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Lower Partial Sternotomy for Atrial Septal Defect Closure: A Case of Minimally Invasive Cardiac Surgery in a Pediatric Patient from South Tamil Nadu

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ABSTRACT

Minimally invasive cardiac surgery (MICS) in pediatric patients remains an emerging field with limited applications in developing countries. This case report describes the successful application of lower partial sternotomy for atrial septal defect (ASD) closure in a 4.5-year-old boy weighing 16 kg. The patient presented with a history of recurrent respiratory tract infections and was diagnosed with ostium secundum type ASD with moderate pulmonary arterial hypertension. Due to deficient inferior rims, device closure was contraindicated, necessitating surgical intervention. The entire procedure was performed through a single midline lower partial sternotomy incision without the need for a groin incision for cardiopulmonary bypass (CPB), making this the first reported case of such technique in a pediatric patient in South Tamil Nadu. The procedure demonstrated significant advantages including reduced postoperative pain, early mobilization, shorter hospital stay, and preservation of chest wall integrity for future cardiac interventions. This case highlights the feasibility and benefits of MICS in carefully selected pediatric patients when performed by experienced surgeons.

Keywords

Minimally invasive cardiac surgery, Atrial septal defect, Lower partial sternotomy, Pediatric cardiac surgery, Congenital heart disease.

Introduction

Atrial septal defect (ASD) is one of the most common congenital heart defects (CHD), accounting for approximately 10–15% of all CHDs [1]. Ostium secundum type ASD represents the most common form, comprising about 70% of all ASDs [2]. Historically, ASD management has evolved from medical observation to transcatheter device closure or surgical repair, depending on the anatomical characteristics and clinical presentation [3].

Traditional surgical repair of ASD involves full median sternotomy, which provides optimal visualization and access to the defect. However, this approach is associated with significant postoperative morbidity, including substantial chest wall trauma, pain, prolonged hospital stay, and potential complications for future cardiac surgeries [4]. In adult populations, minimally invasive cardiac surgery (MICS) techniques using partial sternotomy have been successfully implemented with excellent outcomes [5,6].

The application of MICS in pediatric patients remains limited, particularly in developing nations where resource constraints and technical expertise often necessitate conventional approaches [7]. This case report presents a unique experience of lower partial sternotomy for ASD closure in a young pediatric patient from a resource-limited region in South India, highlighting the potential benefits and feasibility of this technique when carefully selected and performed by experienced surgeons.

Case Presentation

Patient Demographics and Clinical History

A 4.5-year-old boy, weighing 16 kg, presented with a history of recurrent respiratory tract infections (RTIs) that had been ongoing intermittently for approximately 3 years. The patient was born with an unrepaired congenital heart defect that was first detected at age 1 year. His parents, daily wage laborers from a rural farming community in Cumbam, Theni district, were financially unable

to afford surgical treatment at private hospitals. Government hospital physicians had advised conservative management with observation, but due to the persistence and frequency of symptoms, the family sought alternative options.

The patient was referred to a free medical screening camp organized by the Little Moppet Heart Foundation, an NGO dedicated to identifying and providing support to underprivileged children with congenital heart defects in rural South India. Following initial screening at this camp, the patient was referred for comprehensive cardiac evaluation and management.

Diagnostic Evaluation

Detailed clinical examination revealed tachypnea and mild cyanosis at exertion. Cardiac auscultation demonstrated a widely split and fixed second heart sound with a soft systolic murmur, consistent with significant left-to-right shunting.

Transthoracic echocardiography confirmed the diagnosis of ostium secundum type ASD with a defect size of approximately 18 mm. Additional findings included moderate pulmonary arterial hypertension (PAH) with estimated right ventricular systolic pressure of 55 mmHg, mild right atrial and right ventricular enlargement, and normal left ventricular function.

Cardiac catheterization studies revealed:

- Qp:Qs (pulmonary to systemic blood flow ratio) of 2.1:1
- Mean pulmonary artery pressure of 32 mmHg
- Pulmonary vascular resistance index of 2.8 Wood units/m²
- Deficient inferior vena cava rim (< 5 mm)

The deficient inferior rim precluded transcatheter device closure, thus necessitating surgical intervention as per established guidelines [8].

Surgical Planning and Technique

The patient was deemed a suitable candidate for lower partial sternotomy given the surgeon's expertise in minimally invasive techniques. The advantages of single incision access combined with preservation of the majority of the sternum were discussed with the family.

Operative Technique

Under general anesthesia with endotracheal intubation, the patient was positioned supine. A lower partial midline sternotomy incision was made, dividing the lower two-thirds of the sternum while preserving the upper one-third (manubrium). This limited incision provided adequate exposure of the right atrium and the ASD.

Conventional cardiopulmonary bypass (CPB) was established using central aortic and Bicaval cannulation through the primary incision, eliminating the need for a separate groin incision (femoral cannulation). This single-incision approach significantly reduced operative trauma and vascular morbidity.

Following initiation of CPB and aortic cross-clamping, antegrade cold crystalloid cardioplegia was administered. The right atrium was opened with a standard atriotomy. The ASD was inspected and measured. Primary closure of the defect was performed using a single layer of running 5-0 polypropylene suture, obviating the need for patch augmentation. The atriotomy was closed in a standard fashion. Deairing manoeuvres were performed meticulously, and CPB was weaned without difficulty.

After hemostasis was achieved, the sternotomy was closed using interrupted steel wires for the sternal fragments and absorbable sutures for the subcutaneous tissue and skin.

Operative time: 120 minutes
CPB time: 55 minutes
Cross-clamp time: 22 minutes

Postoperative Course

The patient demonstrated an uneventful postoperative recovery. Pain control was achieved with judicious use of opioid and non-opioid analgesics, with the patient requiring significantly less analgesia compared to conventional full sternotomy cases. Early mobilization was accomplished on postoperative day 1, and the patient was discharged on postoperative day 3 in excellent hemodynamic condition.

Postoperative transthoracic echocardiography confirmed complete closure of the ASD with no residual shunt. Right ventricular size normalized over the subsequent 6 weeks, and pulmonary artery pressures decreased to normal range (mean PAP < 20 mmHg).

At 3-month follow-up, the patient was completely asymptomatic with significant clinical improvement in exercise tolerance and cessation of recurrent respiratory infections. Physical examination revealed no cardiac findings, and echocardiography demonstrated normal cardiac anatomy and function.

Discussion

This case report presents a remarkable achievement in extending minimally invasive cardiac surgery techniques to the pediatric population in South India. Several important aspects merit discussion:

Clinical Significance

The application of lower partial sternotomy in a 16 kg pediatric patient represents an advancement in surgical techniques particularly relevant for resource-limited healthcare settings. Unlike conventional full median sternotomy, the minimal approach preserves approximately 50% of the sternal bone, conferring several advantages for future cardiac interventions.

Technical Considerations

While MICS techniques have been well-established in adult cardiac surgery, their adaptation to pediatric patients requires meticulous consideration of anatomical and technical factors. The small mediastinal space in children, combined with the delicate nature of pediatric tissues, demands heightened technical expertise. However, this case demonstrates that with appropriate selection and surgical proficiency, these techniques are entirely feasible.

The single-incision approach employed in this case is particularly noteworthy. Traditional MICS approaches in adult patients often utilize separate incisions for CPB cannulation to minimize mediastinal trauma. In this pediatric case, central cannulation through the primary incision was safely accomplished, further reducing operative trauma and avoiding the morbidity associated

with groin dissection.

Advantages and Clinical Outcomes

The benefits realized in this patient align with established advantages of MICS in adult populations:

1. **Reduced postoperative pain:** The limited incision and preservation of chest wall musculature resulted in dramatically reduced analgesic requirements and faster pain resolution.
2. **Early mobilization and discharge:** The patient was mobilized on postoperative day 1 and discharged on postoperative day 4, compared to typical 7-10 day hospital stays following conventional sternotomy.
3. **Preserved chest wall integrity:** The intact upper sternum and preservation of the sternocostal articulations will facilitate future cardiac surgeries, should they be required.
4. **Improved cosmetic outcome:** The smaller incision resulted in a less conspicuous scar, an important consideration in pediatric patients.

Selection Criteria and Limitations

Not all ASD closures are suitable for MICS approach. This case was particularly amenable to minimally invasive surgery due to:

- Straightforward ASD morphology (ostium secundum type)
- Adequate visualization capability through partial sternotomy
- Surgeon's expertise in MICS techniques
- Availability of appropriate instrumentation

Patients with complex ASD anatomy, requirement for concurrent procedures, or other congenital anomalies may not be suitable candidates for MICS.

Geographic and Socioeconomic Significance

This case carries particular relevance for South India and developing nations more broadly. The successful integration of minimally invasive techniques in a resource-limited setting, combined with humanitarian efforts through the Little Moppet Heart Foundation, demonstrates a model for providing high-quality cardiac care to underprivileged children in rural areas. The reduction in hospital stay and associated costs translate to significant benefits for families with limited financial resources.

Acknowledgments

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Patient Consent

Written informed consent was obtained from the patient's parents for publication of this case report and associated clinical data.

Conclusion

This case report documents the successful application of lower partial sternotomy for ASD closure in a young pediatric patient in South Tamil Nadu. The procedure resulted in excellent clinical outcomes with reduced morbidity and rapid recovery. The achievement of this surgical milestone in South India expands the horizons of pediatric cardiac surgery and provides hope to underprivileged children with congenital heart defects in rural communities.

Further experience with carefully selected pediatric patients will help establish the precise role of minimally invasive cardiac surgery in the pediatric population. With appropriate patient selection, technical expertise, and institutional support, MICS offers distinct advantages over conventional approaches. This case also underscores the critical role of healthcare organizations and NGOs in extending access to quality cardiac care in resource-limited settings.

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