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Comparison of two surgical approaches for the treatment of atrial septal defects

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Abstract

Background: Cardiac surgery has adopted less invasive procedures in the last two decades, aiming to reduce surgical insult and achieve early patient recovery. The present study compared median sternotomy and minimally invasive techniques for managing atrial septal defects.

Methods: The current study is a prospective cohort comparative study that included 67 patients randomly divided into two groups. Group A included 34 patients with median sternotomy; their ages ranged from 2 to 40 years (mean± SD 36.12±7.3 years). Group B (n= 33) underwent minimally invasive surgery, and their ages ranged from 21 to 46 years (mean± SD 32.09±7.35).

Results: Minimally invasive patients had fewer blood transfusions (1.06±0.24 vs. 1.79±0.25 units, P<0.001), less pain on the second day (3.73±0.72 vs. 7.94±1.01, P<0.001) and fifth day (2.09±0.52 vs. 5.38±.49, P<0.001) of the operation, and a shorter duration of hospital stay (4.85±0.75 vs. 6.38±0.78 days, P<0.001) than median sternotomy patients. Wound infection was reported in three cases with minimally invasive surgery, while nine patients had wound infection with median sternotomy. However, both groups had no reported mortality after two months of follow-up.

Conclusion: Atrial septal defect closure with minimally invasive approaches could be safe with low morbidity, a fast recovery phase, and the ability to restore normal activities.

KEYWORDS
Atrial septal defect; Minimally invasive cardiac surgery; Median sternotomy

Introduction

Atrial septal defects (ASDs) are considered the second most common cardiac anomaly [1]. Patients could be asymptomatic in younger patients, and ASDs are discovered accidentally during the investigations for another reason [2]. Patients who survive into adulthood become more symptomatic because of the volume overload on the right ventricle and increased pulmonary blood flow [3].

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Over the last two decades, the treatment of ostium secundum ASD has evolved, and the application of minimally invasive approaches has increased. Median sternotomy and minimally invasive techniques offer excellent clinical outcomes, and the superiority of one approach over the other is still controversial [4]. The present study compared median sternotomy and minimally invasive techniques for managing atrial septal defects.

Patients and Methods

The present study included 67 patients aged between 21 and 46 years with secundum ASD repaired between January 2021 and December 2022. The patients were divided randomly into two groups: Group A (n= 34) had median sternotomy, and Group B (n= 33) had minimally invasive surgery. Fourteen patients presented with mild concomitant functional tricuspid regurgitation, 13 presented with moderate tricuspid regurgitation, and 40 patients were discovered accidentally. Patients with pulmonary vascular resistance > 8 wood units were excluded because ASD closure is not recommended in those patients [5].

All patients had a complete history and clinical examination before surgery. Routine preoperative investigations included chest X-ray, ECG, echocardiography, and coronary angiography. Laboratory investigations included cardiac enzymes, blood gases, blood glucose level, glycated HB (HBA1c), liver functional tests, kidney function tests, complete blood count, and coagulation profile. The pain score was estimated according to Delgado et al. [6]. Scores are based on self-reported measures of symptoms that are recorded with a single handwritten mark placed at one point along the length of a 10-cm line that represents a continuum between the two ends of the scale: "no pain" on the left end (0 cm) of the scale and "worst pain" on the right end of the scale (10 cm).

Ethical Approval

The Institutional Review Board approved the study (IRB local approval number: 17300945). Patients provided informed consent before enrollment.

Surgical techniques

All patients underwent a standard induction protocol. Before surgery, a pulse oximeter, 5-lead ECG, and invasive and noninvasive blood pressure were attached, and then an intravenous line was inserted. Patients were preoxygenated with 100% oxygen before induction. Anesthesia was induced with propofol at doses of 2 to 2.5 mg/kg IV titrated at approximately 40 mg every 10 seconds, 5 µg/kg fentanyl, and either 0.5 mg/kg atracurium or 0.2 mg/kg cisatracurium. Vital signs were recorded at various stages before and during surgery, including tracheal intubation, incision, sternotomy, and transfer to the ICU. Anesthesia was maintained with sevoflurane, which was switched to 1.2% isoflurane, with the infusion of anesthesia fentanyl 1 mg/kg/hour and the same relaxant used in induction.

Patients in the minimally invasive group were operated via a right thoracotomy. A venous cannula was inserted through the right internal jugular vein by the Seldinger technique, and cardiopulmonary bypass was initiated via femoral vessels. A 5-cm skin incision was made below the right nipple. The inferior venous cannula was inserted in the right atrium guided by transesophageal echocardiography. The arterial cannula was positioned by the same technique, and both caval veins were snared. An external aortic clamp was applied, and the right atrium was opened through a longitudinal incision. The defect was closed using an autologous pericardium.

In the sternotomy group, the pericardium was opened, and a suture was placed on the right atrium so that the atrium was retracted to expose the aorta. Standard aortic cannulation was performed, and both the superior and inferior vena cava were cannulated. A standard aortic cross-clamp was applied, and the ASD was closed through transverse right atriotomy using a pericardial patch.

Statistical analysis:

The Statistical Package for Social Sciences (SPSS) v. 20 was used (IBM Corp, Armonk, NY). The Kolmogorov–Smirnov test was used to confirm the normality of the data distribution. Continuous variables were analyzed with the t test or Mann–

Table 1: Preoperative characteristics of the two surgical groups

Item	Group A (n=34)	Group B (n= 33)	P
Age (year). mean±SD	36.12±7.3	32.09±7.35	0.03
Females	17 (50%)	15 (45.45%)	0.71
Symptoms			
Chest pain	0	1(3%)	0.45
Dyspnea	11 (32%)	13 (39%)	
Asymptomatic	23 (68%)	19 (58%)	
ECG			
Sinus	19 (56%)	18 (55%)	
RBBB	6 (18%)	3 (9%)	0.055
AF	9 (26%)	12 (36%)	
Defect size (ml). M±SD	43.32±3.34	43.15±3.96	0.8
EF (%) mean±SD	60.47±4.87	59.51±6.52	0.05

Group A: median sternotomy, Group B: minimally invasive technique, ECG: electrocardiogram, RBBB: right bundle branch block, AF: atrial fibrillation, EF: ejection fraction

Whitney test, and categorical variables were analyzed with the chi-squared or Fisher exact test. Data are presented as the mean, standard deviation, range or counts, and percentages. A P value of less than 0.05 was considered statistically significant.

Results

Baseline data

The present study included 67 patients between 21 and 46 years old. Group A included 17 females aged 22-40 years (mean ± SD 36.12±7.3 years). Group B included 33 patients; 15 were females aged 21-46 years (mean± SD 32.09±7.35). The majority were accidentally discovered [23 in Group A (68%) vs. 19 in Group B (58%)]. In comparison, dyspnea was reported in 11 (32%) and 13 (39%) patients in Groups A and B, respectively. Recurrent chest pain was reported in one case in Group B (3%). Moreover, ECG results showed sinus rhythm in 19 (56%) cases in Group A and 18 (55%) in Group B. Right bundle branch block (RBBB) was reported in 6 cases in Group A (18%) and 3 in Group B (9%), and atrial fibrillation was seen in 9 cases in Group A (26%) and 12 in Group B (36%). The deficit size was 43.32±3.34 mm in Group A and 43.15±3.96 mm in Group B. The ejection fraction was 60.47±4.87% in Group A and 59.51±6.52% in Group B. (Table 1)

Operative data

The perioperative data in the two surgical groups revealed that the operative time was 194.53± 32.19 min in Group A and 285.94±10.02 min in Group B (P < 0.001). The need for blood transfusion was 1.79±0.25 units in Group A and 1.06±0.24 units in Group B (P < 0.001). Blood loss was 0.77±0.09 L in Group A and 0.53±0.11 L in Group B (P < 0.001) (Table 2).

Table 2: Perioperative data in the two surgical groups. Data are presented as mean±SD

Parameter	Group A (n= 34)	Group B (n= 33)	P
Operative time (minute)	194.53±32.19	285.94±10.02	0.001
Need for blood transfusion (units)	1.79±0.25	1.06±0.24	0.001
Bleeding (L)	0.77±0.09	0.53±0.11	0.001

Postoperative data

The pain score on the second day was 7.94±1.01 in Group A and 3.73±0.72 in Group B (P < 0.001). The pain score on the fifth day was 5.38±0.49 in Group A and 2.09±0.52 in Group B (P < 0.001). Wound infection was reported in 9 cases (26%) in Group A and 3 cases (9%) in Group B. Moreover, the hospital stay was 6.38±0.78 days in Group A and 4.85±0.75 in Group B (P < 0.001) (Table 3).

Table 3: Postoperative data in the two surgical groups

Parameter	Group A (n= 34)	Group B (n= 33)	P
Pain score 2nd day (mean± SD)	7.94±1.01	3.73±0.72	0.001
Pain score 5th day (mean± SD)	5.38±0.49	2.09±0.52	0.001
Wound infection (n, %)	9 (26%)	3 (9%)	
Hospital stay (days) (mean± SD)	6.38±0.78	4.85±0.75	0.001
Follow-up ECG (n, %)			
Sinus rhythm	29 (85%)	29 (88%)	>0.99
Atrial fibrillation	5 (15%)	4 (12%)	
Time to regain normal activity (days) (mean± SD)	49.32±6.14	9.67±1.76	0.0001

Follow-up data

The two-month follow-up showed that no residual shunt was reported in either group, and ECG follow-up was normal in 29 cases in Group A (85%) and 29 in Group B (88%), while AF was reported in 5 cases (15%) in Group A and 4 cases in Group B (12%). The regaining of normal activity occurred after 49.32±6.14 days in Group A and 9.67±1.76 days in Group B (P < 0.001) (Table 3).

Discussion

The present study revealed that although the minimally invasive approach had a longer operative time than the median sternotomy, the amount of blood transfusion and postoperative pain and wound infection were significantly lower with the minimally invasive approach. Moreover, hospital stay and regaining regular activity were significantly shorter. No mortality was reported in our series in either group.

The surgical management of secundum ASD has changed significantly over the last two decades. Minimally invasive approaches have replaced median sternotomy with good early and late outcomes [7]. However, this type of surgery requires good expert hands with well-planned surgical techniques.

Head et al. [8] and Cinteza [9] reported fewer complications in patients who underwent minimally invasive approaches with symptom improvement and perfect reduction in the right ventricle size. These results are consistent with other series [10]. Moreover, Butera et al. [11], in their comparative study using surgical and percutaneous closure, reported that both transcardiac catheter (TCC) and minimally invasive surgery were successful. They added that a short hospital stay was achieved with a transcatheter approach. However, the main complications were right pleural effusion and right pneumothorax with atrial arrhythmia. Hani et al. [12] reported that TCC, or minimally invasive surgery for ASD closure, is a safe procedure with very low morbidity. They added that the medical team provides the patients with cosmetic solutions with fast recovery and low complications.

Our results agree with Vallabhajosyula et al. [13], who reported that minimally invasive surgery had fewer arrhythmias, less need for blood transfusion, less bleeding, shorter stay in intensive care and hospital, with earlier extubation, less postoperative pain and earlier return daily life activities. On the other hand, the authors added that minimally invasive surgery required more surgical skills and a long operative time. The authors concluded that minimally invasive surgery could be an alternative to conventional surgery, especially for patients with previous cardiac surgery.

Lee et al. [14] and Dave et al. [15] concluded that the application of minimally invasive surgery extended from ASD to tetralogy of Fallot and mitral valve repair and achieved better outcomes than conventional approaches. Luo et al. [16] reported that minimally invasive surgery seems superior to median sternotomy regarding hospital stay and postoperative pain. The authors suggested that minimally invasive surgery should be standard for surgical ASD closure.

However, Dodge-Khatami and Solazar [17] reported that minimally invasive ASD closure

should have safety equal to a full sternotomy approach. They added that the learning curve and additional training with good equipment are important factors. Moreover, cosmetic results must be considered with the input of breast tissue development. Konstantinov et al. [18] reported that minimally invasive ASD closure should fulfill the following criteria: safety is equal to a full sternotomy approach, and perfection is necessary. Additional training and equipment are important factors. Finally, the cosmetic results should be considered case by case, including all the insults of the incision and the impact on developing breast tissue.

Limitations

The study has several limitations. The small number of patients from one center and short follow-up period. The results may not be generalizable to other centers because the treatment teams' experience is an important factor that affects the surgery outcome.

Conclusion

Atrial septal defect closure with minimally invasive approaches could be safe with low morbidity, a fast recovery phase, and the ability to restore normal activities.

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