Original Article Research

MINIMALLY INVASIVE ATRIAL SEPTAL DEFECT CLOSURE-OURINITIALEXPERIENCEWITHTHEFIRSTHUNDREDCASES AT OUR CENTRE

Dr. Anand Subraya Bhat[1*], Dr. NihazNazer[2], Dr.Rajesh Kishan Rao[3], Dr.Cholenahally Nanjappa Manjunath[4]

[1]AssistantProfessor, Department of Cardiothoracic Surgery,Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bangalore

[2]Postgraduate, Department of Cardiothoracic Surgery, Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bangalore

[3]Professor, Department of Cardiothoracic Surgery, SriJayadeva Institute of Cardiovascular Sciences and Research, Bangalore

[4]DirectorandProfessorofCardiology,Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bangalore

***Corresponding author: Dr. Anand Subraya Bhat**

*Assistant Professor, Department of Cardiothoracic Surgery,Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bangalore

Abstract

Background:- Atrial septal defect (ASD) is the most common acyanotic congenital heart defect detected in early adulthood or diagnosed incidentally in childhood. Most ASDs are known to close spontaneously. The standard surgical approach for ASD is a full midline sternotomy. With advances in minimally invasive cardiac surgery, we present this retrospective analysis of the first (n=100) cases of MICS-ASD closure at our institute.

Methods and materials:- The first 100 (n=100) patients with ASD undergoing minimally invasive cardiac surgery by a single surgical unit were included. Venous cannulation was done to the Internal Jugular Vein (IJV) and Superior Venacava (SVC), while arterial cannulation was done to the femoral artery.

Results:-Of the (n=100) patients, 65%werefemale, with a normal BMI and a mean age of 36.22 +/- 12.44 years. None of the patients underwent re-exploration for bleeding and tachyarrhythmia or did any patients have low cardiac output syndrome (LCOS) requiring additional inotrope support.

Conclusion:- Minimally invasive ASD closure is a sound alternative to conventional sternotomy, offering a better post-operative course for the patient.

Keywords*:* Congenital heartdisease, minimallyinvasivecardiacsurgery, thoracotomy, sternotomy

Introduction

Atrial septal defect (ASD) is the most common acyanotic congenital heart defect with a very high incidence and prevalence in a developing nation like India. Despite it being a congenital heart disease, surgery is curative in nature. Most patients present in early adulthood or are diagnosed incidentally in childhood. Most ASDs are known to close spontaneously [1-5].

When patients are asymptomatic or present with chest pain, palpitations or fatigue, isolated ASDs are considered for either device closure or surgical correction. The standard surgical approach for such patients is a full midline sternotomy, to establish aorto-bicaval cardiopulmonary bypass [6]. However, in the last 20 years or so, small incision cardiac surgery or minimally invasive cardiac surgery (MICS)has gained popularity as the younger generation is concerned about disfigurement and visible carring. As surgical correction of an ASD is relatively straightforward, MICS can be offered for suitable patients. Our center, being a dedicated cardiovascular institute, has made great strides in performing MICS for patients with ASD. Hence, we present this retrospective analysis of the first (n=100) cases of MICS- ASD closure at our institute.

Methods and Materials

This is a retrospective case record-based study that include total of (n=100) consecutive patients, who underwent minimally invasive ASD closure at our institution by a single surgical unit from January2017 to December 2020. Patients who underwent concomitant procedures, such as the Maze procedure, Mitral valve annuloplasty, and Tricuspid valve annuloplasty, were excluded. A hundred patients with isolated ASD closure constituted the final study population. The age of the patients was between 16 and 73 years. Preoperative, operative, and postoperative data were collected from patients medical records. The patients during surgery were positioned with their right side up by inserting towels under the right back. A small incision (approximately 3-4 cm) was made in the upper thigh region for femoral artery and vein exposure. A purse string suture was applied at the common femoral vein, a venous cannula was inserted, and the tip was positioned at the inferior venacava (IVC) level under trans- esophageal echocardiography guidance. Another venous cannula was inserted via the internal jugular vein and positioned at the superior venacava (SVC) level. Internal jugular vein (IJV) cannulation was aided by Ultrasonography-guided puncture in the operative field in selected cases where the blind puncture of the IJV was not successful for cannulation. Two venous cannulae were connected to a Y-connector. A purse string suture was applied at the common femoral artery, and an arterial cannula was inserted (figure1.1). A small anterolateral thoracotomy (approximately4-6 cm) was made at the mid-axillary line, and the pleural cavity was entered through the fourth intercostal space (Figure 1.3) the pericardium was opened and retracted using a suture that passed through the chest wall via separate incision. The SVC and IVC were snared down with umbilical tape and a slider after cardiopulmonary bypass (CPB) was initiated. Aortic cross-clamp (ACC) was achieved using a Chitwood DeBakey Clamp (Scanlan International Inc., St. Paul, MN, USA) through a separate incision at the second inter costal space(Figure1.2).Cardioplegia was infused in an antegrade manner via the aortic root cannula. The right atrium was opened, and the ASD was closed using glutaraldehyde- fixed auto- pericardium (Figure 1.4). During the entire procedure, CO_2 gas was infused into the chest wall to reduce the risk of air embolism. The right atrium was closed in two layers with5-0 prolene, ACC was released, and CPB weaning and decannulation procedures were performed using standard techniques. Thoracotomy and femoral wounds were closed.

Statistical analysis

The value is presented as a number (%) or mean ± standard deviation. Categorical variables are described using frequency and percentage. Continuous variables are described as the means and standard deviation. Comparisons of categorical variables were performed using the chi-square or the Fisher exact test.

Results

This study included the first (n=100) patients that underwent ASD closure in our tertiary care institute. The mean age of the study population was found to be 36.22 +/- 12.44 years; the females were younger than the males (44.6±13.8 years v/s 32.4±11.3 years, p=0.033*). Majority of the study participants were females (65%) and remaining were males (35%) which corroborates with the findings of other similar studies.

Table1: Patientscharectistics (n=100)

Characteristics	MICS	odds	P-value
Sex			
Male	35(35%)	1.63	<0.001
Female	65(65%)	2.84	<0.001
Age(year)	36.22± 12.44	3.19	<0.001
Body mass index(kg/m^2)	21.7±3.1	1.88	<0.001
Ejection fraction(%)	54.1±5.4	1.97	<0.001
Congestive heart failure	0	-	-
Stroke	0	-	-
Arrhythmia	**1**	**<1**	**>0.001**

The preoperative ejection fraction was found to be reduced in only 18% of patients, while right ventricular and biventricular dysfunction was observed in 2%. Intra-operatively, it was observed that the core temperature achieved was 30.1 deg C ± 2.4 deg C, which is moderate hypothermia. This shows that despite the complexity of the procedure, the surgery can be performed with adequate myocardial protection even at moderate hypothermia.

Table2: Shows thevariousintraoperativeparametersduringaroutineMICSASDclosure.

Intraoperative parameters	MICS	odds	P-value
Coretemperature	30.1degC±2.4 degC	2.11	<0.001
Operatingtime	186.4±21.9minutes	1.25	<0.001
CPB time	106.1±14.1minutes	1.33	<0.001
Crossclamptime	68.9±11.3minutes	1.89	<0.001
Blood transfusion	19	3.07	<0.001

Values are presented as number(%)or mean ± standard.

Intra operative complications

In 3 patients there was tear in the site of the venous cannulation, which was managed with suturing. In 2 cases, there was atrial fibrillation noted. However, there were no deaths intraoperatively.

Post-operative

Due to the complexity of the procedure, the post-operative course is expected to best or my; this was not observed in our study. None of our patients underwent re-exploration for bleeding and tachyarrhythmia neither did any patients have low cardiac output syndrome (LCOS) requiring additional inotropic support. 7% of the patients presented with facial edema, which was managed conservatively. There was no mortality noted in this study.

Table3: Shows the various post operative parameters after a routine MICS ASD closure.

Postoperative parameters	MICS	odds	P-value
Re-exploration	0	-	-
Death	0	-	-
Stroke/CNSdeficits	0	-	-
Arrhythmias	2	1.08	<0.001
LCOS	0	-	-
Residual ASD	0	-	-

Fig1.1 Femoralincision with femoral venous cannula insitu **Fig1.2**Aorticcannulaand Cardioplegia cannula in situ

Fig 1.3 Mid axillary thoracotomy incision with retractor placed in situ **Fig 1.4** Sutures being taken through pericardial patch for ASD closure

Discussion

With the advent of the newer surgical techniques as well as minimal access, one of the incisions that is utilized commonly for the closure of atrial septal defects (ASDs) is a right mid-axillary thoracotomy. This method yields superior cosmetic results for patients, both in terms of exposure and overall appearance. MICS ASD closure is a technically challenging procedure. In our study, however, we observed that the operative time and post-operative recovery were similar to what surgeons routinely experience with midline sternotomy. According to the findings of Baharestani et al.[9], 75 patients were able to successfully undergo mini-thoracotomy using the central cannulation approach. It was determined that these alternate methods produced satisfactory outcomes in terms of cosmetic appearance. Also, Doll et al.[11] described their five-year experience with the right mini-thoracotomy and femoral cannulation approach with 122 patients for the treatment of lung cancer.

Besogul et al. [12]revealed their minimally invasive experience in treating 79 patients suffering from a variety of heart diseases. Mishra et al.[13] studied and compared two patient groups: 470 patients who underwent transcatheter closure and 170 patients who underwent MICS, there was no difference in outcomes between the two groups. While aesthetic outcomes are of the utmost importance; nonetheless, the primary considerations still revolve around determining the most effective technique of corrective surgery for the heart anomaly and minimizing the risk of postoperative complications. Adequate exposure, the safe delivery of cardiopulmonary bypass through central site, good myocardial protection, and de- airing prior to there turn of cardiac ejection are the primary considerations of a surgeon.[14,15]Our research team demonstrated that rightmid-axillarythoracotomy, which incorporates classic cannulation procedures with a more limited exposure of the heart, is a safe method for gaining access to the heart, even if there are multiple other incision methods that are already accessible. There was not a single case of intra operative mortality, neurological impairments, or any other issues during our experience with our100 patients. The length of the incision was greatly reduced, and the patient's overall satisfaction with the way they had healed cosmetically was high. The accumulation of these facts points to the fact that the method in question is one that is reliable and fruitful. In minimally invasive and robotic procedures, the femoral and jugular accesses are frequently employed to perform cardiopulmonary bypass.[16] On the other hand, the use of peripheral cannulation is associated with several potential problems. Bedeiret al.[17]found that there was an elevated risk of stroke among the 57 patients who were placed in the group that received femoral cannulation. Additionally, aortic dissection,[1] limb ischemia due to poor vascular diameter, seroma, pseudo aneurysm, chylothorax, or Horner syndrome may be observed as a result of cannulation of the jugular vein.[18-20] In addition, the length of the skin incision required for femoral-cannulated cardiac procedures was significantly longer than that required for central cannulation techniques, which is performed for a conventional midline sternotomy. Sternotomy, on the other hand, is the method that is used the most frequently for ASD closure; nevertheless, it does have some drawbacks. Sternal dehiscence, sternal wound infections, and mediastinitis are extremely dangerous consequences that can be associated with sternotomy. Complications from sternal wounds might also result in a major financial burden. However, minimallyinvasivemethodsarenotonlysuperiortomediansternotomyintermsofefficacyandcost-effectiveness, but they are also safer. In their comparison research of minimally invasive versus full sternotomy procedures, Cohne et al.[21]found that patients were able to return to their normal daily activities more quickly.

Conclusion

In the present study, we present our institutional experience of MICS ASD closure in the first 100 patients. We observed that despite the technical challenges observed with our patients, the intra-operative parameters and post-operative outcomes are good, and probably comparable with a conventional midline sternotomy. However, our study is limited by the lack of comparative data for various standard procedures, as well as the outcomes of ASD patients with concomitant procedures such as valve repair, coronary artery bypass grafting and those with complex congenital heart defects.Also,we lack the long-term follow- up data for these patients, which could be rectified with a longer duration of follow-upon this study.

Recommendation

Hence, based on the findings of this study, were commend MICSASD closure or which it is feasible for better cosmetic and surgical outcomes, with minimal complications.

Conflict of interest

There is no conflict of interest between funding agency and Institution.

Ethical approval

Institutional ethical approval was obtained Asper the SOP

Reference

1. Grossi EA, Galloway AC, LaPietra A, Ribakove GH, Ursomanno P, Delianides J, et al. Minimally invasive mitral valve surgery: a 6-year experience with 714 patients. *Ann Thorac Surg*. 2002;74(3):660-3. doi: 10.1016/s0003-4975(02)03754-2, PMID 12238820.
2. Taşoğlu İ, Sert DE, Demir A, Şahin S, Kavurt AV, Paç FA. Full sternotomy with limited skin incision for surgical treatment of atrial septal defect. *Turk Gogus Kalp Dama.* 2012;20(4):705-9. doi: 10.5606/tgkdc.dergisi.2012.142.
3. Däbritz S, Sachweh J, Walter M, Messmer BJ. Closure of atrial septal defects via limited right anterolateralthoracotomyasaminimalinvasiveapproachinfemalepatients.*EurJCardiothorac Surg*. 1999;15(1):18-23. doi: 10.1016/s1010-7940(98)00267-x, PMID 10077368.
4. Demirsoy E, Arbatli H, Unal M, Yagan N, Tukenmez F, Sonmez B. Atrial septal defect repair with minithoracotomy using two stage single venous cannula. J *Cardiovasc Surg (Torino).* 2004;45(1):21-5. PMID 15041931.
5. Shivaprakasha K, Murthy KS, Coelho R, Agarwal R, Rao SG, Planche C, et al. Role of limited posterior thoracotomy for open-heart surgery in the current era. *Ann Thorac Surg*. 1999;68(6):2310-3. doi: 10.1016/s0003-4975(99)00756-0, PMID 10617022.
6. Xiao C, Gao C, Yang M, Wang G, Wu Y, Wang J, et al. Totally robotic atrial septal defect closure: 7-year single institution experience and follow-up. *Interact Cardiovasc Thorac Surg*. 2014;19(6):933-7. doi: 10.1093/icvts/ivu263, PMID 25228242.

7. Barbero-Marcial M, Tanamati C, Jatene MB, Atik E, Jatene AD. Transxiphoid approachwithout median sternotomy for the repair of atrial septal defects. *Ann Thorac Surg*. 1998; 65(3):771-4. doi: 10.1016/s0003-4975(97)01433-1, PMID 9527211.
8. Kaneda T, Nishino T, Saga T, Nakamoto S, Ogawa T, Satsu T. Small right vertical infra-axillary incision for minimally invasive port-access cardiac surgery: a moving window method. Interact Cardiovasc Thorac Surg. 2013;16(4):544-6. doi: 10.1093/icvts/ivs544, PMID23293265.
9. Baharestani B, Rezaei S, Jalili Shahdashti F, Omrani G, Heidarali M. Experiences in surgical closure of atrial septal defect with anterior mini-thoracotomy approach. *J Cardiovasc Thorac Res.* 2014;6(3):181-4. doi: 10.15171/jcvtr.2014.008, PMID 25320666.
10. ErcanOİÜ.CerrahpaşatıpFakültesisüreklitıpeğitimietkinliklerisempozyumdizisi. *AdolesaninFizikselGelişimi*.2008;63(Mart).s13-8.
11. Doll N, Walther T, Falk V, Binner C, Bucerius J, Borger MA, et al. Secundum ASD closure using a right lateral minithoracotomy: five-year experience in 122 patients. *Ann Thorac Surg*. 2003;75(5):1527-30; discussion 1530. doi: 10.1016/s0003-4975(02)04889-0, PMID 12735574.
12. Beşoğul Y, Ozcan V, Yavuz T, Tünerir B, Aslan R. Experiments on minimally invasive open heart surgery using right anterolateral minithoracotomy. [Article in Turkish]. Anadolu Kardiyol Derg. 2002;2(4):309-12. PMID 12460828.
13. Mishra S, Tomar M, Malhotra R, Radhakrishnan S, Mishra Y, Iyer KS, et al. Comparison betweentranscatheterclosureandminimallyinvasivesurgeryforfossaovalisatrialseptaldefect: a single institutional experience. *Indian Heart J*. 2008;60(2):125-32. PMID 19218721.
14. Wu Q, Luo G, Li S, Shen X, Lu F. Comparison of different approaches for pediatric congenital heart diseases. *Asian Cardiovasc Thorac Ann*. 2003;11(3):226-8. doi: 10.1177/ 021849 23030 1100310, PMID 14514553.
15. Nicholson IA, Bichell DP, Bacha EA, del Nido PJ. Minimal sternotomy approach forcongenital heart operations. *Ann Thorac Surg.* 2001;71(2):469-72. doi: 10.1016/s0003-4975(00)02328-6, PMID 11235691.
16. Wang Y, Wang G, Gao CQ. Ultrasound-guided cannulation of the internal jugular vein in robotic cardiac surgery. *Chin Med J* (Engl). 2013;126(13):2414-7. PMID 23823810.
17. Bedeir K, Reardon M, Ramchandani M, Singh K, Ramlawi B. Elevated stroke risk associated with femoral artery cannulation during mitral valve surgery. *Semin Thorac Cardiovasc Surg*. 2015;27(2):97-103. doi: 10.1053/j.semtcvs.2015.06.008, PMID 26686431.
18. Van de Woestijne PC, Oei FB, Bogers AJ. Minimally invasive atrial septal defect closure. Multimed Man Cardiothorac Surg. 2014;2014:mmu002. doi: 10.1093/mmcts/mmu002, PMID 24618339.
19. Saxena P, Shankar S, Kumar V, Naithani N. Bilateral chylothorax as a complication of internal jugular vein cannulation. *Lung India*. 2015;32(6):675-6. doi: 10.4103/0970-2113.168118,PMID 26664196.
20. Nowak ŁR, Duda K, Mizianty M, Wilczek M, Bieda T. Horner syndrome after unsuccessful venous port implantation by cannulation of the right internal jugular vein. *AnaesthesiolIntensive Ther*. 2015;47(4):336-8. doi: 10.5603/AIT.2015.0049, PMID 26401742.
21. CohnLH,AdamsDH,CouperGS,BichellDP,RosboroughDM, SearsSP,etal. Minimally invasive cardiac valve surgery improves patient satisfaction while reducing costs of cardiac valve replacement and repair.AnnSurg.1997;226:421