Section: CTVS

Original Research Article

RESULTS OF VSD CLOSURE IN PEDIATRIC POPULATION – A SINGLE TERTIARY CARE CENTER EXPERIENCE

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ABSTRACT

Background: Ventricular septal defect (VSD) is the most common congenital heart defect in children, therefore, VSD closure is the most commonly performed surgical procedure in congenital heart disease patients. The aim of this study was to find out the outcome, morbidity, and mortality data following surgical closure of isolated VSD in the pediatric age group at single tertiary care hospital.

Materials and Methods: This is a retrospective study which included patients aged from 3 months to 18 years operated between August 2017 and August 2025 at Sawai Man Singh Hospital (SMS), Jaipur, Rajasthan, India. A total number of 157 patients were included in this study.

Results: out of 157 patients, male outnumbered the female gender with slight margin (male – 81, female – 76). Most common age at surgery was 1 to 5 years. Weight at the time of surgery was ranging from 5 to 10 kg.

Most common type of VSD is perimembranous type. No patient required re-exploration for residual VSD and permanent pacemaker. None of the patients had sternal wound dehiscence. Patients were extubated within 3 – 6 hours after surgery with ICU stay was between 3-5 days. Mortality was seen in 2 patients (1.27%). Hospital stay after surgery was 5 to 6 days. No residual VSD was found at 1 year follow up.

Conclusion: surgical closure of isolated VSD remains a very safe procedure with low morbidity and mortality. A dedicated team approach with good surgical technique, good perfusion management, and effective postoperative care culminates into better results in pediatric population.

Keywords: Ventricular Septal Defect, Congenital, Pacemaker, Perimembranous, ICU.

INTRODUCTION

Most common acyanotic congenital anomaly after bicuspid valve is Ventricular Septal Defect VSD.[1,2] VSD closure is the most commonly performed surgery in congenital heart disease patients. Although device closure is now gaining popularity, still majority of the large VSDs require surgical management. In the early era of VSD closure when cardiac surgery was evoluting, mortality, arrhythmia, and complete heart block were very high but with the better understanding of surgical anatomy, improvement in surgical and perfusion technique and postoperative care these adverse effects decreased drastically.[3] Right ventricular approach was associated with more incidences of arrhythmia but with trans-atrial approach this complication has reduced to insignificant level.

Classification of VSD

According to Size

Size of VSD is defined according to size of aortic annulus and categorized into three types –

- Large VSD - if dimension of VSD is more than 75% of aortic annulus diameter.
- Moderate size VSD – if diameter of VSD is more than 25% but less than 75% of aortic annulus diameter

- Small VSD – if dimension of VSD is less than 25% of the diameter of the aortic annulus.

According to Type

Type of VSD is defined by its position in interventricular septum and divided into following types –

- Perimembranous – defects that involve the membranous septum and may extend into one of the three muscular component of the interventricular septum, i.e. inlet, outlet or trabecular septum. They account for 80% of all VSDs.
- Inlet - defects in inlet septum of interventricular septum are known as inlet VSD and they account for 8% of all VSDs.
- Outlet – defects located in infundibular septum are labelled as outlet VSD. They constitute 6% of all VSDs but in Asian population their frequency is nearly 30%.
- Muscular – defect located in trabecular muscular septum. They account for 6% of all VSDs but in infants/Neonates they account for 20%. Frequency is decreased due to spontaneous closure.

The morbidity and mortality for isolated VSD surgical closure in pediatric population has decreased significantly in last few years worldwide.

Aim of Study

The Sawai Man Singh Hospital (SMS), Jaipur is now continuously operating VSD in pediatric age group for recent past years with good results and is newly emerging center for congenital heart surgery in western India.

Weight was taken as important criteria for VSD closure at our institution and more than 10 kg was used to be requested before surgery but for last 8 years weight criteria is no more contraindication for surgery, but age should be more than 6 months.

We carried out a retrospective study to define type and size of VSD along with mortality and morbidity of surgical closure of VSD at our center between August 2017 and August 2025.

MATERIALS AND METHODS

All patients who underwent surgical closure of simple VSD between August 2017 to August 2025 at SMS Hospital, Jaipur, Rajasthan, India were retrospectively reviewed. By definition, simple VSD is an isolated VSD or VSD associated with PFO (Patent Foramen Ovale), ASD (Atrial Septal Defect), PDA (Patent Ductus Arteriosus), SAM (Subaortic Membrane), or mild AR (Aortic Regurgitation). Patients with complex cardiac anomalies like AVSD Atrioventricular Septal defect), TOF (Tetralogy of Fallot), COA (Coarctation of Aorta), TGA (Transposition of Great Arteries), TRUNCUS ARTERIOSUS, severe aortic stenosis, pulmonary atresia etc. were excluded.

Medical records consisting of history, physical examination, chest x ray, ECG, 2D echocardiography, intraoperative notes, perfusion notes, ICU and ward postoperative data of all patients were thoroughly studied and all required data were collected.

A total of 157 patients were included in this study. Patients were followed up to 1 year after surgery and outcome was assessed.

Data Consisted Of

Pre-operative - Age at surgery, weight at surgery, gender ratio, echocardiographic and intraoperative findings regarding type and size of VSD, associated defects, PA pressure (Pulmonary Artery Pressure).

Past-operative - Total stay in ICU after surgery, rhythm disturbances, bleeding, heart block, requirement of temporary and permanent pacing, residual VSD, postoperative ventilation, sternal wound infection and dehiscence, chylothorax, seizure, neurological deficit, renal failure, status of diaphragm, and total stay in hospital after surgery.

Surgical Technique

The technique described here was used in all patients with no deviations. Experience of single surgeon was included in this study.

The median sternotomy approach was used in all patients. Patient was taken on cardiopulmonary bypass with aortic and selective bicaval cannulation after ACT (Activated Clotting Time) crosses 480 seconds. After cross clamping the aorta antegrade root Del Nido cardioplegia was given and patient was cooled to 30 degree Celsius with hematocrit maintained at 30%. CUF (Conventional Ultrafiltration) was used during bypass and MUF (Modified Ultrafiltration) was done after coming off bypass in patients less than 10 kg weight. PDA was ligated in all patients. Right atrium was opened after snaring SVC and IVC (Superior and Inferior Vena Cava). Main pulmonary artery was opened along with right atrium in outlet VSD. Left ventricle was vented through existing PFO or ASD or created PFO. VSD was closed with sauvage patch with prolene suture in continuous manner. Additional small muscular VSDs were closed with interrupted pledgeted proline suture whenever required. SAM was excised when it was present. PFO was closed with direct repair with continuous prolene suture and ASD was close with untreated pericardial patch with prolene suture in continuous fashion. Right atrium was closed in single layer with continuous prolene suture after checking for tricuspid regurgitation with saline insufflation test.

Aortic cross clamp was removed after proper de-airing of heart. All patients came of bypass in sinus rhythm with minimal inotropes except 3 patients which require temporary pacing for first degree heart block in one patient and 2:1 block in 2 patients. Sinus rhythm was achieved within 48 hours after surgery. Patients were shifted to ICU with stable hemodynamics.

Postoperative 2D echocardiography was done at the time of discharge from hospital, at 6 month and 1 year follow up.

RESULTS

Out of 157 patients Most common age of surgery was between 1 to 5 years (Table 1) There was slight male preponderance (Table 2) with 81 were male (51.6%) and 76 female (48.4%).

Majority of the patient's weight at the time of surgery was between 5 to 10 kg. [Table 3]

Most common type of VSD at our region is perimembranous (86.6%) followed by outlet VSD (9.6%), upper muscular and inlet VSD (1.9% each) (Table 4). In 9 patients (5.8%) 2-3 additional muscular VSDs were present.

Majority of the operated patients had large VSD (n = 102, 65.4%) while moderate VSD constituted 21.7% (n= 34) and small VSD was only 13.5% (n = 21). [Table 5]

52% of large VSD were associated with severe pulmonary arterial hypertension while 12.7% of large VSD showed moderate rise in pulmonary artery pressure. [Table 6]

96.8% (n=152) were extubated within 3 to 4 hours after surgery and only 5 patients (3.2%) had longer extubation time of 7 to 8 hours because of slight delay in gaining consciousness and muscle power.[Table 7]

96 patients (61.1%) were shifted out of ICU on 3rd postoperative day and 52 patients (33.1%) on 4th day. 9 patients (5.7%) required 5 to 6 days in ICU because of increased drain output (n=4), collapsed lung (n=2), and fever (n=3). [Table 8].

Only 3 patients required temporary pacing (1.9%) for first degree heart block in one patient and 2: 1 heart block in 2 patients. All these patients regained sinus rhythm within 48 hours of surgery. None of the patients required permanent pacemaker insertion. [Table 9]

A total of 11 patients (7%) had residual VSD which are less than 3 mm and none required surgical re-exploration for altered hemodynamics. During follow-up it was found that all these VSDs were closed by itself. [Table 9].

No patient was re-explored for bleeding and none had sternal wound infection or sternal dehiscence. Although some patients developed hypertrophic scar and keloid which were treated with intradermal triamcinolone injection and responded well.

Prolonged hospital stays of more than 7 days was seen in 9 patients (5.7%) while 65.6% (n=103) were discharged on 5th day after surgery and 28.6% (n=45) patients on 6th day of surgery. [Table 10]

Mortality was seen in 2 patients (1.3%), one patient had excessive endotracheal bleeding for unknown reason, and one had undiagnosed pneumothorax after chest tube removal. [Table 9]

Table 1: Age of Patients

S.No.	Age (years)	Number	Percentage (%)
1	0.5 – 1	21	13.46
2	1 – 5	73	46.15
3	5 – 10	33	26.15
4	10 – 15	27	17.3
5	15 – 20	3	1.92
Total		157	100

Table 2: Sex Ratio of Patients

S.No.	Gender	Number	Percentage (%)
1	Male	81	51.6
2	Female	76	48.4
Total		157	100

Table 3: Weight at the time of Surgery

S.No.	Weight (KG)	Number	Percentage (%)
1	3 -5	5	3.18
2	5 – 10	91	57.96
3	10 – 15	18	11.46
4	15 – 20	11	7
5	20 – 30	24	15.28
6	>30	8	5.09
Total		157	100

Table 4: Type of VSD

S.No.	Type of VSD	Number	Percentage (%)
1	Perimembranous	136	86.61
2	Outlet	15	9.55
3	Inlet	3	1.91
4	Muscular	3	1.91
Total		157	100

Table 5: Size of VSD

S.No.	Size of VSD	Number	Percentage (%)
1	Large	102	65.38
2	Moderate	34	21.65

3	Small	21	13.46
Total		157	100

Table 6: Pulmonary artery hypertension

S.No.	Pulmonary artery hypertension	Size of VSD	Number	Percentage (%)
1	Severe	Large	82	52.22
2	Moderate	Large	20	12.7
3	Moderate	Moderate	31	19.7
4	Mild	Small	24	15.38
Total			157	100

Table 7: Extubation time

S.No.	Time of extubation (hours)	Number	Percentage (%)
1	3 – 5	152	96.8
2	5 – 7	2	1.27
3	7 – 9	3	1.91
Total		157	100

Table 8: Length of ICU stay

S.No.	Days in ICU	Number	Percentage (%)
1	2	96	61.14
2	3	52	33.12
3	5	9	5.73
Total		157	100

Table 9: Postoperative complications

S.No.	Complication	Number	Percentage (%)
1	Reintubation	0	0
2	Re exploration for bleeding	0	0
3	Residual VSD	11	7
4	Re exploration for significant residual VSD	0	0
5	Transient heart block	3	1.91
6	Permanent pacemaker	0	0
7	Sternal wound infection	0	0
8	Sternal dehiscence	0	0
9	Chylothorax	0	0
10	Diaphragmatic paralysis	0	0
11	Renal failure	0	0
12	Neurological deficit	0	0
13	Mortality	2	1.27

Table 10: Length of hospital stay after surgery

S.No.	Days in Hospital	Number	Percentage (%)
1	5	103	65.60
2	6	45	28.66
3	8	7	4.45
4	10	2	1.27
Total		157	100

DISCUSSION

To do cardiac surgery in pediatric population with limited resources is a very challenging job. This study evaluated the results of isolated VSD closure in a center which has just stepped into the pediatric cardiac surgery area.

VSD shows no gender predilection, but still variable results are seen with some studies showing slightly female predominance,[4,5] and some studies showing male preponderance.[6] In this study male gender was slightly more affected than female ones.

Cresti A et al and Pugnaloni F et al suggested that females are more likely to present with milder form of the condition.,[7,8] but such association was not found in this study.

A unified classification system has been introduced to simplify VSD description and eliminate confusion from multiple synonyms.[9,10,11]

This system organizes VSD into 4 significant group –

- Perimembranous VSD - 80% of all VSDs
- Outlet VSD - 6% of all VSDs but occurs in 30% of Asian population
- Inlet VSD - 8% of all VSDs
- Muscular VSD -6% of all VSD but 20% of all VSDs in infants.

In studies done by Hoffman et al, Pinto et al, and Kussman et al showed that perimembranous VSDs remained the most common type followed by muscular, inlet, and outlet type.[9,10,11,12] In our study the perimembranous type also emerged as most common type while the inlet VSD was least common.

Some studies showed that inlet VSD was second most common variety after perimembranous type.[13,14]

In this study, majority of the patients who were operated had large VSD which shows that usually small VSDs of muscular and perimembranous type close spontaneously or patients did not become symptomatic and do not reach to the hospital or closed by device.

Complication rate was minimal therefore majority of patients were extubated early and discharged from hospital early. Anderson et al showed complete heart block requiring permanent pacemaker in 2.1% cases,[15] while study by Morales et al and Jacob JP et al showed that permanent pacemaker was required in 0.9 % cases.[16,12] In this study no patient required permanent pacemaker and similar results were also shown by Sally BB et al.[17]

At our center, mortality rate was 1.27% which was comparable to as shown by Anderson BR et al (1.8%), although mortality rate has reduced to 0.5% in the current era.[17]

With careful attention on margins of VSD and closing it properly with good bite leaving no dog ears ensures significant decrease in residual VSDs as seen in this study and also by Sally et al.[17]

On follow up at 1 year, no patient had greater than mild tricuspid regurgitation, results similar to shown by Scott et al.[18]

CONCLUSION

Simple VSD closure by surgery is very safe method with excellent results and complications can be avoided with meticulous surgical technique, a dedicated team approach for intraoperative management and postoperative care.

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