



Surgical closure of VSD in infants: Results in our centre over 4 years

Authors

**Dr Mohd Javed Banday, Dr Dhananjay Bansal, Dr Rahul Bhushan,
Dr Narender Singh Jhajhria*, Dr Vijay Grover, Dr Vijay Gupta**

PGIMER, Dr R.M.L. hospital, New Delhi, New Delhi, Pin Code: 110001

Email: javedbanday82@gmail.com

*Corresponding Author

Dr Narender Singh Jhajhria

Prof Dept of CTVS, Dr RML Hospital, New Delhi, India

Telephone: 01123404562, Fax: 0112374788, Email: drnsjhajhria@yahoo.com

Abstract

Ventricular septal defect (VSD) is the most commonly diagnosed congenital heart defect presenting with failure to thrive. Surgical closure of the defect is the treatment of choice for these patients and should be done preferably in infancy. We present our experience of 84 patients of isolated VSD below one year of age treated in our hospital over period of four years. The median age of patient was 8 months (range 2 months to 11.5 months) and a median weight of 5 kg (range 2.5 kg to 9 kg). The following VSD types were found: 74 perimembranous (88%), 2 supracristal (2.3%), 3 inlet (3.5%) and 5 muscular (5.9%). Most common indication was recurrent pneumonias and failure to thrive. Pulmonary artery hypertension was present in 55 patients (65%) out of 84.

None of our patient was re-operated for residual VSD. Median extubation time was 12 hours (range 6 hours to 30 hours), median ICU stay was 3 days (range 2 to 15 days) and median hospital length of stay was 5 days (range 4 to 26 days). There were 2 early mortalities (2.3%) and 1 late death (1.15%) in our series. 1 patient developed complete heart block requiring permanent pacemaker implant. 50 patients were discharged on medication for pulmonary hypertension. Pulmonary hypertension regressed over median time of 2 months. On median follow up of 2 years, 80 patients (95%) were asymptomatic. No patient had new onset aortic or tricuspid regurgitation greater than trivial postoperatively.

We concluded early surgical closure of VSD in infancy is treatment of choice for patients with VSD with low mortality and extremely low incidence of adverse events.

Introduction

Ventricular septal defect (VSD) is the most commonly diagnosed congenital heart defect, occurring in approximately 2 of 1,000 live births, and one of the most common congenital cardiac lesion requiring surgical intervention¹. Surgical closure of VSD was first performed in 1955 by

Lillehei and associates, and since then improvements in surgical techniques as well as advancements in techniques of cardiopulmonary bypass, myocardial preservation, anesthesia, and postoperative care, have greatly reduced operative mortality and morbidity².

Anderson et al. found that young age (≥ 6 months) and low body weight were risk factors for complications³. This, however, contrasts with data published by Kogon et al. and many others in recent series⁴. The purpose of this study is to evaluate the results of surgical VSD closure in infants less than one year and to define whether infancy is a risk factors for VSD closure or not.

Patients and Methods

Patient Population

Database of all patients with age less than one year, who were operated in our hospital between January 1, 2014 and December 31, 2017 was collected.

Inclusion Criterion

- 1) Children of less than one year age, who were operated for isolated VSD and were on regular follow-up in our institute.

Exclusion Criterion

- 1) Patients with concomitant procedures except those who underwent patent foramen ovale closure or PDA ligation.
- 2) Syndromic patients.
- 3) Patients with multiple VSDs.
- 4) Patients who had undergone previous pulmonary artery banding.

Out of 120 patients, only 84 patients were identified as satisfying these criteria. Preoperative, perioperative and postoperative data of these patients was collected from the echocardiography reports, perfusion reports, clinic, inpatient and operative notes. All these patients who met the inclusion criteria were analyzed in follow-up.

Surgical Technique

All patients underwent median sternotomy. Cardiopulmonary bypass with moderate hypothermia was used in all patients. *Del Nido* cold crystalloid cardioplegia was used for myocardial preservation, supplemented with topical ice slush. Three surgeons operated during this period. Dacron (with interrupted polypropylene sutures) was the patch material used in all cases. Ductus arteriosus was dissected and ligated, if present before VSD closure.

Statistical Analysis

Statistical analyses were performed as follows: means, medians, standard deviations, and ranges were used to describe continuous variables. Frequencies and percentages were used for categorical data.

Definitions

Early mortality was defined as death within one month period of surgery while death after one month was defined as late mortality. Other characteristics like size of defect, degree of valvular regurgitation and degree of residual VSD, demonstrated on postoperative echocardiograms, were based on the judgment of the interpreting paediatric cardiologist. A clinical diagnosis of failure to thrive was made for children whose weight fell below the fifth percentile for their age or who weighed less than 80% of their ideal weight based on the standard growth charts. During cardiography, right ventricular and pulmonary artery pressures were estimated using the tricuspid regurgitation jet velocity. Residual VSDs were defined as small if they were less than 2 mm in size and were pressure restrictive.

Results

Patient Demographics

The median age at repair was 8 months (range, 2 months to 11.5 months) and weight was 5 kg (range, 2.5 to 9 kg). No patient with genetic abnormality was included in our study. 81 patients (95%) were admitted for surgery electively from outpatient clinic while 3 patients were transferred from paediatric cardiology department for urgent surgery. 74 patients (88%) had a perimembranous VSD, while 2 had supracristal (2.3%), 3 had inlet (3.5%), and 5 had muscular (5.9%) defects. 13 patients (15.7%) underwent concomitant repair of an atrial septal defect or patent foramen ovale closure, and 9 patients (10.71%) had a patent ductus arteriosus ligation.

Indications for Surgery

Indications for operative intervention were taken from the referring cardiologist's or the surgeon's preoperative note and are summarized in table 1.

Table 1 Indications for Surgery Based on Referring Cardiologist's or Surgeon's Preoperative Note

| Indication | Number of patients | % |
|--------------------------|--------------------|-------|
| Recurrent pneumonias | 48 | 57.14 |
| Poor weight gain | 36 | 42.85 |
| Pulmonary hypertension | 55 | 65.47 |
| Failure to thrive | 42 | 50.00 |
| Congestive heart failure | 32 | 38.09 |

Most of patients have two or more of these indications.

Echocardiographic findings on preoperative studies are summarized in Table 2. Of the patients with left atrial enlargement, 16 were characterized as mild, 3 as moderate, and 1 as severe. Of the patients with left ventricular enlargement, 4 were characterized as mild, and 1 as moderate. None of the patients underwent preoperative cardiac catheterization. Of the patients with pulmonary arterial hypertension, 25 were characterized as mild, 8 as moderate, and 22 as severe.

Table 2 Findings on Preoperative Echocardiography

| Finding | Number of patients | % |
|---------------------------------|--------------------|-------|
| Left atrial enlargement | 20 | 23.51 |
| Left ventricular enlargement | 5 | 5.95 |
| Pulmonary arterial hypertension | 55 | 65.47 |
| Large non restrictive VSD | 60 | 73.15 |

Surgical Approach and Operative Data

All patients were approached through median sternotomy. After pericardiotomy, aorto bicaval cannulation done. PDA dissected and ligated if present. Heart arrested with *del Nido* cold blood cardioplegia and adenosine, supplemented with topical ice slush. Of the perimembranous VSDs, all were closed from a transatrial approach. Of the supracristal VSDs, 1 from a transatrial approach, and 1 from a combined transatrial and transpulmonary approach. All inlet and muscular

VSDs, including apical VSDs, were closed transatrially through the tricuspid valve. 82 patients underwent Dacron patch repair of their VSD while in two patients VSD was closed primarily using interrupted sutures. None of our patients had intraoperative transesophageal echocardiography.

Median operative time was 206 minutes (range, 120 to 456 minutes). Median cardiopulmonary bypass time was 117 minutes (range, 60 to 235 minutes). Median cross-clamp time was 63 minutes (range, 35 to 138 minutes). Moderate hypothermia was used during cardiopulmonary bypass (mean temperature, $28^{\circ}\pm 2^{\circ}\text{C}$). All patients (100%) received blood products, either packed red blood cells, platelets, or fresh-frozen plasma, intraoperatively. All the operative characteristics are summarized in table 3.

Table 3 Operative data and early hospital course

| | | |
|---------------------------------------|-------------------|---------------------------|
| Trans atrial approach | 83 patients | 98.80% |
| Transatrial + transpulmonary approach | 1 patient | 1.20% |
| Dacron patch repair | 82 patients | 97.61% |
| Direct suture closure | 2 patients | 2.39% |
| Operative time | Mean, 206 minutes | Range, 120 to 456 minutes |
| Cardio pulmonary bypass time | Mean, 117 minutes | Range, 60 to 235 minutes |
| Cross clamp time | Mean, 63 minutes | Range, 35 to 138 minutes |
| Extubation time | Mean, 12 hours | Range, 6 to 30 hours |
| ICU stay | Mean, 3 days | Range, 2 to 15 days |
| Post operative hospital stay | Mean, 5 days | Range, 4 to 26 days |

Hospital Course

Mean extubation time was 12 hours (range, 6 hours to 30 hours), mean ICU stay was 3 days (range, 2 to 15 days) and mean postoperative hospital length of stay was 5 days (range, 4 to 15 days). 1 reoperation (1.15%) was performed for permanent pacemaker implantation. 1 patient (1.15%) had postoperative bleeding requiring reoperation. 1 patient (1.15%) was reintubated after three hours of extubation. 3 patients (3.5%) needed pleural drain placement in ICU. 1 patient

developed urethral injury related hematuria in ICU, which resolved on its own in 24 hours. 20 patients (23.2%) received packed red blood cells or other blood products, postoperatively. There were no mediastinal or deep sternal wound infections. There were no neurologic complications or seizures in early postoperative period. Complications have been summarised in table 4.

Table 4 Post Operative Complications

| Complication | No of patient | Percentage |
|----------------------------|---------------|------------|
| Reintubation | 1 | 1.15 |
| Reoperation | 2 | 2.30 |
| Hemo/pneumothorax | 3 | 3.45 |
| Hematuria | 1 | 1.15 |
| Wound infection | 0 | 0 |
| Neurological complications | 0 | 0 |
| New valvular insufficiency | 0 | 0 |
| Complete heart block | 1 | 1.15 |
| Early deaths | 2 | 2.30 |
| Late death | 1 | 1.15 |

Mortality

Two early deaths (2.3%) occurred in our series (see table 4). 1 early mortality occurred in a 4 month infant with large perimembranous VSD and severe Pulmonary artery hypertension. He developed complete heart block post operatively, permanent pacemaker implantation was done on 26th post operative day, the patient expired on 28th post operative day in ICU of sepsis and ARDS. Another early death in our series is of a 6 month old infant with large perimembranous VSD with severe Pulmonary artery hypertension. Patient couldn't be weaned off cardiopulmonary bypass and was shifted to ICU on venoarterial ECMO support. Patient expired on 7th day post operative day of sepsis and disseminated intravascular coagulation (DIC).

Follow-Up

Median follow-up period of our patients was 3 years (range, 1 year to 5 years). On follow-up electrocardiograms, none of our patients exhibited complete heart block. At follow-up echocardiograms, 78 patients (93%) had no residual VSD. Of the remaining 3 patients, the

residual VSDs were characterized as small, all of which closed spontaneously in over follow up period. 79 patients (94.2%) had normal left ventricular function on follow up echocardiogram, 1 patient (1.15%) had mildly depressed left ventricular function on 4th post operative day while none had severely depressed left ventricular function. No patient had new onset aortic or tricuspid regurgitation greater than trivial postoperatively. 50 patients were discharged on medication for pulmonary hypertension. Pulmonary hypertension regressed over median time of 2 months (range, few hours after surgery to 5 months). One pulmonary artery hypertension (PAH) related death occurred in follow up period, 5 months after surgery in a 7 month old infant with preoperative diagnosis of large VSD with severe PAH, whose PAH didn't regress even after surgery.

Discussion

There has been significant improvements in results for surgical repair of ventricular septal defects since the first series reported by Lillehei and colleagues in 1955 and are attributed to advancements in surgical technique and intraoperative and perioperative management². In 2004 Roos et al in a study cited excellent long-term survival and clinical outcomes for these patients, 92% of patients were in New York Heart Association class I more than 20 years after repair⁵. Long-term results are similarly positive for infants who undergo repair of VSD, with Meijboom et al reporting all survivors growing normally with a good quality of life after more than 10 years after surgery⁶.

In terms of overall outcomes, our in-hospital mortality of 3.4% was higher than mortality rates for VSD repair in developed countries. Mortality has been reduced to between 0.5% and 1.7% in Western healthcare systems^{3,7}. Our mortality rate however, is lower than the mortality rates shown by Vaidyanathan et al for the same procedure⁸.

Similarly, there has been a significant reduction in perioperative morbidity since last two decades,

from 29% to 15% in children who underwent VSD repairs⁹. This is comparable to the post operative morbidity seen in this study, but different in that cardiac dysrhythmia is the most common complication in developed countries⁹, while chest complications were most common in our study.

In our study, most adverse complications were re-do surgery (1.15%) and complete heart block leading to permanent pacemaker implantation (1.15%). These adverse events are however lower than reported by Anderson et al who reported 2.1% rate for permanent pacemaker, and 4.9% for re-do surgery⁹. Another study reported a reoperation rate of 2.8% after surgical closure of an isolated single VSD¹⁰.

Vaidhyanathan et al in 2002, demonstrated that operative weight was not associated with the length of hospital stay, but that younger age and preoperative pneumonia required longer post-operative care⁸. Another study by Kouchooukos et al in 2003 concluded that young age, patient size etc, which have been predictive of hospital mortality in the past are no longer risk factors¹¹.

65% of our patients had PAH, which was significantly associated with adverse outcome, as all our mortalities were in patients with severe PAH. Several studies have shown the association between PAH and higher mortality and morbidity in patients undergoing VSD repair. Aldemir et al (2013) strongly advised early surgical repair of VSD in patients having severe PAH for more favourable results¹¹.

Limitations

The limitations of this study are primarily defined by the limitations of all retrospective chart studies. In a prospective study more information could be assessed and the length of follow-up could be more consistent. Secondary this was a single institutional experience so our findings may not be applicable to other centers.

Conclusion

Surgical closure of VSD in infancy is associated with low mortality and extremely low incidence of adverse events. Surgery should not be postponed just for gaining weight or increasing age as early surgical correction of VSD is the only safeguard against this left to right shunt with all its accompanying morbidity and mortality.

Disclosure Statement and conflict of interest:

The authors declare that they have no disclosure and there is no conflict of interest.

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