Early Outcomes of Minimal Invasive Surgery Via the Axillary Approach for Complex Congenital Heart Disease at the Cardiovascular Center - E Hospital

Do Anh Tien[1,2], Luong Thi Nhu Huyen[2], Nguyen Tran Thuy[1,2]*

Objective: This study aims to outline the initial outcomes of implementing minimally invasive surgery via the right axillary approach to completely repair complex congenital heart diseases.

Summary: Minimally invasive surgical techniques have gained widespread adoption in managing simple congenital heart diseases such as atrial septal defect, ventricular septal defect, partial atrioventricular septal defect, cor triatriatum, and partial anomalous pulmonary venous return. Postoperative results have demonstrated equivalence, if not superiority, to traditional sternotomy procedures while offering enhanced cosmetic benefits. However, for more intricate congenital heart conditions such as tetralogy of Fallot (TOF), complete atrioventricular septal defect (CAVSD), and Ebstein syndrome, this study evaluates the early outcomes of employing minimally invasive surgery via the right axillary approach, a technique that remains relatively uncommon globally. Our study seeks to assess the initial outcomes of this approach in managing complex congenital heart diseases.

Subjects and methods: descriptive method based on a series of cases. From April 2023 to December 2023, 45 patients diagnosed with complex congenital heart disease underwent minimally invasive surgery utilizing the axillary approach. This cohort comprised 40 patients with tetralogy of Fallot, 3 patients with complete atrioventricular septal defect, and 2 patients with Ebstein syndrome.

Results: All procedures were technically successful, without requiring sternotomy. The cardiopulmonary bypass times for the TOF, complete AVSD, and Ebstein syndrome groups were 81 minutes, 91 minutes, 96 minutes, respectively. Corresponding aortic cross - clamp times were 70 minutes, 72 minutes, and 74 minutes. There were no postoperative fatalities or significant complications. Postoperative echocardiographic evaluations demonstrated favorable outcomes.

Conclusion: Minimally invasive surgery via the axillary approach for managing complex congenital heart diseases yields promising early results and offers notable cosmetic advantages.

Keywords: *Complex congenital heart disease, minimally invasive surgery, axillary approach*

[1] *University of Medicine and Pharmacy - Vietnam National University, Hanoi;*
[2] *E Hospital*
**Corresponding author: Nguyen Tran Thuy,*
Tel: 0944216866 - Email: drtranthuyvd@gmail.com
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BACKGROUND

Minimally invasive surgery for congenital heart disease encompass several approaches, including partial sternotomy, right or left thoracotomy, the axillary approach, endoscopically assisted surgery, and complete endoscopic surgery. These methods primarily target uncomplicated congenital heart conditions such as atrial septal defect, ventricular septal defect, partial atrioventricular septal defect, partial anomalous pulmonary venous return, and cor triatriatum[1]. The advantages of minimally invasive surgery over sternotomy include reduces trauma, eliminating the risk of sternal deformity, quicker recovery time, and enhanced aesthetics outcomes, particularly notable in female patients[2, 3]. While minimally invasive surgery has become routine for managing simple congenital heart diseases at E Hospital, its application in complex cases such as tetralogy of Fallot, complete atrioventricular septal defect, and Ebstein syndrome, has been gradually emerging. This study aims assess the feasibility and early postoperative results of employing minimally invasive surgery for these complex congenital heart diseases.

SUBJECTS AND METHODS

Method: descriptive analysis of a series of cases

Subjects: from April 2023 to December 2023, 45 patients diagnosed with complex congenital heart disease underwent complete surgical repair via the right axillary approach. This cohort comprised 40 patients with tetralogy of Fallot, 3 patients with complete atrioventricular septal defect, and 2 patients with Ebstein syndrome.

Technique: Patients underwent anesthesia with single-lumen endotracheal intubation. Monitoring lines included a femoral or radial arterial catheter and a central venous catheter (femoral or SVC). Patients were positioned laterally at a 90-degree angle to the left. A vertical infra-axillary incision was made from the 3rd to 5th intercostal space, the heart was approached through the 4th intercostal space. Two anterior-posterior and superior-inferior chest retractors were positioned (see Figure1). The entire thymus gland was removed, and the pericardium was opened 15mm anterior to the phrenic nerve. Systemic heparinization was administered, establishing central extracorporeal circulation via arterial cannulation in the ascending aorta and venous cannulation in the superior and inferior vena cavae. Cardioplegia was administered downstream through the aortic root using custodial solution (see Fig. 2). Lesions were then repaired based on their pathological characteristics.

Figure 1: Right infra-axillary incision

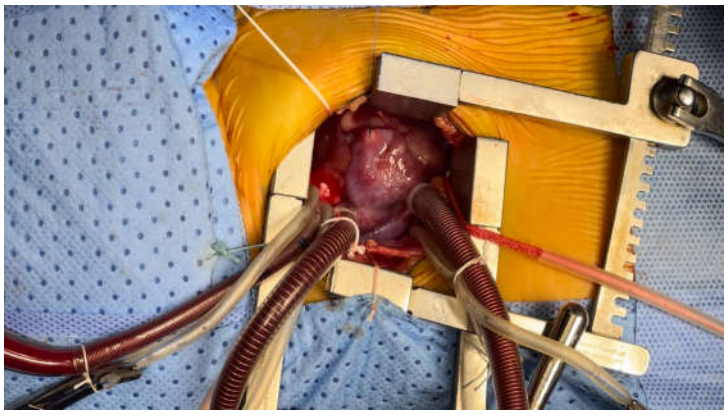

Figure 2: Central extracorporeal circulation establishment

Results: In our study of 45 patients, the distribution was as follows: 40 patients had tetralogy of Fallot, 3 patients had complete atrioventricular septal defects and 2 patients had Ebstein syndrome.

Preoperative characteristics are shown in Table 1.

Table 1: Preoperative characteristics

Fallot 4 (n = 40)	
Age (month)	5.8±2.6
Weight (kg)	6.3±0.87
SpO2 (%)	83.45±5,5
PDA (%)	32,5
Anomalous coronary (%)	15
Z-score PVA	-1.38±0.92
Mc Goon index	1,7 ± 0,34
Complete Atrioventricular septal defect (n = 3)	
Age (month)	3
Weight (kg)	4,5 ± 0,62
Rastellie A/B	2/1
AV valve regurgitation (medium)	3
PAP (mmHg)	45
Ebstein' anomaly (n = 2)	
Age (month)	42
Weight (kg)	12 ± 0,8
SpO2 (%)	92
Type B	2
TV regurgitation (severe)	2

Both intraoperative and postoperative outcomes are detailed in Table 2. Notably, none of the patients required conversion to open surgery.

Table 2: Intraoperative and postoperative outcomes

Disease	CBP time (min)	Cross-clamping Ao time (min)	Mechanical ventilation time (hour)
Fallot 4	80	68	22
CAVSD	91	72	25
Ebstein'anomaly	96	74	6

Postoperative complications were minimal, with no reported deaths or cerebrovascular accidents. However, one patient with TOF experienced right diaphragmatic paralysis necessitating diaphragmatic plication surgery.

Postoperative echocardiography revealed favorable outcome (Table 3)

Table 3: Pre- discharge echocardiography

Fallot 4			
Pressure gradient across the pulmonary valve (mmHg)	16,36		
Pulmonary valve regurgitation (%)	Absent	Mild	Moderate
	45,5	48,5	6
CAVSD			
Mild mitral valve regurgitation (n)	3		
Tricuspid valve regurgitation (absent - mild)	3		
Ebstein' Anomaly			
Tricuspid valve regurgitation (mild)	2		

Discussion: Minimally invasive surgery has emerged as a popular tendency in cardiac surgery, particularly in congenital heart surgery[4]. Numerous published studies have highlighted its advantages over traditional sternotomy, including reduces risk of bleeding, sternal deformity, and infection, as well as accelerated postoperative recovery, decreased need for blood transfusions, and enhanced aesthetic outcomes, particularly notable in young female patients[5] Minimally invasive surgery to treat congenital heart disease was first described by Dominique Metras in 1996 with a right thoracotomy for atrial septal defect repair[6]. Today, minimally invasive approaches include various techniques such as partial sternotomy, right or left thoracotomy, assisted endoscopic surgery, complete endoscopic surgery, and robotic surgery.

Establishing extracorporeal circulation poses a significant challenge in performing minimally invasive surgery for congenital heart disease. In patients weighing over 15 kg, peripheral extracorporeal circulation can be established via the femoral bundle. However, in low-weight children, establishing peripheral extracorporeal circulation becomes markedly challenging due to small arteries and veins, leading to increased pressure when operating the artificial heart-lung machine and a heightened risk of postoperative peripheral artery stenosis. Consequently, central extracorporeal circulation become imperative in low-weight children[7]. In our study, all patients underwent central extracorporeal circulation.

The minimally invasive approach through the axilla offers advantages over thoracotomy as the incision is situated in the axilla, ensuring that

the surgical scar remains concealed by the arm[8], thereby enhancing aesthetics. Moreover, the axillary incision has minimal impact on breast development, especially advantageous for female children[9]. While this approach has been widely applied to simple congenital heart diseases such as ventricular septal defect, atrial septal defect, and partial atrioventricular septal defect[10], its application in complex congenital heart diseases like complete atrioventricular septal defect, Ebstein's syndrome, and tetralogy of Fallot has only recently gain traction, yielding promising early results[11]. Repairing multiple lesions through a small surgical field may pose challenges during operations. To facilitate exposure of defects, we implemented several key measures, including positioning patients in the lateral recumbent hold, inserting a single-lumen trachea, and disconnecting the endotracheal tube and ventilator when CEC reached full flow to expand the surgical field. All patients underwent complete lesion repair via an infra-axillary incision without necessitating conversion to sternotomy, resulting in favorable early postoperative outcomes.

Conclusion: Minimally invasive surgery via the axillary incision emerges as a safe and effective alternative for treating complex congenital heart diseases, offering promising initial outcomes and evident cosmetic advantages.

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