

Mid-term outcomes of minimally invasive surgery for partial atrioventricular septal defect in children

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Objective: This study aims to describe the mid-term outcomes of minimally invasive surgery for partial atrioventricular septal defect in children.

Summary: Partial atrioventricular septal defect is one of the three types of atrioventricular septal defect, accounting for about 3.5% of congenital heart disease. Traditionally, complete repair has been performed via sternotomy. However, with the advancement of minimally invasive surgical techniques in treating congenital heart conditions, we conducted this study to assess the feasibility and mid-term outcomes of this approach.

Subjects and methods: This descriptive study spanned from January 2018 to December 2023, involving 30 patients diagnosed with partial atrioventricular septal defect who underwent minimally invasive complete repair. The cohort comprised 12 males and 18 females, with an average age of 18 months and average weight of 10.3 kg. The mean diameter of the primary atrial septal defect was 15 mm. Eight patients (26.7%) exhibited moderate to severe

mitral regurgitation, and the average pulmonary artery pressure was 37 mmHg.

Results: The average durations of cardiopulmonary bypass and aortic cross-clamp were 82 minutes and 58 minutes, respectively. None of the patients required sternotomy. The average time of artificial ventilator post-surgery was 6.9 hours, with a mean hospital stay of 7.6 days. Postoperative echocardiography showed promising results: complete closure of atrial septal defect, with 90% of patients having absent or mild mitral valve regurgitation, only 10% experienced moderate mitral valve regurgitation. The average follow-up period was 38 months, during which there were no postoperative fatalities. One patient required reoperation due to severe mitral regurgitation from an anterior cleft.

Conclusion: Minimally invasive surgery for partial atrioventricular septal defect in children can be safely performed, yielding favorable mid-term outcomes during follow-up.

Key word: MICS, partial ventricular septal defect.

BACKGROUND

Partial atrioventricular septal defect is one of three progressive forms of atrioventricular septal defect, alongside complete and intermediate types. Surgical intervention for complete atrioventricular septal defect typically occurs within the first 3-6 months of life[1]. For partial atrioventricular septal defect, surgery is considered around 2 to 4 years of age if there are no signs of heart failure and echocardiogram indicates acceptable atrioventricular valve

function[2]. Minimally invasive surgery is increasingly utilized in congenital heart diseases[3], including partial atrioventricular septal defect, prompting the need to evaluate their mid-term outcomes.

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SUBJECTS AND METHODS

Methods: This cross-sectional description study spanned from January 2018 to December 2023. Thirty patients underwent total repair surgery using minimally invasive approaches, divided into two stages. From January 2028 to December 2021, 16 patients underwent surgery via right anterior thoracotomy, while from January 2022 to December 2023, 14 patients were operated on via the right axillary approach. Preoperative characteristics are detailed in Table 1.

Surgical technique: Patients were anesthetized and positioned laterally at a 45-degree angle (right anterior thoracotomy) or 90-degree angle (right axillary approach). The

corresponding skin incisions were at the level of the 5th intercostal space below the breast crease or from the 3rd to 5th intercostal space in the midaxillary line (**figure 1**). After entering the pleural cavity through the 4th intercostal space, the entire thymus was removed. The pericardium was then opened, and central extracorporeal circulation was established. Cardioplegia was administered through the aortic root (**figure 2**). Right atriotomy, assess the lesions including primary atrial septal defect, mitral valve cleft, and tricuspid regurgitation. Complete repair involved suturing of the mitral valve cleft, testing valve function, patching of the atrial septal defect, repairing the tricuspid valve, and subsequent closure of the heart chamber.

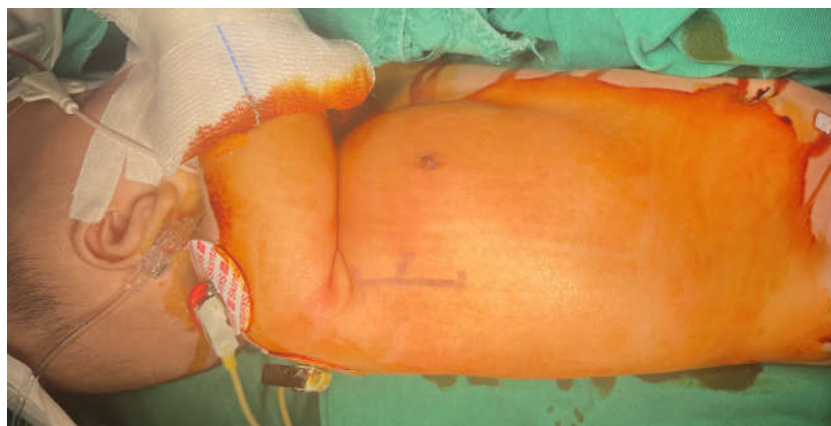


Figure 1: Skin incision (midaxillary line)

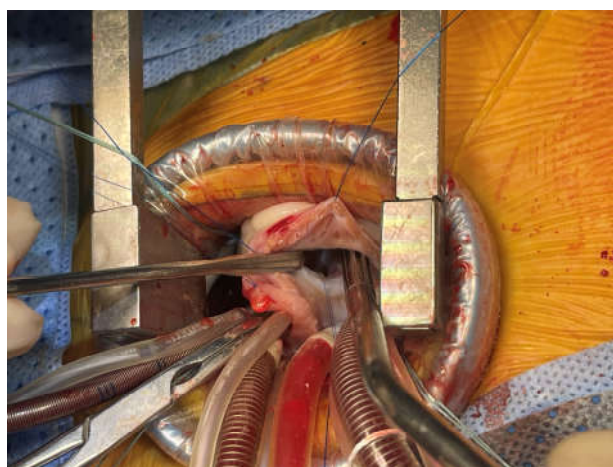


Figure 2: central CBP

Results: Over the study period, 30 patients underwent minimally invasive surgery. Detailed preoperative characteristics are presented in Table 1.

Table 1: Preoperative characteristics

Characteristics		Right thoracotomy	Right axillary thoracotomy	Total
N		16	14	30
Age (month)		23,5	12,6	18
Body weight (kg)		14,7	8,4	10,3
ASD diameter		16,8	14,2	15
Mitral valve regurgitation	Mild (n)	11	11	
	Moderate - severe (n)	5	3	8
Mild tricuspid valve regurgitation (n)		16	14	30
Pulmonary artery pressure (mmHg)		39,6	35,5	37

All patients underwent minimally invasive thoracotomy, without having to convert to open sternotomy. The intraoperative and postoperative results are shown in Table 2.

Table 2: Intraoperative and postoperative results

Characteristics		Right thoracotomy	Right axillary thoracotomy	Total
CBP (min)		78,7	86,4	82
Cross-clamp Ao(min)		56,4	62,6	58
Mortality (n)		0	0	0
Artificial ventilation time (hours)		6,8	7,3	6,9
Mitral valve regurgitation	Mild (n)	11	11	
	Moderate (n)	3	0	3
Tricuspid valve regurgitation	Absent (n)	8	6	14
	Mild (n)	8	8	16
Residual ASD (n)		0	0	0

No fatalities or serious complications occurred. Postoperative echocardiography revealed that 3 patients still had moderate mitral valve regurgitation. The average duration of postoperative follow-up was 38 months. There were no incidences of fatality. One patient required reoperation to address severe mitral valve regurgitation, which resulted in left ventricular dilation (left ventricular end-diastolic diameter z-score was 3), and the average pulmonary artery pressure was 21 mmHg.

Discussion

Partial atrioventricular septal defect comprises these following lesions: primary atrial septal defect, mitral valve regurgitation due to anterior cleft, and occasionally tricuspid valve regurgitation[4]. Since the last century, this condition has typically been surgically corrected using the traditional sternotomy approach in most hospitals. Nowadays, with significant advancements in anesthesia, resuscitation, and surgical techniques, minimally invasive surgery is increasingly being adopted for straightforward congenital heart conditions such as ventricular septal defect, atrial septal defect, cor triatriatum[5]. This approach offers numerous advantages, including reduced risk of bleeding, sternal inflammation, postoperative sternal deformity, faster recovery times, and improved cosmetic outcomes, particularly beneficial for female pediatric patients[6, 7].

Minimally invasive surgical techniques for congenital heart disease include various approaches such as partial sternotomy, right thoracotomy, assisted endoscopic surgery, and

total endoscopy[8]. Among these, thoracotomy (anterior lateral or axillary) is widely used small children with low body weight because it allows to facilitate the establishment of central extracorporeal circulation, which is challenging to accomplish through peripheral vessels in young children weighing under 15kg. In this group of small children, peripheral extracorporeal circulation during artificial heart-lung machine use increases arterial pressure and poses a higher risk of postoperative peripheral artery stenosis and occlusion[9]. All patients in the study were established with central extracorporeal circulation.

The study was conducted in two phases. Initially, a skin incision through the right anterior chest wall, followed by a right infra-axillary incision. These incisions differ only in their location on the skin. Both approaches enter the pleural cavity through the 4th intercostal space. The anterior chest incision provides better access to the lesion but may result in more visible scarring, whereas the axillary approach offers better cosmetic outcomes by hiding the surgical scar beneath the arm[10]. All patients underwent successfully minimally invasive surgery without requiring sternotomy. Postoperative echocardiography revealed moderate mitral valve regurgitation in only 3 patients. During follow-up, one patient underwent reoperation due to severe mitral regurgitation leading to left ventricular dilation.

One potential risk of minimally invasive thoracotomy is its impact on mammary gland, particularly in female patients. However, no cases of breast deformities or hypoplasia were observed during the postoperative follow-up period. It is

crucial to note that careful dissection during entry into the pleural cavity through the intercostal space is essential to avoid damaging the mammary glands and their blood supply, including the internal mammary artery, external thoracic artery, and intercostal arteries.

Conclusion: Minimally invasive surgery for complete repair of partial atrioventricular septal defect can be performed safely with favorable mid-term postoperative outcomes and improved cosmetic results.

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