pathology" at Pediatric Cardiology Society of India Annual Conference 2021*
13. *"Joint Laxity In a Young Boy: What Lies Underneath" at Pediatric Cardiology Society of India Annual Conference 2021*
14. *"Recurrent Pericardial Effusion in a Boy: A Clue to Underlying Pericardial and Pulmonary Lymphangiectesia" at Pediatric Cardiology Society of India Annual Conference 2021*
15. *"Outcome of Epicardial Permanent Pacemaker In Neonates: A Tertiary Care Experience from South India" at Pediatric Cardiology Society of India Annual Conference 2021*

16. *"Long term outcomes of portosystemic shunt closure in children" at Pediatric Cardiology Society of India Annual Conference 2021*
17. *"A Curious Case of Aortic Regurgitation in a Young Girl" at Pediatric Cardiology Society of India Annual Conference 2021*
18. *"Thoracic Sympathetectomy in Children with Jervell Lange-Nielsen Syndrome: Silver Lining among Grey Clouds" at Pediatric Cardiology Society of India Annual Conference 2021*
19. *"Outcome of Epicardial Permanent Pacemaker In Neonates: A Tertiary Care Experience from South India" at Asia Pacific Heart Rhythm Society Annual Conference 2021*
20. *"A Curious Case of Aortic Regurgitation" in ECHO INDIA 2021 (Annual Conference of Indian Academy of Echocardiography)*
21. "Inflammatory markers in COVID19 are they really specific?" at *Cardiology Society of India Annual Conference 2021 (CSI 2021)*
22. "Recurrent thrombosis in a lady: Is there a missed connection?" at *Cardiology Society of India Annual Conference 2021 (CSI 2021)*
23. "Outcome of permanent epicardial pacemaker implantation in neonates: A tertiary center experience from South India" at *Cardiology Society of India Annual Conference 2021 (CSI 2021)*
24. "Outcome of ventricular septal rupture from a tertiary care centre in South India" at *Cardiology Society of India Annual Conference 2021 (CSI 2021)*
25. "A Lady with Chest Pain: Is there a clue in the chest radiograph?" at *Cardiology Society of India Annual Conference 2021 (CSI 2021)*
26. *"A Curious Case of Aortic Regurgitation" at* Cardiology Society of India National Intervention Council Mid Term Meet, June 2022, Ahmedabad

Papers Published

1. **Bhattacharya D**, Endrakanti M, Kumar R. Right Internal Jugular Vein Phlebectasia: A Rare Cause of Neck Swelling. Case Rep Pediatr. 2017;2017:9278728.

2. ***Bhattacharya D**, Sharawat IK, Saini L. Intraventricular haemorrhage and obstructive hydrocephalus in a term neonate: an uncommon presentation of haemophilia B. BMJ Case Rep. 2018 May 30;2018. pii: bcr-2018-225341.*

3. **Bhattacharya D**, Angurana SK, Suthar R, Bharti B. Congenital hypoplasia of depressor anguli oris muscle (CHDAOM): an uncommon cause of asymmetric crying facies in childhood. BMJ Case Rep. 2018 Oct 23;2018. pii: bcr-2018-227240.

4. **Bhattacharya D**, Ghosh A. Neurocysticercosis: Do not miss the eye. BMJ Case Rep. 2018 Nov 3;2018. pii: bcr-2018-227869.

5. **Bhattacharya D**, Kumar R, Dayal D. Prolonged neonatal hyperbilirubinaemia in a case of congenital hypopituitarism. BMJ Case Rep. 2019 Feb 7;12(2). pii: bcr-2018-228793.

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8. **Bhattacharya D**, Anil Kumar BN, Panigrahi I, Kaur A. (2019). Congenital Cytomegalovirus Infection Masquerading as Antenatal Ventriculomegaly With Intraventricular Hemorrhage in a Term Neonate. *The Neurohospitalist*. https://doi.org/10.1177/1941874419846044

9. **Bhattacharya D**, Patra P, Pilania RK Jindal AK. Tear of long head of biceps following cardiopulmonary resuscitation: a rare complication. BMJ Case Rep. 2019 May 23;12(5). pii: e229218.

10. **Bhattacharya D**, Iyer R, Nallasamy K, Vaiphei K. Haemophagocytic lymphohistiocytosis with pulmonary mucormycosis: fatal association. BMJ Case Rep. 2019 May 30;12(5). pii: e230587.

11. Sharawat IK, **Bhattacharya D**, Saini L. Goldenhar Syndrome with Imperforate Anus: New Association or Coincidence! Indian J Pediatr. 2019 Jul 13.

12. **Bhattacharya D**, Kumar BN A, Panigrahi I, Kaur A. Hepatomegaly with neutropenia: a girl with glycogen storage disease Ib. BMJ Case Rep. 2019 Jul 18;12(7). pii: e230660.

13. Sharawat I, **Bhattacharya D**, Saini L, Singh P. Multiple cerebral sinus venous thrombosis and venous infarct: Rare complication of tuberculous meningitis in a child. BMJ Case Rep. 2019 Jul 22; 12(*7)*. pii:e231419.

14. Reddy C, **Bhattacharya D**, Madaan P, Saini L. Corpus callosum agenesis with interhemispheric cyst: a neuroimage to remember. BMJ Case Rep. 2019 Jul 25; 12(7). pii: e231375.

15. **Bhattacharya D**, Rathore V, Tiewsoha K, Dawman L. Episodic hematuria in a young boy - do not miss familial idiopathic hypercalciuria. Case Rep Open A Open J. 2019; I(1): 1-2

16. **Bhattacharya D**, Angurana SK, Nallasamy K, Iyer R, Jayashree M. Severe Dengue and Associated Hemophagocytic Lymphohistiocytosis in PICU. Indian J Pediatr. 2019 Jul 29. doi: 10.1007/s12098-019-03040-0.

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18. Rathore V, **Bhattacharya D,** Pandey J, Bhatia A, Dawman L, Tiewsoh KL. Chylothorax in a Child with Nephrotic Syndrome. Indian J Nephrol. 2020 Jan-Feb;30(1):32-34. doi: 10.4103/ijn.IJN_24_19. Epub 2019 Sep 17.

19. **Bhattacharya D**, Sharma YK, Muralidharan J, Mathew JL. Spontaneous pneumothorax in an infant: an unusual complication of pertussis. BMJ Case Rep. 2019 Sep 30;12(9). pii: e231878.

20. **Bhattacharya D**, Kumar R, Yadav J. Pituitary macroadenoma secondary to Hashimoto's thyroiditis: inadvertent diagnosis in a pre-pubertal girl [published online ahead of print, 2020 Feb 27]. *Trop Doct*. 2020;49475520907421.

21. **Bhattacharya D**. Overdosage of Calcarea phosphorica causes severe hypocalcaemia in a toddler. Trop Doct. 2020 Apr 1:49475520915126. doi: 10.1177/0049475520915126. [Epub ahead of print]

22. Angurana SK, Peruri G, Williams V, **Bhattacharya D**, Choudhary A**.** (2020) Amitraz poisoning – an uncommon pesticide poisoning in children. International Journal of Clinical Case Reports and Reviews**.** 2(1); DOI:10.31579/2690-4861/005

23. **Bhattacharya D**, Panigrahi I, Chaudhry C. Clinical profile of symptomatic congenital cytomegalovirus infection: cases from a tertiary hospital in north India [published online ahead of print, 2020 May 21]. *Trop Doct*. 2020;49475520923491.

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25. **Bhattacharya D**, Angurana S K, Suthar R, Sundaram V, Kumar P, Saini A, Saini L, Malik MA, Munda VS, Gautam V. Disseminated Staphylococcal Disease in Neonates Admitted to Pediatric Emergency of a Developing Economy: Clinicomicrobiological Profile, Management, and Outcome. J Postgrad Med Edu Res 2020; 54 (2):45-49.

26. Banday AZ, **Bhattacharya D**, Pandiarajan V, Singh S. Kawasaki disease in siblings in close temporal proximity to each other-what are the implications? [published online ahead of print, 2020 Aug 10]. *Clin Rheumatol*. 2020;1-7.

27. **Bhattacharya D**, Dash N, Kavitha TK, Sharma M, Gautam V, Verma S. Lurking Infantile Pertussis: Experience from a Tertiary Care Center in Northern India. J Pediatr Infec Dis. 2020

28. **Bhattacharya D**, Bhattacharya D. Sudden Onset Mutism in an Elderly Women. J Clinical Research and Reports, 5(2); DOI:10.31579/2690-1919/109

29. **Bhattacharya D**, Ghosh A, Biswas S. "Changes in Retinal Nerve Fibre Layer (RNFL) Thickness in Patients with Type II Diabetes Mellitus: An Observational Cross-Sectional Study from a Tertiary Care Centre in Eastern India. *Acta Scientific Clinical Case Reports* 1.8 (2020).

30. **Bhattacharya D**, Chattopadhyay M. Systemic Thromboembolisation as an Uncommon Manifestation of Dilated Cardiomyopathy in Sinus Rhythm. International Journal of Clinical Case Reports and Reviews. 2020. 2(4); DOI: 10.31579/2690-4861/025

31. **Bhattacharya D**, Ghosh A, Biswas S. Retinal Nerve Fibre Layer Thickness in HIV positive patients: A Cross Sectional Study from a Tertiary Care Centre In Eastern India. International Journal of Clinical Case Reports and Reviews. 3(4); DOI: 10.31579/2690-4861/048

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34. **Bhattacharya D**, Mohanan Nair KK, Namboodiri N, Prabhu MA, VK Ajit Kumar. Cardiac MRI in Right Ventricular Outflow Tract Arrhythmia: A retrospective analysis. Indian Heart Journal. 2020; 72(S1):S38.

35. **Bhattacharya D**, Sambaturu VK, Pillai VV, Kurup Harikrishnan, VK Ajit Kumar. Clinical outcome of aortic abscess from a tertiary care centre in South India. Indian Heart Journal. 2020; 72(S1):S44.

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44. **Bhattacharya D**, Kurup HKN, S Bijulal, VK Ajitkumar. Recurrent thrombosis in a lady: Is there a missed connection? Indian Heart Journal. December 2021. 73S1: S52

45. **Bhattacharya D**, Namboodiri N, Nair KKM, Dharan BS. Outcome of permanent epicardial pacemaker implantation in neonates: A tertiary center experience from South India. Indian Heart Journal. December 2021. 73S1: S51

46. **Bhattacharya D**, Sambaturu VS, Kurup HKN, VK Ajitkumar. Outcome of ventricular septal rupture from a tertiary care centre in South India. Indian Heart Journal. December 2021. 73S1: S52

47. **Bhattacharya D**, Sambaturu VS, Harikrishnan S, VK Ajitkumar. A Lady with Chest Pain: Is there a clue in the chest radiograph? Indian Heart Journal. December 2021. 73S1: S589-90

48. **Bhattacharya D**, Sasikumar D, Kurup H, Krishnamoorthy KM. Left ventricular noncompaction in primary systemic carnitine deficiency: A rare association. Ann Pediatr Card 2021:14(4):521-23.

49. **Bhattacharya D**, Sasikumar D, Gopalakrishnan A, Anoop A. *Ventricular Septal Defect with Pulmonary Arterial Hypertension in an infant: is there something more than what meets the eye?* Ann Pediatr Card. 2021:14(4):554-6.

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51. ***Bhattacharya D**, Sasikumar D, Kurup KH, Anoop A, Gaddamedi SK. Thrombosis of aneurysmal pulmonary arteries in patent ductus arteriosus with Eisenmenger syndrome. Ann Pediatr Card* 2022;15:97-9

CHAPTERS AUTHORED

1. **Bhattacharya D,** Verma S. Infections (Section 7). In: Jat KR, Bagri NK, Gupta AK, Meena JP (eds) Textbook of Child Health Nursing. Indian Journal of Pediatrics

2. Chopra, V.K., Harikrishnan, S., **Bhattacharya, D**. (2022). Heart Failure in Different Asian Populations. In: Ram, C.V.S., Teo, B.W.J., Wander, G.S. (eds) Hypertension and Cardiovascular Disease in Asia. Updates in Hypertension and Cardiovascular Protection. Springer, Cham.

3. **Bhattacharya D**, Harikrishnan S. Hemodynamics of Heart Failure and Appropriate Mechanical Circulatory Support Considerations. Cardiology Society of India 2022 Update. (under publication)

Achievements in Medical Quiz

UNDERGRADUATE

1. ***3rd in MediQuiz*** in Medical College Ex-Students' Association's 79th Reunion 2013 at Medical College, Kolkata
2. ***2nd in College round of IAP Pediatrics Quiz*** for Undergraduates 2013, Medical College Kolkata
3. ***1st in UG Rheumatology Quiz 2013*** organized by Indian Rheumatological Association WB Chapter at IPGMER
4. ***3rd in MediQuiz*** in Medical College Ex-Students' Association's 80th Reunion 2014 at Medical College, Kolkata
5. ***3rd in Litmus Clinical Quiz 2014*** at CNMC&H
6. ***1st in UG Rheumatology Quiz 2014*** organized by Indian Rheumatological Association WB Chapter at CNMC&H
7. ***1st in College round of IAP Pediatrics Quiz*** for Undergraduates 2014, Medical College, Kolkata
8. ***1st in Syndrome X (MediQuiz)*** at AGON 2014, Calcutta National Medical College
9. ***2nd in Intercollegiate MediQuiz at ILLUMINATI 2014***, Armed Forces Medical College, Pune
10. ***1st in InterCollege MediQuiz at RHAPSODY 2014***, Medical College Kolkata
11. ***1st in Public Health Quiz at ISOMOPH 2014***, organized by Indian Public Health Association, at NICED, Beleghata ID Hospital
12. ***2nd in MediQuiz 2015 at 81st Reunion, Medical College Kolkata*** *organized by MCESA 2015*
13. ***2nd in MediQuiz at AGON 2015,*** *at Calcutta National Medical College and Hospital*
14. ***1st in Anatomy Quiz 2016*** at **82nd Reunion organized by Medical College Ex-Students' Association** at Medical College Kolkata
15. ***1st in Surgery Quiz 2016*** at **82nd Reunion organized by Medical College Ex-Students' Association** at Medical College Kolkata
16. ***2nd in MediQuiz 2016*** at **82nd Reunion organized by Medical College Ex-Students' Association** at Medical College Kolkata

POSTGRADUATE

1. ***2nd in CritiQuiz 2018*** at ***3rd Pediatric Critical Care Symposium 2018,*** at Advanced Pediatrics Centre, PGIMER, Chandigarh
2. ***1st in College Round of ISHBT Haematocon Quiz 2018***, at PGIMER, Chandigarh
3. ***2nd in Zonal Round of ISHBT Haematocon Quiz 2018,*** at UCMS and GTBH, New Delhi
4. ***1st in College Round of IAP Pediatrics Quiz*** for Postgraduates 2018, PGIMER, Chandigarh
5. ***1st in Divisional Round of IAP Pediatrics Quiz*** for Postgraduates 2018, Government Medical College and Hospital, Chandigarh
6. ***1st in Zonal Round of IAP Pediatrics Quiz*** for Postgraduates 2018, Acharya Shri Chander College of Medical Sciences (ASCOMS), Jammu
7. ***1st in National Round of IAP Pediatrics Quiz*** for Postgraduates 2018, PEDICON, Mumbai
8. ***1st in Pediatric Gastroenterology, Hepatology and Nutrition (PGHN) Quiz 2019,*** PGIMER, Chandigarh

POSTDOCTORAL

1. ***2nd in Epignosis Cardiology Quiz 2020*** organized by The White Army
2. ***Finalist in CSI National Quiz 2021,*** CSI Annual Conference 2021, Hyderabad
3. ***Winner in Congenital Heart Disease Quiz Session 2022,*** conducted by Centre for Digital Health, Public Health Foundation of India
4. ***2nd in National Heart Failure Quiz 2022***, HFAI Annual Conference, 2022
5. ***Winner in Prodigy 2022 – The Echo Quiz,*** IAE Kerala Chapter Annual Conference, 2022
6. ***Winner in Infection Control Quiz*** organized by Department of Microbiology and Infection Control Unit, SCTIMST, May 2022
7. ***Winner in CSI Kerala Cardiology Quiz 2022***, CSI Kerala Summer Conference 2022, Thrissur
8. ***Winner in Cardiology Quiz, Cardiovascular Update 2022,*** organized by Department of Cardiology, Medical College Trivandrum

9. ***Winner in CSI NIC 2022 Quiz*** at Cardiology Society of India National Intervention Council Mid Term Meet, June 2022, Ahmedabad

CMEs/Workshops attended

- Researching 2011 organised by INFORMER
- ASKLEPIAN 2012 organised by Indian Medical Students' Association
- KARMIC 2012 organised by Indian Medical Students' Association
- ***IHTM Haematology Masterclass 2013*** organised by Institute of Haematology and Transfusion Medicine, Medical College Kolkata
- KARMIC 2013 organised by Indian Medical Students' Association
- ***IHTM Haematology Masterclass 2014*** organised by Institute of Haematology and Transfusion Medicine, Medical College Kolkata
- ***National CME 2014 on Tropical and Infectious Diseases*** organized by Society of Tropical Medicine and Infectious Diseases in India
- Workshop on Basic Radiography at Illuminati 2014, Armed Forces Medical College, Pune
- ***Illuminati 2014*** at Armed Forces Medical College, Pune
- Road to ISOMOPH 2014, organized by Indian Public Health Association at NICED, Beleghata ID Hospital
- Update in Cardiology 2014 at The Oberoi Grand, Kolkata organized by Cardiological Society of India – West Bengal branch
- CME on Basics of CPR at Medical College, Kolkata organized by The Medical College Ex-Students' Association 2014
- ***5th Kolkata Liver Meeting 2014 (EASL endorsed)*** at Swissotel, Kolkata organized by Liver Foundation, Bengal
- ***DHR – ICMR – PGI Workshop on Primary Immunodeficiency Diseases, September 2017,*** *PGIMER Chandigarh*
- ***19th National Conference of Pediatric Intensive Care and 2nd Asian Congress of Pediatric Intensive Care, November 2017,*** *Chandigarh*
- ***55th National Conference of Indian Academy of Pediatrics, PEDICON 2018, Nagpur***

- ***3rd Pediatric Critical Care Symposium, August 2018*** at Advanced Pediatrics Centre, PGIMER, Chandigarh
- ***29th Annual Conference of Delhi Society of Hematology, 2018*** at Leela Ambience Convention Hotel, New Delhi
- ***6th Kawasaki Disease Summit and 1st Annual Conference of Kawasaki Disease Society of India, November 2018,*** at Advanced Pediatrics Centre, PGIMER, Chandigarh
- ***3rd AOCM Masterclass in Pediatric Neurology for Postgraduates 2019***, at Metropolitan Hotel, New Delhi
- ***56th National Conference of Indian Academy of Pediatrics, PEDICON 2019,*** Mumbai
- ***National Conference & Workshop on Evidence Based Medicine (EBCON)2019,*** at Advanced Pediatrics Centre, PGIMER, Chandigarh
- ***National CME on Evidence Based Pediatric Pulmonary Diseases 2019,*** a Advanced Pediatrics Centre, PGIMER, Chandigarh
- ***Pediatric Gastroenterology, Hepatology & Nutrition Mini CME & 1st Saroj Mehta Memorial Oration in PGHN,*** at Advanced Pediatrics Centre, PGIMER, Chandigarh
- ***DHR – ICMR – PGI Workshop on Primary Immunodeficiency Diseases,*** August 2019***,*** *PGIMER Chandigarh*
- ***IAP Pediatric Cardiology CME***, September 2019, GMSH-16, Chandigarh
- ***Indian Heart Rhythm Society Annual Conference 2020*** (IHRS 2020)
- ***Asia-Pacific Heart Rhythm Society Annual Conference 2020*** (APHRS 2020)
- ***Cardiological Society of India Delhi Annual Conference 2020***
- ***Kerala Heart Rhythm Society Annual Conference 2020*** (KHRS 2020)
- ***Kerala Cardiological Society of India Annual Conference 2020*** (Kerala CSI 2020)
- ***Cardiological Society of India Annual Conference 2020*** (CSI 2020)
- ***Cardiological Society of India Delhi Annual Conference 2021***
- ***Taiwan Heart Rhythm Society Annual Conference 2021***
- ***American College of Cardiology Annual Conference 2021***
- ***Pediatric Cardiology Society of India Annual Conference 2021***
- ***Cardiology Society of India Annual Conference 2021***

- ***Indian Heart Rhythm Society Annual Conference 2021***
- ***Heart Failure Society Annual Conference 2022***
- ***Indian Academy of Echocardiography Kerala Chapter Annual Conference 2022***
- ***Cardiology Society of India Kerala Chapter Mid Term Meet 2022***
- ***Cardiology Society of India National Intervention Council Mid Term Meet, June 2022***

Other Awards

- Certified Swimmer, Bidhannagar Swimming Association, Salt Lake
- 6th Kyu Blue Belt in Karate, All India Seishinkai Shito Ryu Karate Do Federation
- Passed 4th year in Painting from Surabharati Sangeet Parishad
- Won various prizes in Essay Writing and Instrumental Music
- Winner of Mr. Rhapsody award at Rhapsody 2010, annual social of Medical College Students' union
- Winner of Freshers' Quiz 2016 at Advanced Pediatric Centre, PGIMER, Chandigarh
- Winner of Extempore, ZENITH 2019, PGIMER Chandigarh
- Winner of Photography Competition at ZENITH 2019, PGIMER, Chandigarh
- Winner of Mr. Zenith award, at ZENITH 2019, PGIMER, Chandigarh
- Participated in debates at state and national levels
- Reviewer at British Medical Journal, Journal of Tropical Pediatrics, Journal of Pediatric Hemato-Oncology

Former Associations

- Formerly associated with Helpage India
- Member of the Organizing Committee of Rhapsody 2012, annual social of Medical College Students' Union
- Won various quizzes at interschool and intercollege level
- Associated with Arogya User Driven Healthcare

- Participated in debates at state and national levels
- Formerly associated with SaltLake Theatre

Family Details:

Details	Name	Occupation
Father	Dr. Rudrendu Bhattacharya	Service
Mother	Mitra Bhattacharya	Housewife
Wife	Dr Koyel Chakraborty	Senior Resident (Ophthalmology) RIO Medical College Kolkata

Personal Details:

Date of Birth **: 3rd June, 1991**

Gender **: Male**

Marital status **: Married**

Languages Known **: English, Hindi and Bengali**

Nationality **: Indian**

Country of Residence **: India**

APPENDIX A: ETHICS COMMITTEE APPROVAL

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/1563 /OCTOBER-2020 30.11.2020

Dr. Deepanjan Bhattacharya
Senior Resident
Department of Cardiology
SCTIMST, Thiruvananthapuram

Dear Dr. Deepanjan Bhattacharya,

Thank you for submitting documents related to your proposal titled "**LONG TERM OUTCOME OF CARDIAC PACEMKER IMPLANTATION IN PADIATRIC POPULATION** (IEC/1563)" to the IEC for review.

The following documents were reviewed:

Original submission

1. *Covering letter addressed to Chairman, IEC dated 07.08.2020*
2. *TAC Approval with comments dated 15/07/2020*
3. *Application form for TAC endorsed by HOD*
4. *IEC Application dated14/05/2020*
5. *Study consent form in English*
6. *Study consent form in Malayalam*
7. *Patient information sheet in English*
8. *Assent form in English*
9. *Patient information sheet in Malayalam*
10. *Complete proposal*
11. *CV of PI signed including TCMC registration*
12. *CV of Co-PI Dr.Narayanan Namboothiri signed with TCMC registration*
13. *CV of CO-PI Dr.Krishna Kumar Mohanan Nair with TCMC Registration*
14. *CV of Co-PI Dr.Baiju Dharan with TCMC registration*
15. *Declaration sighed by PI and Co-PIs Proforma*

Revised submission on 23/11/2020

1. *Checklist*
2. *Covering letter to Chairman, IEC undated indicting revisions made*
3. *TAC Approval with comments dated 15/07/2020*
4. *Copy of covering letter addressed to Chairman, IEC dated 07.08.2020*
5. *TAC certification by Dean, dated12th May 2020*
6. *Covering letter addressed to Chairman TAC dated 08/07/2020*
7. *TAC application form*
8. *TAC certification from Dean 15/05/2020*
9. *IEC application form*
10. *Thesis protocol*
11. *Data collection proforma*
12. *Revised Participant information sheet in English*
13. *Revised Participant information sheet in Malayalam with title changed- minor revision*
14. *Consent form for parents of children aged below 7 in English*
15. *Consent form for parents of children aged below 7 in Malayalam*
16. *Assent form for children aged above 7 years of age in English*
17. *Assent form for children aged above 7 years of age in Malayalam*
18. *CV of PI signed including TCMC registration*
19. *CV of Co-PI Dr.Narayanan Namboothiri signed with TCMC registration*
20. *CV of CO-PI Dr.Krishna Kumar Mohanan Nair with TCMC Registration*
21. *CV of Co-PI Dr.Baiju Dharan with TCMC registration*
22. *Declaration form signed by all PIs and Co-PIs*

The following members of the Students Sub-Committee of the Institutional Ethics Committee participated in the discussions held between August 23-October 29, 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 – PUBLICATIONS

Papers published from thesis

Bhattacharya D, Namboodiri N, Nair KKM, Dharan BS. Outcome of permanent epicardial pacemaker implantation in neonates: A tertiary center experience from South India. Indian Heart Journal. December 2021. 73S1: S51

ABCSI21228

BALLOON MITRAL VALVULOPLASTY IN LOW FLOW LOW GRADIENT/ NORMAL FLOW LOW GRADIENT SEVERE MITRAL STENOSIS: IMMEDIATE AND SHORT TERM OUTCOMES

Manny Kumar Chaudhary, Jamal Yusuf, Saibal Mukhopadhyay. *G B Pant Hospital, New Delhi, India*

Background: Effect of Balloon Mitral Valvuloplasty (BMV) in low gradient severe mitral stenosis (MS) patients is incompletely understood. To study the immediate (72 hrs) and short term (3 months) outcomes of BMV in low gradient severe MS patients.
Methods and Results: Severe MS is defined as mitral valve area < 1.5cm^2. Low gradient was defined as mean transmitral gradient (MG) less than 10mm Hg and low flow as stroke volume index (SVI) less than 35ml/ m^2 on echocardiography. Forty patients were included in the study and based on flow pattern they were divided into normal flow (NF)/low gradient (LG) (30 patients) or low flow (LF)/low gradient (LG) (10 patients) group. BMV was done in all patients and post BMV parameters were recorded at 72 hrs and at the end of 3 months. Mean age was 36.2 yrs in NF/LG group and it was 40.6 yrs in LF/LG group (p value < 0.01), and females were 80% (n=24) in NF/LG group as compared to 60% (n=6) in LF/LG group (p value =<0.01). Patients in the LF/LG group had more percentage of atrial fibrillation (n =4, 40%) as compared to NF/LG group (n=6, 20%), p value <0.01. Symptomatic improvement following BMV correlates better with decrease in mean gradient (ΔMG) and was better seen in NF/LG group (ΔMG < 3.5 in NL/LG group vs 1.6 in LF/LG group), whereas increase in MVA was similar in both the group (NF/LG group 1.7 cm^2 vs 1.62cm^2 in LF/LG group).At the end of 3 months, patients did not have any significant change in clinical or echo-cardiographic parameter.
Conclusion: Symptomatic improvement following BMV was better seen in NF/LG group because of decrease in mean gradient rather than increase in mitral valve area. Results of BMV was suboptimal in LF/LG group because of higher subvalvular obstruction and increased prevalence of atrial fibrillation.

ABCSI21229

OUTCOME OF EPICARDIAL PERMANENT PACEMAKER IN NEONATES: A TERTIARY CARE EXPERIENCE FROM SOUTH INDIA

Deepanjan Bhattacharya, Krishnakumar Mohanan Nair, Narayanan Namboodiri, Baiju S. Dharan. *Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, India*

Background: Permanent pacemaker implantation (PPI) in the neonatal age group is one of the challenging practices in both electrophysiology and paediatric cardiac surgery. There is lack of data of outcome of this subset of patients, especially from the Indian subcontinent.
Methods and Results: We prospectively followed up 22 children who underwent epicardial PPI in the newborn period (<30 days), in our institute from 2009 to June 2021. Clinical data at baseline and at follow-up were assessed including need for reinterventions, pacing parameters and major adverse cardiovascular events (MACE). Median age of implantation was 2.9 (IQR 1 – 9.5) days and median weight at implantation was 3.0 kg. 19 underwent single chamber (VVI) pacemaker, while 3 underwent dual chamber (DDD) pacemaker. Leads were placed on the right ventricle +/- right atrium by epicardial approach. Only 10% were preterm, and 75% had congenital heart disease, out of which PDA (66.7%) was the commonest, followed by ASD (46.7%) and VSD (26.7%). 17 had congenital complete heart block, out of which 36% had history of maternal SLE. 3 developed complete heart block post-operatively. Median duration of follow-up was 50months. 7 underwent PG change, which was performed at a median age of 46 months. 2 children developed pacing induced LV dysfunction leading to hospitalisation for heart failure at a mean age of 30 months. Cardioembolic stroke was seen in 1 child with LV dysfunction. Average percentage of ventricular pacing was 87.5±24.9%, mean threshold was 1.4±0.7 V and mean impedance was 604.4±98.0 ohms, which remained relatively stable throughout follow-up. There were 3 deaths in the peri-operative period due to myocardial dysfunction, and 4 children had surgical site ±infection which were managed conservatively. 1 child underwent endocardial pacemaker implantation for elevated lead threshold at 88 months, while another had CRT upgradation at 52 months of age. There was no significant difference between the outcome of those who underwent PPI for congenital complete heart block and post-operative complete heart block. There was no significant effect of maternal SLE on the survival, heart failure, percentage of pacing requirement or duration of freedom from pulse generator replacement.
Conclusion: This is one of the largest cohorts of neonatal PPI with a long follow-up duration. Overall outcomes are favourable with very low mortality and MACE. However, pulse generator replacement is required more frequently as compared to adults due to higher pacing requirements.

ABCSI21231

INCREMENTAL VALUE OF LONGITUDINAL STRAIN ANALYSIS DURING FOLLOW-UP FOR DETECTING SUBCLINICAL LV DYSFUNCTION IN PATIENTS OPERATED FOR TETRALOGY OF FALLOT

Prayaag Kini, Reeta Varyani, B. Barooah. *Sri Sathya Sai Institute of Higher Medical Sciences, Bangalore, India*

Background: Pulmonary regurgitation following repair of tetralogy of Fallot is a common postoperative sequela associated with progressive right ventricular enlargement, RV dysfunction, progressive exercise intolerance, right heart failure, tachyarrhythmia, and late sudden death identifying the appropriate timing of such intervention can be challenging. Deterioration in RV function is known but decrease in LV function however has NOT been the subject of most earlier studies The aim of the study was to assess the longer-term impact of pulmonary regurgitation (PR) in otherwise asymptomatic patients having undergone surgical repair of TOF at least 5 years or earlier.
Methods and Results: The study subjects were 50 adolescent asymptomatic operated TOF patients between 2012 and 2018, and 46 matched-cohort of healthy controls. 2-D and 2D strain analysis by AFI were performed in all subjects using Vivid E9 machine by three experienced sonographers. LV-GLS and RV- GLS were assessed by automated functional imaging. Color TDI tracings were obtained The peak longitudinal early diastolic (e′) velocity was measured and the average was calculated from the lateral and septal velocities and used to obtain the E/e′. AoV opening and closing were assessed by placing a 2–4 cm straight M-mode line through the septal half of the mitral leaflet in the color TDI 4-chamber view, and measured directly from the color diagram. RV FAC, RVEF, RVEDVI, RV/LV EDVI ratio and PRF were calculated from CMR analysis ("gold standard" for the study).PR fraction (PRF) was calculated by the volumetric method. Although traditionally measured RVEF and LVEF, as well as TDI values were not reported lower on standard 2D echo reporting between the two groups, LV- GLS (−15.1± 2.7%) was reduced significantly in the operated-TOF group (−22.5±.9%, p=0.008) particularly in the anterior and antero-lateral wall (-13.8+/- 3.2%). RV- FAC and RV-GLS were also significantly lower compared to healthy controls- mean RV GLS was significantly abnormal (-14.3±3.6%) compared to controls (-22.9±4.3%; p<.001). By ROC analysis, RV GLS cutoff value of -15% had 79% sensitivity and 82% specificity in identifying RVEF<45% (AUC:0.85, p<.001). By ROC analysis, RV GLS cutoff value of -15% had 79% sensitivity and 82% specificity in identifying RVEF< 45% (AUC: 0.85, p< 001). Intra- and inter-observer reproducibility of GLS for both RV and LV were within acceptable limits. On multivariate linear regression, reduction of free wall LV-GLS correlated well with both RVEDVI and RV–GLS (Pearsons r:0.76).A subanalysis also showed wider QRS, worse RV indices and lower RV- GLS and higher PRF(all p< 0.001) in patients undergoing transannular patch(TAP) repair versus no TAP
Conclusion: LV global and regional 2D strain,as well as RVGLS are significantly reduced in patients operated for TOF in the past (despite preserved RVEF and LVEF on 2DE) underscores the incremental use of Strain analysis on f/u.

APPENDIX C – PLAGIARISM CHECK REPORT

RE-2022-42799-plag-report

ORIGINALITY REPORT

9%	5%	7%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.science.gov Internet Source	2%
2	"7th World Congress of Pediatric Cardiology & Cardiac Surgery Abstracts", Cardiology in the Young, 2017 Publication	1%
3	" Abstracts and Posters of the 3 World Congress of Pediatric Cardiology & Cardiac Surgery: Toronto, Ontario, Canada, 27–31 May, 2001 ", Cardiology in the Young, 2009 Publication	1%
4	www.indianpediatrics.net Internet Source	1%
5	www.ncbi.nlm.nih.gov Internet Source	1%
6	Deepanjan Bhattacharya, Krishnakumar Mohanan Nair, Narayanan Namboodiri, Baiju S. Dharan. "Outcome of epicardial permanent pacemaker in neonates: A tertiary care	<1%