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Right Anterior Minithoracotomy vs. Conventional Median Sternotomy in Surgical Ostium Secundum Atrial Septal Defect Closure: Assessment of Clinical Outcomes and Health-Related Quality of Life

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ABSTRACT

Background: Ostium secundum Atrial Septal Defect (ASD) is one of the most common congenital heart diseases. Right Anterior Minithoracotomy (RAMT) is a promising technique for surgical closure of ASD.

Objectives: This study aimed to assess the safety of minimally invasive RAMT with peripheral cannulation and compare it to full median sternotomy (Conventional Median Sternotomy, CMS) regarding clinical outcomes and Health-Related Quality of Life (HRQOL) in surgical ostium secundum ASD closure.

Methods: In this quantitative, cross-sectional study, all clinical records of 51 patients (30 RAMT and 21 CMS) who underwent ASDII closure between March 2016 and November 2019 were collected. The patients' HRQOL was evaluated using a Short Form-12 (SF-12) questionnaire. The two groups' clinical outcomes and HRQOL were compared using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA).

Results: This study was conducted on 30 patients (23 females and 7 males) with RAMT and 21 patients (10 females and 11 males) with CMS ASD closure. The two groups were similar with respect to age, left ventricular ejection fraction, preoperative hemoglobin (Hb), family status, level of education, and employment status. However, operation length, Cardiopulmonary Bypass (CPB) time, and mean aortic cross clamp time were significantly lower in the CMS group ($P < 0.001$). The mean amount of chest tube drainage in the first 24 hours after surgery was 148.27 ± 122.82 mL in the RAMT group and 217.50 ± 134.04 mL in the CMS group ($P = 0.02$). The results showed no significant difference between males and females regarding the mean CMS and total score of HRQOL. Yet, the mean score of PCS was significantly better in the female patients in the RAMT group ($P = 0.03$).

Conclusions: Despite the longer operation and cardiopulmonary bypass time, RAMT procedure was associated with similar mortality and lower postoperative bleeding. Moreover, female patients in the RAMT group showed better physical component of HRQOL.

1. Background

In 1953, with the advent of Cardiopulmonary Bypass (CPB), cardiac surgical procedures were developed. Full median sternotomy also known as Conventional Median Sternotomy (CMS) was the standard approach in most cases, including treatment of Atrial Septal Defect (ASD) (1, 2). CMS prepared a good exposure of the heart and great vessels, but was not without complications (3-5). In the late 1990s, Minimally Invasive Cardiac Surgery (MICS) began to be applied (5, 6). Some studies reported that minimally invasive techniques reduced morbidity, pain, surgical trauma, bleeding, scaring, and duration of the recovery time (7, 8). With development of surgical techniques, MICS has been more widely used in the last two decades (2, 6,

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8). MICS approaches with peripheral perfusion access have modified methods to access the heart (9). They need changes in CPB circuit and surgical techniques (10). Right Anterior Minithoracotomty (RAMT) with peripheral cannulation is one of the most popular approaches of MICS for treating ASD (11), mitral valve, and tricuspid valve problems. This approach provides better aesthetic results, avoids sternal complications, is more comfortable for patients (8, 12), and is more widely desired by female patients (9).

2. Objectives

This study aimed to compare different approaches of surgical repair of ostium secundum ASD (ASD II). ASD II was chosen due to its prevalence and higher disease uniformity (13). In addition to clinical outcomes, RAMT and CMS approaches were compared with regard to Health-Related Quality of Life (HRQOL).

3. Patients and Methods

The first operation of RAMT with peripheral cannulation was done in Chamran Heart Center, Isfahan University of Medical Sciences, Isfahan, Iran in October 2016. Between March 2016 and November 2019, 51 patients underwent the surgical closure of ASD; 30 patients with the RAMT approach and 21 patients with the midsternotomy approach. Patients who had concomitant tricuspid band annuloplasty were not included in the study. The patients were interviewed for assessment of quality of life. Retrospective data were also collected using the archived data. The study was approved by the Ethics Committee of Isfahan University of Medical Sciences.

The inclusion criteria of the study were aging ≥ 16 years and having undergone elective surgical ASD II closure using either RAMT with peripheral cannulation or CMS approach between March 2016 and November 2019. Patients with concomitant coronary artery disease, valve dysfunction needing intraoperative intervention, coagulopathy, psychological disorders, and incomplete medical records were excluded from the study.

HRQOL questionnaires evaluate patients' perspectives of the impact of diseases on daily life (14). In this study, a short form-12 (SF-12) questionnaire was used to assess the HRQOL, which could be reported as a Physical Component Summary (PCS) and a Mental Component Summary (MCS). PCS was the sum of general health, physical functioning, role limitation caused by physical health problems, and bodily pain subscales, while MCS was the sum of mental health, role limitation caused by emotional problems, vitality, and social functioning subscales. The total score of HRQOL was the sum of the abovementioned eight domains, with higher scores indicating better HRQOL.

The SF-12 questionnaire is the short version of the SF-36 questionnaire (15). The SF-12 questionnaire was designed by Ware et al. in 1996 and its validity and reliability were assessed (16). The validity and reliability of the Persian version of this scale have been approved, as well (0.73 for PCS and 0.72 for MCS) (17). The advantages of this questionnaire are being brief and easy to use. In order to control bias, the interviewer was unaware of the type of surgery.

All patients underwent ASD II closure with intravenous anesthesia. Minimally invasive ASD closure was done using RAMT with peripheral cannulation entering the chest through the fourth or fifth intercostal space with a

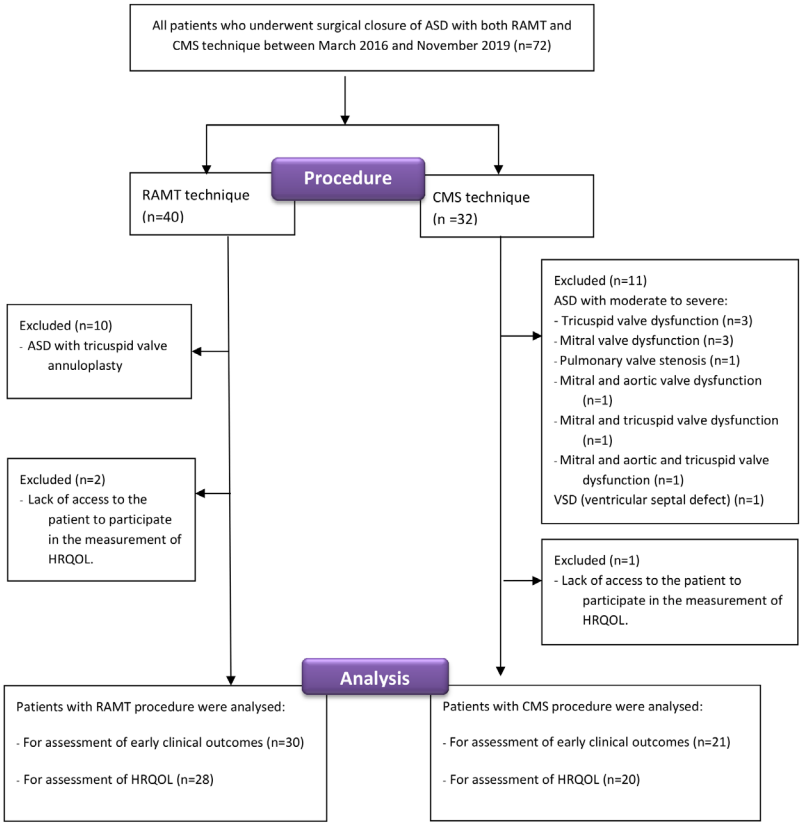


Figure 1. Flow Diagram Outlining the Included and Excluded Patients and the Study Design

45 - 60 mm skin incision along the right inframammary groove between the midclavicular and anterior axillary lines. Peripheral cannulation was established with femoral arterial, femoral venous, and right internal jugular vein cannulation. On the other hand, conventional approach was performed through full median sternotomy. The aortic and cava cannulations were done directly.

Shapiro-Wilk test was used to assess the normal distribution of the data, and Levene's test was used to assess the equality of variances. Then, independent samples t-test or Mann-Whitney U test was used. Categorical variables were compared using chi-square test or Fisher's exact test. The data were analyzed by means of IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA) and $P < 0.05$ was considered to be statistically significant.

4 Results

The clinical records of 51 patients were reviewed. Thirty patients (23 females and 7 males) undergoing RAMT and 21 patients (10 females and 11 males) undergoing CMS ASD closure completed retrospective clinical data collection. In addition, 28 patients in the RAMT group and 20 patients in the CMS group completed the study in quality of life assessment (Figure 1). Both groups were similar with respect to age, left ventricular ejection fraction, preoperative Hemoglobin (Hb) level, family status, level of education, and employment status (Table 1). However, a larger number of female patients were included in the RAMT group ($P = 0.04$) and RAMT patients had a lower body surface area ($P = 0.03$). Operation length, CPB time, and aortic cross clamp time were significantly lower in the CMS group ($P < 0.001$) (Table 2). No patients received blood products during CPB and packed cell transfusion rate was the same in both groups (Table 2). In addition, no patients in the two groups required reoperation for bleeding and no conversion from the RAMT to the median sternotomy was done.

The major primary postoperative complications, including death, Acute Myocardial Infarction (AMI), Congestive Heart Failure (CHF), and cerebrovascular accident, were not reported in the two groups (Table 2). Nonetheless, a Transient Ischemic Attack (TIA) was reported in the CMS group.

The results revealed no significant difference in the amount of Packed Red Blood Cell (PRBC) transfusion in the first and second 24 hours after surgery (Table 2). The results also showed no statistically significant difference in Hb level on the first and second postoperative days (Table 2). The two groups were also the same concerning the length of ICU stay, length of surgery ward stay, total length of hospital stay, and intubation time (Table 2). No cases of cannulation site complication, including femoral artery dissection, infection, or lower limb ischemia, were reported (Table 2).

The mean amount of chest tube drainage in the first 24 hours after surgery was 148.27 ± 122.82 mL in the RAMT group and 217.50 ± 134.04 mL in the CMS group ($P = 0.02$). The mean amount of chest tube drainage in the next 24 hours after surgery was 92.41 ± 60.86 mL in the RAMT group and 102.50 ± 75.17 mL in the CMS group (P = not significant). The mean amount of total chest tube drainage after surgery was 242.41 ± 152.44 mL in the RAMT group and 320.00 ± 188.06 mL in the CMS group ($P = 0.04$) (Figure 2) (Table 2).

Considering the assessment of HRQOL, three patients did not respond to phone calls and 48 patients completed the study (Figure 1); 28 patients (22 females and 6 males) in the RAMT group and 20 patients (9 females and 11 males)

Table 1. Preoperative Patients' Characteristics for Assessment of Early Clinical Outcomes

Variables	RAMT Group	CMS Group	P-value
N	30	21	
Age, years	10.99 ± 33.13	13.54 ± 38.14	0.186
Range	16 - 69	19 - 62	
Male, n (%)	7 (23.3)	11 (47.6)	0.042
Female, n (%)	23 (76.7)	10 (52.4)	
HTN, n (%)	2 (6.7)	4 (19)	0.181
DM, n (%)	1(3.3)	3(14.3)	0.184
Smoking, n (%)	1(3.3)	0 (0.0)	0.5
Addiction, n (%)	0 (0.0)	0 (0.0)	-
Height, cm	163.16 ± 9.73	167.33 ± 12.0	0.197
BSA, m²	1.68 ± 0.18	1.80 ± 0.20	0.030
EF, %	56.33 ± 4.53	54.19 ± 7.50	0.46
Range	45 - 65	38 - 65	
Hb (preoperative), gr/dL	13.59 ± 1.58	13.79 ± 1.64	0.672
Family status			
Married, n (%)	27 (90)	17 (81)	0.301
Single, n (%)	3 (10)	4 (19)	
Divorced, n (%)	0 (0)	0 (0)	
Education, years	10.33 ± 4.07	9.76 ± 4.24	0.544
Range	5 - 16	5 - 18	
Employment			
Homemaker, n (%)	18 (60.1)	9 (42.9)	0.293
Employed, n (%)	4 (13.3)	2 (9.5)	
Self-employed, n (%)	7 (23.3)	10 (47.6)	
Student, n (%)	1 (3.3)	0 (0)	

Abbreviations: EF, ejection fraction; BG, blood group; Hb, hemoglobin; BSA, body surface area; HTN, hypertention; DM, diabetes mellitus. The values have been presented as mean ± SD; $P < 0.05$ is considered as statistically significant; bold values indicate $P < 0.05$.

Table 2. Intra- and Post-Operative Results

Variables	RAMT Group	CMS Group	P-value
N	30	21	
Operation time, hour	4.85 ± 0.54	3.24 ± 0.45	< 0.001
CPB time, min	85.60 ± 27.14	54.38 ± 21.48	< 0.001
AXC time, min	46.13 ± 13.68	29.00 ± 16.09	< 0.001
Mortality, n (%)	0(0.0)	0(0.0)	-
AMI, n (%)	0(0.0)	0(0.0)	-
CHF, n (%)	0(0.0)	0(0.0)	-
TIA, n (%)	0(0.0)	1(4.8)	0.412
AKI, n (%)	0(0.0)	0(0.0)	-
PRBC transfusions during CPB, mL	0	0	-
PRBC transfusions in OR, mL	93.63 ± 169.15	90.52 ± 197.68	0.980
Range	0-500	0-810	
PRBC transfusions within 24 h, mL	45.06 ± 102.50	65.19 ± 119.49	0.384
Range	0 - 275	0 - 275	
PRBC transfusions in the next 24 h, mL	52.26 ± 106.34	52.33 ± 110.55	0.804
Range	0 - 268	0 - 275	
Total PRBC transfusions, mL	191.13 ± 242.49	208.04 ± 321.16	0.663
Range	0 - 756	0 - 1359	
Chest drainage in the first 24 h, mL	148.27 ± 122.82	217.50 ± 134.04	0.024
Chest drainage in the next 24 h, mL	92.41 ± 60.86	102.50 ± 75.17	0.612
Chest drainage in total, mL	242.41 ± 152.44	320.00 ± 188.06	0.048
Hb in the first 24 h, gr/dL	10.67 ± 1.54	9.74 ± 1.59	0.054
Hb in the next 24 h, gr/dL	9.04 ± 1.29	8.72 ± 1.91	0.531
ICU stay, day	2.80 ± 0.49	2.55 ± 0.51	0.095
Surgery ward stay, day	4.00 ± 1.17	3.63 ± 0.83	0.37
Total of hospital stay, day	6.751.35	6.05 ± 1.43	0.281
Mechanical ventilation, h	6.61 ± 1.74	7.18 ± 2.44	0.400
Cannulation site complication, n (%)	0(0.0)	0(0.0)	-
Re-operative for bleeding, n (%)	0(0.0)	0(0.0)	-
Residual shunt, n (%)	0(0.0)	0(0.0)	-

Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; CVA, cerebrovascular accident; TIA, transient ischemic attack; AKI, acute kidney injury; CPB, cardiopulmonary bypass; AXC, aortic cross clamp time; PRBC, packed red blood cells; OR, operation room; Hb, hemoglobin; ICU, intensive care unit; MV, mechanical ventilation. The values have been presented as mean ± SD; P < 0.05 is considered as statistically significant; bold values indicate P < 0.05.

in the CMS group. The results revealed no significant difference between the two groups regarding the mean PCS score (P = 0.164), mean MCS score (P = 0.912), and total HRQOL score (P = 0.42) after surgery. Analysis of HRQOL was also done by dividing the patients by sex. The results indicated no significant difference between males and females regarding the mean score of MCS and total score of HRQOL. Nevertheless, the mean score of PCS was significantly better in female patients in the RAMT group (P = 0.03) (Figure 3).

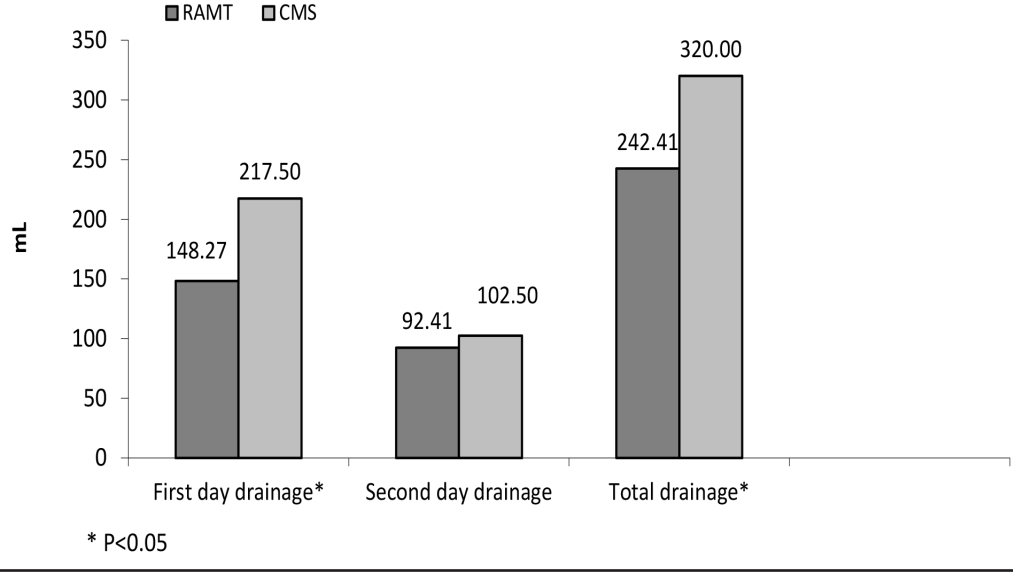
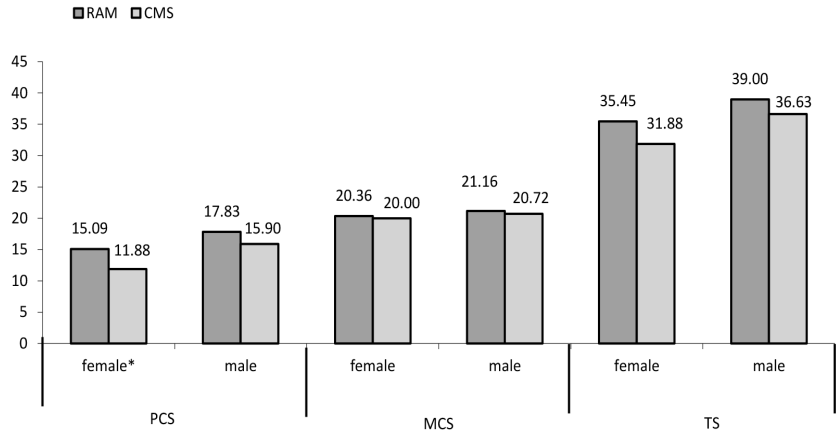


Figure 2. Comparison of the RAMT and CMS Groups Regarding the Amount of Chest Tube Drainage

Figure 3. Comparison of the Two Groups Regarding the Mean Score of Health-Related Quality of Life Based on Sex



Abbreviations: PCS, physical component summary; MCS, mental component summary; TS, total score; the values are mean ± SD; P < 0.05 is considered statistically significant; *P < 0.05.

5. Discussion

Cardiac surgery was one of the last specialties, which developed minimally invasive approaches (18). After having optimum results in cardiac operations, the thought of less invasiveness and better cosmetic results was one of the desires of patients and physicians (19). In this context, the major obstacles were safe exposure and peripheral cannulation for a safe cardiopulmonary bypass (20). In 1996, Carpentier was the first who operated a mitral valve through right minithoracotomy and peripheral cannulation (21). After that, RAMT increasingly became one of the most popular MICS approaches and several centers reported their results. Many centers reported RAMT approach as a safe method for operations on mitral valve, tricuspid vale, and ASD closure (1, 8, 22-24). In the present study, in addition to comparison of the clinical outcomes of RAMT and midsternotomy approaches, HRQOL was evaluated. The two study groups were homogeneous with respect to risk factors, such as age, diabetes, hypertension, smoking, and addiction. The results showed that RAMT with peripheral cannulation was a safe method with comparable or even superior results in some aspects, such as postoperative bleeding. Despite less postoperative bleeding and less Hb change in the RAMT group, transfusion rate was not higher in the sternotomy group.

Establishment of CPB by applying peripheral perfusion access is standard for many types of MICS, including ASD closure (25). The femoral artery is the first choice for arterial cannulation (26). In this situation, systemic perfusion from the femoral artery cannula is retrograde and is not physiologically normal (27). There are conflicting data showing cerebrovascular and peripheral cannulation site complications (28, 29). In this study, no cannulation site or lower extremity ischemia was detected in the two groups; the two groups had no cerebrovascular accidents, except for one patient in the CMS group who experienced TIA postoperatively.

HRQOL is a subset of the general concept of quality of life (30) that is subjective (31) and includes domains related to physical, mental, and social functions. In addition to increasing lifespan, a successful treatment should have an impact on the HRQOL (32). In the current study, the patients' quality of life was evaluated retrospectively. Based on the results, the two groups were matched regarding family status, level of education, and employment status. The used questionnaire evaluated the physical and mental components of quality of life. When all patients were analyzed, there was no significant difference between the two groups with regard to HRQOL. As satisfaction with surgery is generally lower in female patients and the two groups in the present study were not matched regarding sex, analysis of HRQOL was done on female and male patients separately. Interestingly, female patients showed a significantly better physical component outcome with the RAMT approach. In other words, female patients undergoing ASD closure through the RAMT approach had better physical functions and lower limitations caused by physical problems postoperatively. Because of lack of prior studies on quality of life, the results could not be compared to those of other studies.

5.1. Conclusion

Despite longer operation and CPB times, the RAMT procedure was associated with similar mortality and less postoperative bleeding. Moreover, female patients in the RAMT group showed better outcomes in the physical component of HRQOL.

5.2. Ethical Approval

IR.MUI.MED.REC.1398.616

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Authors' Contribution

Study concept and design: A.M., B.F., and M.M.; analysis and interpretation of the data: A.M., B.F., and M.M.; drafting of the manuscript: B.F.; critical revision of the manuscript for important intellectual content: A.M., M.M., and S. B.; statistical analysis: B.F.

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Financial Disclosure

The authors have no financial interests related to the material in the manuscript.

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