

Beating Heart as an Alternative for Closure of Atrial Septal Defect: A Case ReportKhan Mohammad Amanur Rahman^{1*}, Md. Sazzed-Al-Hossain², Najeeb Ahsan³, Nasif Imtiaz⁴, Shakil Ahmed⁵, Kazi Mahub⁶¹Medical Officer, Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.²Resident (Phase-B), Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh³Medical Officer, Department of Cardiac Surgery, National Institute of Cardiovascular Disease (NICVD), Dhaka, Bangladesh.⁴Medical Officer, Department of Cardiac Anesthesia, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.⁵Medical Officer, Department of Cardiac Anesthesia, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.⁶Resident (Phase A) Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh***Corresponding author**

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Abstract: Atrial septal defect (ASD) closure is a commonly performed surgical intervention for congenital heart anomalies, traditionally conducted using cardiopulmonary bypass (CPB) with hypothermic and hyperkalemic cardiac arrest. Although effective, this approach is associated with risks such as myocardial edema and ischemia-reperfusion injury, which may impact postoperative outcomes. Beating heart surgery has recently emerged as a promising alternative, offering the potential to reduce these complications by maintaining cardiac activity during the procedure. At Bangabandhu Sheikh Mujib Medical University (BSMMU), we performed a successful beating heart closure of a secundum ASD in a 9-year-old female patient. The surgery was conducted using CPB without arresting the heart, demonstrating the feasibility and effectiveness of this technique. This case highlights the potential of the beating heart approach as a safe and viable alternative for secundum ASD closure, particularly in reducing myocardial injury and improving surgical outcomes. Further studies are required to evaluate its broader applicability and long-term outcomes. Our findings support the consideration of beating heart techniques as an innovative option in congenital cardiac surgery.

Keywords: Beating heart surgery, atrial septal defect, cardiopulmonary bypass.

INTRODUCTION

Secundum atrial septal defect (ASD) is present in approximately 10% of patients with congenital heart disease and remains one of the most common congenital heart defects in adults¹. Over the past decade, transcatheter ASD closure has increased globally, particularly in children and adults². However, morphologic variations in ASD are common and can significantly affect procedural outcomes, where surgical closure remains the standard treatment³.

Traditionally, ASD closure involves cardiopulmonary bypass (CPB) with aortic cross-clamping and the use of cardioplegia solutions to preserve myocardial function during cardiac arrest. These solutions are effective for myocardial protection; however, a period of ischemia occurs when the heart is deprived of circulation, leading to reperfusion injury upon aortic declamping⁴. Even with continuous warm blood cardioplegia, some degree of myocardial stunning is inevitable⁵.

To minimize reperfusion injury, off-pump beating-heart surgery has been introduced, yielding significant advances in coronary artery bypass grafting, mitral valve surgery, and right heart operations⁵. Although beating-heart surgery for ASD II repair is performed under CPB to avoid myocardial dysfunction after cardiac arrest, there is a risk of ischemic stroke due

to systemic air embolism⁶⁻⁷. This has prompted the need to evaluate the safety of the beating-heart technique for ASD closure. The primary objective of this study was to assess the safety of the beating-heart technique, with a secondary aim of evaluating the risk factors for embolism in stroke patients.

CASE REPORT

A 9-year-old female patient, diagnosed with a secundum atrial septal defect (ASD), was admitted to the Department of Cardiac Surgery at Bangabandhu Sheikh Mujib Medical University (BSMMU) for surgical correction. Preoperative transthoracic echocardiography revealed an ASD measuring approximately 25 mm by 16 mm, with an ejection fraction of 57% and moderate pulmonary hypertension (pulmonary arterial systolic pressure 46 mmHg), along with a left-to-right shunt.

The surgery was performed through a median sternotomy. Following administration of heparin, full anticoagulation was achieved, and cardiopulmonary bypass (CPB) was established by cannulating the ascending aorta and both venae cavae, which were looped. In this technique, the aorta was clamped, and warm blood was continuously perfused to maintain myocardial activity, with the electrocardiogram showing normal sinus rhythm while the heart remained beating. No cardioplegic solution was used to induce cardiac arrest, and a suction tip was placed at the coronary sinus ostium to maintain a bloodless operative field.

A key aspect of this technique was the careful de-airing of the cardiac cavities. Initially, a blood sucker was used gently to avoid emptying the left atrium. The patch was sutured starting at the inferior aspect of the defect and finished superiorly. Before ligating the ASD, the anesthesiologist used a self-insufflation bag to initiate positive-pressure ventilation, aiding in the de-airing of the pulmonary veins just before closure. Postoperative transthoracic echocardiography was performed before discharge, and the patient was monitored both during hospitalization and at follow-up visits. Perioperative and postoperative parameters are summarized in Tables 1 and 2.

Table 1: Pre-operative data

Variable	Values
Bypass time (Minutes)	40
Cross clamp time (Minutes)	21
Weaning time (Minutes)	26
Arrhythmia	No
Mean blood pressure (mmHg)	70
Central venous pressure (mmHg)	6
DC Shock required	No

Table 2: Post-operative data

Variable	Values
Troponin I	1.58 IU
Alanine aminotransferase	49 IU/L
CK-MB	28 IU/L
Electrocardiogram	Sinus rhythm
Ejection fraction	60%
Post-operative mechanical ventilation time (min)	90
Post-operative pacing	No
Systemic embolism	No
Length of ICU Stay (hours)	33

DISCUSSION

Standard surgical repair of atrial septal defects (ASD) via median sternotomy is a well-established procedure with a low-risk profile and near-zero operative mortality⁸. Recently, minimally invasive cardiac surgery has gained popularity due to its reduced surgical trauma, faster postoperative recovery, and superior cosmetic outcomes compared to conventional

full sternotomy approaches. Various minimally invasive techniques, including submammary anterior thoracotomy, lateral thoracotomy, and lower-midline sternotomy, have been explored⁹.

In recent years, advancements in transcatheter closure devices have shifted the management of secundum-type ASD from surgical repair to interventional closure. However, transcatheter ASD closure has notable limitations. The procedural success rate is highly dependent on the size and shape of the defect. A large ASD with insufficient rims to anchor the closure device, or a fenestrated or aneurysmal interatrial septum, can significantly decrease the success rate of this technique¹⁰.

The primary advantage of the beating-heart technique is the avoidance of ischemia-reperfusion injury. Additionally, it allows for immediate assessment of any associated mitral or tricuspid valve insufficiency and facilitates identification of potential conduction system injuries during repair. Our findings suggest that the beating-heart technique is a safe and effective approach for ASD closure¹¹⁻¹⁵.

CONCLUSION

Based on our experience, on-pump beating heart surgery for ASD closure was found to be a feasible approach. However, further randomized multicenter studies are necessary to comprehensively evaluate the advantages, limitations, and overall effectiveness of this technique.

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