Evaluate the Results of Anesthesia and Resuscitation of Minimally Invasive Surgery for Pediatric Patients with Ventricular Septal Defect at Cardiovascular Center, E Hospital in 2022

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ABSTRACT

Objective: Minimally invasive surgery has recently been implemented safely and effectively on children. The study aimed to evaluate the results of anesthesia and resuscitation in pediatric patients with ventricular septal defects (VSD) undergoing minimally invasive surgery.

Methods: A cross-sectional study from January 1, 2021 to June 30, 2022 on 65 patients underwent minimally invasive surgery to repair ventricular septal defect, at Cardiovascular Center, E Hospital.

Result: A toltal of 65 children aged from 1 month to 34 months, mean weight of 9.0 ± 6.3kg, mean height of 73.6 ± 22.1cm, with main clinical symptoms of slow weight gain (62.5%) and grade I heart failure (87.7%). The most common VSD location was perimembranous VSD (67.7%) with an mean size of 5.7±2.6 mm. The mean surgical time was 175 minutes with cardiopulmonary bypass time and aortic cross-clamp time of 77.5 and 53.0 minutes, respectively. Postoperative hemodynamic parameters changed statistically significantly compared to pre-operation: blood pressure decreased, heart rate increased, lactate level increased, P/F ratio decreased, blood potassium level decreased. The patient mainly needed to use 1 vasopressor, 1 type of sedative analgesic, continuous diuresis, and prophylactic antibiotics with a vasopressor withdrawal time of 34.2 hours, a sedation withdrawal time of 13.35 hours, and a sedative withdrawal time of 13.35 hours. Intubation time of 20.8 hours (minimum 2 hours) and length of stay ICU was 3.8 days. Postoperative complications were low, mainly pneumonia (9.2%) and residual shunt (9.2%), and no death was observed.

Conclusion: Minimally invasive ventricular septal defect surgery showed that the anesthesia and surgical process did not change much, with relatively fast post-operative recovery results, short medication time, quick recovery, and no recording severe complications.

***Key words**: ventricular septal defect, minimally invasive surgery, anesthesia.*

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INTRODUCTION

Ventricular septal defect (VSD) is the most common congenital heart disease in children(1). Today, the standard treatment is still open heart surgery, although there have been many advancements in catheter-based intervention for closure of VSD. In addition to safety factors, aesthetic have become a factor of crucial concern, especially in young children (2). Previously, cardiovascular surgeons had to use a sternotomy to closure the VSD, and consequences was noticeable scars leading inferiority complex for children. Nowadays, according to the minimally invasive surgical approach of repairing the ventricular septal defect via the right thoracotomy, it has brought high aesthetic outcomes with small surgical scars, helping pediatric patients recover quickly and reducing the risk of surgical wound infection. Along with the development of surgical techniques is the process of accumulating experience in anesthesia and post-operative care. Contributed to reducing the mortality rate of pediatric patients undergoing simple ventricular septal defect repair surgery to nearly 0%. Currently, at the Cardiovascular Center - Hospital E, we have implemented surgery via a small thoracotomy to repair most types of VSD that are indicated for surgery. Therefore, we conducted a study to evaluate the clinical and paraclinical characteristics and evaluate the results of anesthesia and resuscitation after surgery in this group of children.

METHODS

a. Study Design: cross-sectional study

b. Subjects: Children with ventricular septal defects undewent minimally invasive surgery from 2021 to 2022 at Cardiovascular Center, E Hospital.

c. Procedures:

- Patients were evaluated for preoperative parameters: age, gender, weight, clinical symptoms, and echocardiography.

- Routine monitoring (5-lead ECG, invasive arterial blood pressure, central venous catheter, Sp02), general anesthesia. Initiate anesthesia with intravenous anesthetics (Midazolam, Fentanyl, Rocuronium), maintainance of anesthesia with Sevoflurane. Inject heparin dose 3mg/kg, retest ACT if it reached > 450, then you can perform cardiopulmonary bypass. After cross-clamping the aorta, surgeons approach the lesions and suturing the Xenosure patch to close the VSD. Intraoperative data recorded included: surgery time, cardiopulmonary bypass time, aortic cross-clamp time, and amount of blood transfused during surgery.

- After surgery, the patients were transferred to postoperative ICU, general condition was assessed clinically, arterial blood gas parameters and post-operative medications. Developments during surgery, results, and complications are statistically analyzed and compared, thereby providing comments on characteristics, early results of surgery.

- Parameters of anesthesia and resuscitation before, during and after surgery are collected.

d. Data Analysis: SPSS 26.0 software. The value is statistically significant at $p < 0.05$.

Ethics: The study was conducted in accordance with ethical research standards and was approved at the institutional level by E Hospital.

RESULT

Table 1. General preoperative characteristics.

Characteristics		**Value (n=65)**
Age (month) (min – max)		10,2 (1-34)
Sex (% men)		39 (60,0%)
Height (cm) (mean±sd)		73,6 ± 22,1
Weight (kg) (mean±sd)		9,0 ± 6,3
Clinical symptoms	Shortness of breath	11 (16,9%)
	Slow weight gain	40 (62,5%)
	Pneumonia	17 (26,2%)
	Poor breastfeeding	34 (52,3%)
	Detected accidentally	29 (44,6%)
	Heart failure - Grade I - Grade II	 57 (87,7%) 8 (12,3%)
Echocardiography	Location - Inlet (n,%) - Perimembranous (n,%) - Infundibular (n,%)	 5 (7,7%) 44 (67,7%) 16 (24,6%)
	Size (mm) mean ±sd	5,7 ± 2,6
	Dd (mm) (mean ±sd)	30,0 ± 5,0
	EF (%) (mean ±sd)	68,9 ± 8,2
	Pulmonary hypertension (n, %)	21 (32,3%)

Table 2. Perioperative Parameters

Characteristics	**Value**
Surgery time (minutes) (mean ±sd)	175 ± 43,3
cardiopulmonary bypass time(Minutes) (mean ±sd)	77,5 ± 26,7
Aortic cross-clamping time (minutes) (mean ±sd)	53,0 ± 24,4
Heart rebeat immediately after aortic declamped (n,%)	65 (100%)
Support equipment (n,%)	0 (0%)

Table 3. Hemodynamic parameters before and immediately after surgery

Characteristics	Pre-operation	Post-operation	p
Heart rate	131,9 ± 18,5	138,2 ± 16,5	**0,007**
Blood pressure	88,7 ± 13,1	83,9 ± 8,8	**0,001**
spO2	99,9 ± 0,5	99,9 ± 0,5	1,00
ACT	170,0 ± 17,0	163,9 ± 18,6	**0,01**
pH	7,55 ± 0,1	7,52 ± 0,1	0,21
pO2	324,6 ± 90,9	174,7 ± 78,7	**0,0001**
pCO2	24,6 ± 5,7	27,8 ± 6,3	**0,003**
HCO3	21,75 ± 3,5	25,4 ± 2,7	0,329
P/F ratio	541,2 ± 145,7	310,4 ± 144,52	**0,0001**
Lactat	1,1 ± 0,4	2,75 ± 1,1	**0,0001**
Hct	32,5 ± 3,7	30,2 ± 4,1	**0,0001**
Kali	3,8 ± 0,4	3,6 ± 0,5	**0,002**

Table 4. Medicines used in ICU

Medicines	Quantity	%
Vasopressors	Did not use	30,8
	1 medicine	67,7
	2 medicine	1,5
Antibiotic	Preventive	92,3
	Treatment	7,7
Vasoactive drug (mcg/kg/ph)	Adrenalin	4,6
	Milrinone	64,6
	Dobutamine	27.7
	Noradrenaline	3,1
Pain reliever and sedative	Fentanyl	32,3
	Midazolam	93,8
	Paracetamol	64,6
Antiarrhythmic drugs	Cordarone	1,5

Table 5. Results of postoperative care

Parameter	Value
Time stop vasopressors (hour) (min-max)	34,2 ± 39,8 (0 – 192)
Time stop sedative (hour) (min-max)	13,35 ± 22,1 (0 – 168)
Intubation time (hour) (min-max)	20,8 ± 33,8 (2-264)
Length of stay in ICU (days)	3,8 ± 5,1 (1 – 33)
Complications	14 (21,5%)
- Residual shunt	6 (9,2%)
- Pneumonia	6 (9,2%)
- Pneumothorax	1 (2%)
- Bleeding	2 (3%)
- Neurological disorders	3 (5%)
- Cardiac arrhythmia	1 (2%)
- Death	0 (0%)

DISCUSSION:

Nowadays, ventricular septal defect patients and their families not only need curative treatment but also pay a lot of attention to the patient's quality of life for a long time after surgery. In young children, chest deformation after heart surgery is the cause of self-esteem in children when growing up. Minimally invasive surgery shows outstanding aesthetic advantages thanks to the scar location on the side with good scar concealment. The incision is far from the development area of the mammary gland and costochondral joints, without causing damage to the muscles involved in arm movement, thus minimizing trauma to the chest wall with the risk of wall deformity chest and hunchback.

General characteristics: Of the 65 children who had surgery, the average age was 10.2 months (oldest was 34 months, youngest was 01 month), only 6 children (9.2%) had surgery after 24 months of age. This is consistent with the views of many authors to prevent the progression of pulmonary vascular disease (3). Numan Ali Aydemir (2013) also believes that in children with severe PE, surgery should be performed early. under three months for best results (4). Gender: The number of boys is 39 (60%), girls are 26 (40%), the male/female ratio is not much different. This observation is also consistent with many domestic and foreign authors (5, 6). The mean weight in the study was 9.0 ± 6.3kg. According to Hong Liu (2018), the mean weight is 13.16 kg (7). In our study, the mean age and weight were lower. It shows that in recent years, our ability to perform surgery as well as anesthetic resuscitation for VSD is increasingly progressing, catching up with cardiovascular surgery centers around the world.

Clinical symptoms: the rate of admission to the hospital for scheduled surgery due to accidental discovery is 29%, main symptoms are bronchopneumonia (26.2%), poor breastfeeding is 52.3%, and symptoms of slow weight gain is the majority with 62.5%. Early stage I and II

heart failure accounts for 100%. This result is similar to the study of Tran Thien Dat (8).

Characteristics on echocardiography: Regarding prostate location on echocardiography (Table 1), the majority are perimembranous prostate (67.7%), funnel part (7.7%), and subaortic valve (24.6%).). This result is similar to the study of Dixit and colleagues (2020) (9). The average diameter of the prostate hole in our study on ultrasound was 5.7 ± 2.6mm. This result is consistent with the research of Liu Huagang (2017) (10). Size of heart chambers on echocardiography: diastolic left ventricular diameter enlarged, average 30.0 ± 5.0mm, due to T-P shunt causing more blood to the lungs => more blood to the left ventricle in diastolic period => the left ventricle will relax according to the Frank-Starling mechanism. Left ventricular systolic function was preserved in 68.9 ± 8.2%. There were 21 children (32.3%) with pulmonary hypertension before surgery.

Our surgery time, extracorporeal circulator running time, and aortic cross clamp time were 175 ± 43.3 minutes; 77.5 ± 26.7 minutes and 53.0 ± 24.4 minutes (Table 2). Our results are not much different from the study of Schipper M (2017) on 243 patients: thoracotomy time 63.5 ± 22.5 minutes, aortic coupling time 41.2 ± 18.1 minutes (11). All patients had their hearts rebeat immediately after releasing the aortic cross-clamp without using support devices such as Ecmo or Intra-Aortic Balloon Pump. Regarding hemodynamic indices before and after surgery (table 3), the average heart rate of the study group increased from 131.9 ± 18.5 to 138.2 ± 16.5 with statistical significance. Systolic blood pressure decreased from 88.7 ± 13.1 to 83.9 ± 8.8 with statistical significance. This is consistent with heart failure following a period of cardioplegia and intracardiac repair.

Regarding air blood gas parameters before and after surgery (table 3), we have a clear decrease in pO2 as well as the arterial blood P/f index. Arterial hypoxemia often occurs after cardiac surgery and can last for the first several weeks after surgery. Due to many reasons: due to anemia - blood dilution during surgery, due to damage to the lungs and pleura during the process of approaching the heart through the right lung from a small thoracotomy (12, 13). Although there was a decrease in PaO2, there was no difference in arterial oxygen saturation (spO2) before and after surgery. PaCO2 tends to increase statistically significantly before and after surgery, possibly due to a compensation mechanism to respond to the decrease in PaO2, this is similar to the study of Pramanik et al (14). Based on the acid-base compensation, the postoperative pH remains similar to before surgery. Meanwhile, the average lactate concentration increased significantly from 1.1 ± 0.4 mmol/l to 2.75 ± 1.1 mmol/l, due to ischemia of organs during extracorporeal circulation. ACT result after surgery decreased significantly compared to before surgery because we neutralized an amount of protamine in a 1:1 ratio with the initial dose of Heparin, while ACT gradually decreased over time. Also due to post-operative blood dilution, blood electrolytes, here potassium ions, also decreased with statistical significance before and after surgery.

In ICU post-operation, 100% of pediatric patients had fluid overload, so we used intermittent diuretics on 21.5% of patients and continuous diuretics on 78.5%.

A total of 69.2% of patients were maintained on vasopressors. Mainly Milrinone has proven effects to significantly reduce pulmonary artery pressure. Only 1 patient with paroxysmal supraventricular tachycardia required maintenance of arrhythmia medication post-operation (cordarone). The mainly used pain

relievers and sedatives are Midazolam and Paracetamol. Among them, Midazolam is used the most because pediatric patients are very agitated after being transferred to resuscitation, sometimes it is necessary to combine Midazolam and Fentanyl for maintenance as a sedative therapy.

We used prophylactic antibiotics in 92.3% of cases. Only 7.7% of cases required antibiotic treatment due to prolonged mechanical ventilation. In our study, the average time to stop vasoactive drugs was 34.2 ± 39.8 hours, the average duration of mechanical ventilation was 20.8 ± 33.8 hours, the average time stay in ICU was 3.8 ± 5, 1 day, the shortest is 1 day and the longest is 33 days. In Dixit's study, the recovery time was 2.13 ± 1.32 days (9). According to HongLiu's study (2018), the average mechanical ventilation time was 16.6 ± 4.4 hours. Recovery time is 21.7±5.2 hours (15). Our recovery time after surgery is longer than the above authors because we have a number of patients with postoperative pneumonia and need to must be in prolonged recovery. However, our mechanical ventilation time was similar, which shows that the minimally invasive right chest surgery method, in addition to bringing aesthetic benefits, also saw a quick recovery after surgery.

Regarding complications after surgery: occurs in 21.5% of cases. There were 6 cases of residual shunts after surgery, accounting for 9.2%, all of which were small residual shunts < 2mm. Also according to Maartje Schipper (2017), the rate of residual shunts in his study was 71% and were all very small shunts, most of which closed on their own after an average of 3.1 years (11). In total, there were 6 patients with pneumonia and 1 patient with pneumothorax. According to Zhi-Nuan Hong (2018), a study on 62 patients in the right thoracotomy group had 7 patients with pneumonia, 3 patients with pneumothorax (15), this result is consistent with our study.

Post-operative bleeding complications that required re-operation we encountered in 2 patients (3.4%), in both of these cases the bleeding was from the draining spot of the chest wall and both were sutured and left no residue. 2 patients had diaphragmatic paralysis after surgery (3%), Charles D.Fraser (2021) compiled research on 126 cardiovascular surgery centers showing that the rate of this complication in congenital heart surgery ranges from 0 3% to 12.8%, and is associated with prolonged mechanical ventilation and hospital stay (16). This study is also similar to our results. AV block III with pacemaker placement we encountered in 1 (2%), a rate equivalent to the study by Stephanie L (2013) on 828 patients undergoing caesarean section surgery, 1.9% had AV III block requires pacemaker placement (17). Through our research results and those of the above authors, we can see that complete atrioventricular block is a complication with a small percentage, often caused by abnormalities in the path of the conduction system that cannot be detected. learned during surgery. There were no cases of severe complications leading to death in our study.

CONCLUSION

Minimally invasive ventricular septal defect surgery shows that the anesthesia and surgical process do not change much, with relatively fast post-operative recovery results, short medication time, quick recovery, and no recording. receive serious complications.

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