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# Comparison of postoperative outcome between vertical right axillary thoracotomy and conventional median sternotomy for atrial septal defect closure in pediatric patients

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## ABSTRACT:

**Background:**

Surgical management of atrial septal defect has evolved from conventional sternotomy to less invasive approaches, with vertical right axillary thoracotomy emerging as a promising alternative offering superior cosmetic and recovery outcomes. This study was therefore designed to compare postoperative results, safety, and parental satisfaction between VRAT and conventional median sternotomy to address the existing gap in pediatric data.

**Methods:**

This comparative cross-sectional study was conducted from January 2023 to December 2024 at the National Heart

Foundation Hospital and Research Institute, Dhaka, involving 66 pediatric patients with atrial septal defect who underwent surgical closure. Participants were equally divided into two groups: one treated by vertical right axillary thoracotomy (VRAT) and the other by conventional median sternotomy (CMS). All patients underwent standardized preoperative evaluation, anesthesia, and cardiopulmonary bypass under uniform monitoring protocols.

**Results:**

Both groups were comparable in baseline characteristics, with no significant differences in age ($p = 0.5$), sex distribution ($p = 0.1$), body surface area ($p = 0.1$), pulmonary artery systolic pressure ($p = 0.3$), or type of atrial septal defect ($p = 0.3$), ensuring a homogeneous study population. Per-operatively, the duration of surgery ($p = 0.5$) and aortic cross-clamp time ($p = 0.8$) were similar between groups, though cardiopulmonary bypass time was significantly longer in the VRAT group ($p < 0.001$), reflecting its technical complexity. No major intraoperative complications occurred, highlighting procedural safety. Postoperatively, patients undergoing VRAT demonstrated significantly shorter ICU stay ($p < 0.001$), reduced hospital stay ($p < 0.001$), and lower blood loss ($p < 0.001$) compared to the sternotomy group. Other variables, including mechanical ventilation duration ($p = 0.3$), arrhythmia ($p = 0.7$), and wound infection ($p = 0.5$), showed no statistical difference, confirming comparable safety with superior recovery in the minimally invasive approach.

**Conclusions:**

Vertical right axillary thoracotomy proved to be a safe and effective minimally invasive alternative to median sternotomy, offering comparable surgical outcomes with faster recovery and superior cosmetic benefits in pediatric atrial septal defect closure.

**Keywords:** *Atrial Septal Defect, Vertical Right Axillary Thoracotomy, Conventional Median Sternotomy, Minimally Invasive Cardiac Surgery, Pediatric Cardiac Surgery*

## INTRODUCTION

Since the first intracardiac repair of atrial septal defect (ASD) by Lewis and Varco in 1952, surgical techniques for congenital heart defects (CHDs) have markedly evolved with a significant reduction in mortality and morbidity[1] (Dave et al., 2009). Over recent years, transcatheter device closure has gained wide acceptance and, in many centers, largely replaced surgical repair for ostium secundum ASDs with adequate rims, though surgery remains necessary for other types and those with deficient rims[2,3] (Lou et al., 2019; Fraisse et al., 2018). Traditionally, conventional median sternotomy (CMS) has been the gold standard, offering excellent exposure for cardiopulmonary bypass and safe defect repair; it carries drawbacks such as its invasive nature, visible midline scar, and the psychological distress it may evoke[1,4] (Khan et al., 1998; Dave et al., 2009). Growing demand for less invasive and cosmetically superior approaches has driven cardiac surgery toward minimally invasive and robotic techniques, shifting from midline to lateral chest incisions without compromising safety[4] (Khan et al., 1998). Minimally invasive ASD repair, though initially hindered by concerns over safety, technical complexity, and challenges of altered cannulation for bypass, has gradually expanded, particularly as parental expectations and peer influence have fueled its acceptance[5] (Dodge et al., 2021). In adults, minimally invasive approaches have shown excellent outcomes, especially in valve and coronary procedures, though their uptake in congenital heart disease has been slower. Alternatives to CMS, such as right anterolateral thoracotomy, partial thoracotomy, and vertical right axillary thoracotomy (VRAT), have been proposed, with VRAT—a muscle-sparing mini-thoracotomy through the right axilla—emerging as a promising option[6] (Said et al., 2023). VRAT offers quicker recovery, high mental satisfaction, and superior cosmetic results, especially in young females where body image is of great importance. Despite these advantages, literature remains scarce regarding body image and parental satisfaction after ASD closure, though recent studies continue to emphasize reducing surgical trauma and enhancing cosmetic outcomes[7] (Yang et al., 2022). The present study aims to compare early postoperative outcomes of VRAT versus CMS for pediatric ASD closure, focusing on safety, effectiveness, scar cosmesis, and parental satisfaction to address this critical knowledge gap.

## METHODS

This comparative cross-sectional study was conducted over a period of two years, from January 2023 to December 2024, in the Department of Pediatric Cardiac Surgery at the National Heart Foundation Hospital and Research Institute (NHFH & RI), Mirpur, Dhaka, Bangladesh. The study population consisted of admitted pediatric patients diagnosed with atrial septal defect (ASD) who required surgical closure and met the defined inclusion and exclusion criteria. A total of 66 patients were enrolled through convenience sampling, and they were equally distributed into two groups: Group A comprised 33 patients who underwent ASD closure via the vertical right axillary thoracotomy (VRAT) approach, while Group B included 33 patients who underwent closure through the conventional median sternotomy (CMS) approach. Patients eligible for inclusion were those with ASD requiring surgical correction by either CMS or VRAT. Exclusion criteria were carefully applied to maintain homogeneity, excluding patients with dextrocardia, associated anomalies such as patent ductus arteriosus (PDA), mitral regurgitation (MR), or pulmonary stenosis (PS), those undergoing emergency cardiac procedures such as device retrieval, and those with major non-cardiac congenital anomalies, known coagulopathies, hemoglobinopathies (e.g., thalassemia, sickle cell disease), or musculoskeletal deformities such as scoliosis and kyphosis.

All patients admitted to the Pediatric Cardiac Surgery Department of NHFH\&RI who met the inclusion and exclusion criteria were considered for enrollment, and informed consent was obtained prior to participation. A thorough preoperative assessment, including medical history, clinical examination, and relevant investigations, was recorded on structured data sheets, later compiled into a master folder and analyzed using SPSS. The patients were allocated into two groups based on the surgical approach—vertical right axillary thoracotomy (VRAT) or conventional median sternotomy (CMS)—and all procedures were carried out under a standardized anesthetic protocol with general anesthesia and cardiopulmonary bypass, while routine monitoring included ECG, invasive blood pressure, $SpO_2$, core temperature, central venous pressure, activated clotting time, arterial blood gas, and urine output. In the CMS group, a standard midline sternotomy was performed with

bicaval and aortic cannulation, aortic cross-clamping, and cardioplegia, followed by right atriotomy and ASD closure either directly or using pericardial/Dacron patches; concomitant valve procedures were performed as needed, and the sternum was stabilized with sternal wires. In the VRAT group, a 4–6 cm vertical incision was made in the right mid-axillary line at the 4th intercostal space, with careful mobilization of flaps to preserve the long thoracic nerve, retraction of the right lung, and pericardiotomy anterior to the phrenic nerve; central cannulation, right atriotomy, and ASD closure with a Dacron patch using continuous polypropylene sutures were then performed, followed by smooth weaning from cardiopulmonary bypass and layered chest closure with drain placement. Postoperatively, all patients were transferred to the Pediatric Cardiac Intensive Care Unit (PCICU), initially ventilated with CMV and later SIMV, with extubation guided by hemodynamic stability and blood gas status. Antibiotics and analgesics were administered as per institutional protocol, and patients were discharged once clinically stable. Outcome variables—including duration of mechanical ventilation, inotropic support, postoperative blood loss, sepsis, cardiac arrest, ICU stay, hospital stay, mortality, guardian satisfaction, and scar assessment using the Vancouver Scar Scale—were systematically documented, while transthoracic echocardiography before discharge ensured assessment of surgical success and identification of any residual pathology.

## RESULTS

The baseline characteristics of both groups in table 01 demonstrated that the two cohorts were well-matched, with no significant differences in demographic or clinical variables prior to surgery. The age distribution was comparable, with children in both groups spanning similar age ranges, and the mean age was almost identical. The proportion of male and female patients showed no meaningful variation, ensuring gender balance between the groups. Body surface area and pulmonary systolic pressure were also closely aligned, indicating physiological comparability. In terms of defect type, the majority of patients in both groups presented with fossa ovalis atrial septal defects, while smaller proportions had sinus venosus or ostium primum variants, again without significant intergroup difference. The absence of statistical disparity across these parameters highlights that both groups were

homogeneous at baseline, providing a sound foundation for comparing surgical outcomes between the two approaches.

Table 2 illustrates the intraoperative variables of the two groups, revealing that the overall duration of surgery, aortic cross-clamp time, and the rate of on-table extubation were comparable between the approaches, reflecting similar procedural efficiency and immediate recovery profiles. The only notable difference observed was in cardiopulmonary bypass time, which was significantly longer in the minimally invasive group, reflecting the technical demands and learning curve associated with this approach. No major intraoperative complications such as aortic dissection, air embolism, or accidental decannulation occurred in either group, highlighting the safety of both surgical techniques.

Table 3 presents the postoperative outcomes, showing that both groups experienced comparable durations of mechanical ventilation and similar rates of postoperative complications such as arrhythmia, prolonged inotropic support, wound infection, or lung compliance issues, with no residual shunts detected in either group. Important differences emerged in recovery parameters: patients who underwent vertical right axillary thoracotomy demonstrated shorter stays in both the intensive care unit and the hospital, as well as significantly less postoperative blood loss compared to those treated with conventional sternotomy. These findings suggest that while both surgical approaches were equally safe and effective in terms of complication rates, the minimally invasive technique offered clear advantages in terms of quicker recovery and reduced surgical trauma.

## DISCUSSION

Our two cohorts were closely matched across pediatric age bands with a similar mean age, indicating no age-related selection bias. One study reported older adolescents/young adults with mean ages 29.7 vs 28.6 years[8], while another observed mid-teens means 17.1 vs 21.2 years[9], highlighting that published VRAT/CMS comparisons often involve older populations than ours. Our groups showed a balanced male–female distribution where external reports vary, with male proportions of 51.9% vs 66.7%[5], 40% vs 45.5%[10], and female shares of 43.8% vs

40.3% in another series[11], while one comparison documented 45.4%:55.6% vs 50%:50% male:female ratios[8], collectively suggesting wide sex-mix heterogeneity across centers. Our cohorts were physiologically comparable at baseline; a pediatric series reported a mean BSA of 1.01 ± 0.29 $m^2$ in the minimally invasive arm, consistent with smaller body habitus typical of younger patients[12]. Our groups were similar preoperatively; comparative literature ranges from relatively low pressures 9.72 ± 10.73 vs 40.0 ± 14.27 mmHg in mixed-age cohorts[8] to tightly clustered pediatric means 32.25 ± 3.01 vs 33.00 ± 3.35 mmHg[2] , and a single-arm pediatric report of 32.18 ± 14 mmHg[12], indicating our case-mix aligns with contemporary pediatric norms. Our sample predominantly comprised ostium secundum (fossa ovalis) defects with smaller shares of sinus venosus and primum variants, yielding a balanced substrate for technique comparison. Published distributions vary such as secundum 46.1%, sinus venosus 34.6%, partial AVSD 19.2% in one CMS-leaning cohort and secundum 47.6%, sinus venosus 38%, partial AVSD 14.3% in the comparator group[9], while a pediatric minimally invasive series reported ostium secundum 80%, sinus venosus 6%, primum 14%[12], together reinforcing that our baseline pathology spectrum mirrors the common epidemiology of ASD subtypes across centers.

In our cohort the operative duration was essentially equivalent between techniques, mirroring reports that span from slightly longer minimally invasive times to parity or even shorter times for either approach; for example, one series reported 2.99 vs 2.6 hours[8], another 2.3 vs 2.7 hours[11], a pediatric-focused cohort 1.5 vs 1.4 hours[2], and another 2.8 vs 2.1 hours[7], showing center- and technique-dependent variability. In terms of aortic cross-clamp time, our groups were comparable, while external data vary widely with 43.3 vs 21.2 minutes[8], 54.6 ± 30.8 vs 67.9 ± 22.7 minutes[5], 55 vs 50 minutes[10], and near-equivalence such as 22 vs 24 minutes[13] and 20 vs 20 minutes[7]. Regarding cardiopulmonary bypass time, our minimally invasive arm required longer support, consistent with several reports showing extended bypass for non-sternotomy access (e.g., 76.3 vs 46.8 minutes[8], 105.7 vs 110.2 minutes[5], 88.1 ± 43 vs 79.8 ± 37.3 minutes[10], 58 ± 19 vs 52 ± 24 minutes[11], and pediatric times around 37.98 ± 6.12 vs 34.37 ± 4.58 minutes[2]). We observed no major intraoperative adverse events (aortic dissection, air embolism, accidental decannulation), aligning with

many contemporary series where catastrophic events are uncommon; nonetheless, heterogeneity exists, with one report noting 0% vs 44% for air embolism depending on technique and safeguards[7].

in our cohort, ventilatory support was comparable between techniques, aligning with pediatric series that report narrow differences such as 6.8 ± 2.1 vs 7.1 ± 3.3 hours and 5.67 ± 1.18 vs 5.92 ± 1.37 hours[2,11], while other reports span faster-track extubation (0.1 vs 1.0 hours) and longer courses (11.6 vs 15 hours; 2.4 ± 1.2 vs 3.5 ± 2.1 hours) reflecting protocol heterogeneity[5,9,10]. Our patients in the minimally invasive arm recovered sooner, which is consistent with literature showing shorter or comparable intensive care utilization ranging from 1.7 vs 3.6 days, 24.8 ± 6.2 vs 48.2 ± 2.1 hours, and 14.31 ± 1.85 vs 14.96 ± 2.17 hours, though some cohorts report longer stays depending on age and comorbidity mix[2,5,9,12]. Our minimally invasive group left hospital earlier, echoing several series that demonstrate shorter convalescence for non-sternotomy access—e.g., 4.1 vs 14.4 days, 3.4 vs 7.3 days, 4.2 ± 0.07 vs 8.3 ± 0.11 days, 4 ± 1.4 vs 7.1 ± 1.6 days, with some studies showing modest differences such as 6.9 vs 8 days[5,8,9,10,11]. Our cohort experienced less drainage after minimally invasive repair; this trend is frequently noted in comparative pediatric reports, although exact volumes vary widely across centers and are not uniformly detailed in all series[8,9,11]. We observed similar low heart rates between approaches, in keeping with series reporting very low to modest incidences (e.g., 4.5% vs 9.1%) and even cohorts with no arrhythmic events in either arm[8,11]. Our need for prolonged multi-agent ionotropic support was comparable between techniques; published reports rarely standardize this metric, but available descriptions generally indicate low, protocol-driven utilization without systematic differences[2,8,11]. Infections were infrequent in our series, mirroring reports of 0% vs 1.9%, 0% vs 19.4%, and multiple cohorts noting no deep sternal or thoracotomy infections in either group, showing robust perioperative prophylaxis and smaller incisions as contributory factors[7,8,10,13]. Pulmonary compliance issues were rare in our experience and are sparsely reported in the literature, with most pediatric series noting negligible ventilatory complications when fast-track protocols are followed[2,11]. No residual shunt was detected in our cohort before discharge, aligning with reports of 0% vs 2.9% and single-arm series documenting complete closure after minimally invasive repair[1,10].

The present study was conducted in a single tertiary center with a relatively small sample size, which may limit the generalizability of the findings. Long-term outcomes, including cosmetic satisfaction and psychological impact, were not assessed due to time constraints. The study's cross-sectional design did not allow for evaluation of late complications or functional recovery beyond the immediate postoperative period.

**Conclusion:**

This study demonstrated that vertical right axillary thoracotomy is a safe and effective alternative to conventional median sternotomy for atrial septal defect closure in pediatric patients. Both approaches yielded comparable intraoperative safety and postoperative complication rates, but VRAT offered significant advantages in terms of reduced ICU and hospital stay, as well as less postoperative blood loss. These findings suggest that the minimally invasive VRAT approach ensures equivalent surgical efficacy while enhancing recovery and cosmetic outcomes in children.

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**DECLARATIONS**

*Conflict of interest: None Declared*

*Ethical approval: This study was approved by the academic and institutional ethical review board of the National Heart Foundation Hospital and Research Institute, Mirpur, Dhaka.*

**References**


1. Arif, S., Nahian, A., Ahmed, M., Forhad, R., Chanda, P., & Ahmed, F. (2020). Comparison of initial outcomes between minimally invasive right minithoracotomy and standard median sternotomy in patients undergoing isolated surgical closures of atrial septal defects. *Current Trends in Cardiology*, *4*, 18–23.
2. Dave, H., Comber, M., Solinger, T., Bettex, D., Dodge-Khatami, A., & Prêtre, R. (2009). Mid-term results of right axillary incision for the repair of a wide range of congenital cardiac defects. *European Journal of Cardio-Thoracic Surgery*, *35*(5), 864–870.
3. Dodge-Khatami, J., & Dodge-Khatami, A. (2021). Advantages of a mini right axillary thoracotomy for congenital heart defect repair in children. *Cardiology in the Young*, *32*(2), 276–281.
4. Essa, Y., Said, S. M., Greathouse, K. C., McCarthy, C., Khan, M., & Hagen, M. (2024). Right axillary thoracotomy vs. median sternotomy for repair of congenital heart defects in infants and children. *Congenital Heart Disease*, *19*(6), 563–575.
5. Fraisse, A., Latchman, M., Sharma, S. R., Bayburt, S., Amedro, P., & di Salvo, G. (2018). Atrial septal defect closure: Indications and contra-indications. *Journal of Thoracic Disease*, *10*(S24), S2874–S2881.
6. Hu, C., Tan, J., Chen, S., Ding, H., & Xu, Z. (2014). Comparison of clinical outcomes and postoperative recovery between two open heart surgeries: Minimally invasive right subaxillary vertical thoracotomy and traditional median sternotomy. *Asian Pacific Journal of Tropical Medicine*, *7*(8), 625–629.
7. Khan, J. H., McElhinney, D. B., Reddy, V. M., & Hanley, F. L. (1998). Repair of secundum atrial septal defect: Limiting the incision without sacrificing exposure. *The Annals of Thoracic Surgery*, *66*(4), 1433–1435.
8. Luo, Z., Chen, Q., Yu, L., Chen, L., & Huang, Z. (2020). Comparative study between surgical repair of atrial septal defect via median sternotomy, right

submammary thoracotomy, and right vertical infra-axillary thoracotomy. *Brazilian Journal of Cardiovascular Surgery*, *35*(3).

9. Rokonujjaman, M., SK, N., Islam, S., Ghafoor, N., Ahmad, S. T., & Shoeb, A. A. (2021). Experience of minimal invasive cardiac surgery for repair of atrial septal defects: A single center study. *Cardiovascular Journal*, *14*(1), 37–43.
10. Said, S. M., Greathouse, K. C., McCarthy, C. M., Brown, N., Kumar, S., & Salem, M. I. (2023). Safety and efficacy of right axillary thoracotomy for repair of congenital heart defects in children. *World Journal for Pediatric and Congenital Heart Surgery*, *14*(1), 47–54.
11. Yaliniz, H., Topcuoglu, M. S., Gocen, U., Atalay, A., Keklik, V., & Basturk, Y. (2015). Comparison between minimal right vertical infra-axillary thoracotomy and standard median sternotomy for repair of atrial septal defects. *Asian Journal of Surgery*, *38*(4), 199–204.
12. Yan, L., Zheng-chun, Z., Li, H., Lin, M., Wang, H., & Zhao, Z. (2012). Right vertical infra-axillary mini-incision for repair of simple congenital heart defects: A matched-pair analysis. *European Journal of Cardio-Thoracic Surgery*, *43*(1), 136–141.
13. Yang, X., Hu, Y., Dong, J., Huang, P., Luo, J., & Yang, G. (2022). Right vertical axillary incision for atrial septal defect: A propensity score matched study. *Journal of Cardiothoracic Surgery*, *17*(1).

**Table 1:** Pre-operative Characteristics

| Variable | Group A | Group B | p-Value |
|---|---|---|---|
| Age (years) | | | |
| ≤5 | 9 (27.3%) | 11 (33.3%) | 0.5 |
| 6-10 | 12 (36.4%) | 12 (36.4%) | |
| 11-13 | 12 (36.4%) | 10 (30.3%) | |

| Mean ± SD | 8.8 ± 3.7 | 8.3 ± 4.2 | |
|---|---|---|---|
| Sex | | | |
| Male | 14 (42.4%) | 20 (60.6%) | 0.1 |
| Female | 19 (57.6%) | 13 (39.4%) | |
| BSA ($m^2$) | 0.9 ± 0.2 | 1 ± 0.2 | 0.1 |
| PASP (mmHg) | 30.8 ± 8.9 | 32.1 ± 9.4 | 0.3 |
| Type of ASD | | | |
| Fossa ovalis defect | 26 (78.8%) | 22 (66.7%) | 0.3 |
| Sinus venous defect | 5 (15.1%) | 8 (24.2%) | |
| Ostium primum defect | 2 (6.1%) | 3 (9.1%) | |

*p-value was calculated by using chi-square test for categorical and t-test for quantitative variables.*

*Fisher's exact test was done if any of cell had expected value less than 5*

**Table 2:** Per-operative Variables

| Variable | Group A | Group B | p-value |
|---|---|---|---|
| Duration of surgery (hours) | 3 ± 0.8 | 3.1 ± 0.8 | 0.5 |
| Aortic cross clamp time (minutes) | 24 ± 5.5 | 23.8 ± 6.6 | 0.8 |
| Cardiopulmonary Bypass time (minutes) | 46.3 ± 5.9 | 37.6 ± 4.9 | <0.001 |
| Aortic dissection | 0 (0%) | 0 (0%) | 0.02 |
| Air embolism | 0 (0%) | 0 (0%) | 0.03 |
| Accidental decannulation | 0 (0%) | 0 (0%) | 1.0 |
| On table extubation | 26 (78.8%) | 25 (75.8%) | 0.8 |

*p-value was calculated by using chi-square test for categorical and t-test for quantitative variables.*

*Fisher's exact test was done if any of cell had expected value less than 5*

**Table 3:** Post-operative Outcomes

| Variable | Group A | Group B | p-value |
|---|---|---|---|
| Mechanical Ventilation time(hours) | 5.7 ± 1.2 | 5.9 ± 1.4 | 0.3 |
| ICU stay (days) | 2.8 ± 0.3 | 3.5 ± 0.4 | <0.001 |
| Postop. hospital stay (days) | 5.1 ± 0.2 | 6.1 ± 0.4 | <0.001 |
| Post-operative blood loss (ml) | 95.5 ± 35.8 | 148.7 ± 66.9 | <0.001 |
| Postoperative arrhythmia | 4 (12.1%) | 3 (9.1%) | 0.7 |
| Use of >2 inotropes >2 days | 5 (15.1%) | 4 (12.1%) | 0.7 |
| Wound infection | 1 (3%) | 2 (6.1%) | 0.5 |
| Abnormality of lung compliance | 0 (0%) | 1 (3%) | 0.3 |
| Residual shunt | 0 (0%) | 0 (0%) | 1.0 |

*p-value was calculated by using chi-square test for categorical and t-test for quantitative variables.*

*Fisher's exact test was done if any of cell had expected value less than 5*