

Minimally Invasive Repair of Atrial Septal Defects—A Case Series

M J Naik,*^{MBBS, MS, FRCS}, Y L Chua,**^{FAMS, MBBS, FRCS}

Abstract

Introduction: Repair of atrial septal defects in adults has become so safe that emphasis is now placed on improving cosmesis without compromising safety. The results of our series of minimally invasive repair of atrial septal defects done through a lower partial sternotomy are reported. **Materials and Methods:** Eight adult patients underwent minimally invasive repairs of atrial septal defects over a period of 1 year (Group 1). Conventional repairs of atrial septal defects were performed in 26 patients over the same period (Group 2). We describe the technique and compare our results on time taken for surgery, bypass time, cross clamp time, time to extubation and total hospital stay. Early complications and complications at 1 year are also presented. **Results:** No difference in the demographic data was found between the two groups. The time taken for surgery was more, while cross clamp times and bypass times were shorter in Group 1. There was also no difference in the amount of blood loss, early postoperative complications and later complications like cardiac rhythm or wound pain. **Conclusion:** The improved cosmetic appearance, both in males and females, is an important factor to recommend minimally invasive repair of atrial septal defects in an adult population. Surgical closure of atrial septal defects can be performed through a lower partial sternotomy without compromising access or safety with good cosmetic outcome.

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Key words: Atrial septal defect, Cosmesis, Lower partial sternotomy, Minimally invasive repair

Introduction

Atrial septal defect (ASD) forms the commonest grown up congenital heart diseases seen in cardiac surgical practice. Repair of this has become so safe that the emphasis now is on cosmetic outcome. The development of catheter based techniques and popularisation of minimally invasive cardiac surgery has put pressure on the cardiac surgeons from both the lay public and peers for less invasive procedures. Various approaches are being assessed and the advantages and disadvantages compared. The results of our series of minimally invasive repair of ASD done through a lower partial sternotomy are presented.

Material and Methods

Study Population

From March 1997 to March 1998, 8 adult patients (7 females and 1 male) underwent minimally invasive repairs of atrial septal defects (Group 1). In the same period, 26 adult patients underwent repair of atrial septal defects using a full median sternotomy and conventional cardiopulmonary bypass (Group 2). All surgeries were performed by one surgeon (CYL). There was no difference in the

demographic data between the two groups (Table I). Other parameters like cross clamp time, bypass time, time taken for surgery, time to extubation and total hospital stay were compared. The early postoperative complications and blood transfusion requirements were also assessed. All patients were followed up for a minimum period of 1 year and the results compared.

Technique

A lower partial median sternotomy was used to gain access to the heart. The initial incisions were 10 cm in length but we soon managed to do the same procedure through a 6-cm incision (Fig. 1). The incision was centred over the lower sternum up to the top end of the xiphisternum. The skin and subcutaneous tissue were undermined superiorly and inferiorly to gain better access. The xiphisternum was exposed and divided. Sternotomy was started from the lower end and extended upwards. The manubrium was not divided in any of the cases and neither was the sternotomy extended into the intercostal spaces. The thymus was dissected away and the pericardium was opened up to its reflection on the ascending aorta. Full

* Registrar

** Senior Consultant

Department of Cardiothoracic Surgery
National Heart Centre

Address for Reprints: Dr M J Naik, Department of Cardiothoracic Surgery, National Heart Centre, Mistri Wing, 17 Third Hospital Avenue, Singapore 168752.
E-mail: mjnaik@yahoo.com

TABLE I: CHARACTERISTICS OF PATIENTS

Variable	Minimally invasive (n = 8) Mean $\pm$ SE (range)	Conventional (n = 26) Mean $\pm$ SE (range)	P value
Age (years)	25.04 $\pm$ 2.88 (16.49 to 36.43)	33.75 $\pm$ 3.14 (7.15 to 62.29)	0.155
Gender (M:F)	1:7	9:17	–
Height (cm)	159.53 $\pm$ 2.87 (149 to 174.5)	156.95 $\pm$ 2.89 (122 to 178)	0.745
Weight (kg)	52.86 $\pm$ 3.48 (40.1 to 74.2)	51.35 $\pm$ 3.03 (15.8 to 72.9)	0.839

SE: standard error

exposure of the heart was not obtained because of the variation in spatial orientation of the incisions on the skin, sternum and the pericardium. The following manoeuvres were hence performed. A goligher retractor was placed at the upper end of the sternotomy to retract upwards and outwards. Pericardial stay sutures were placed on either side of the aorta on to the periosteum of the inner table of the sternum, which brought the aorta into the field of

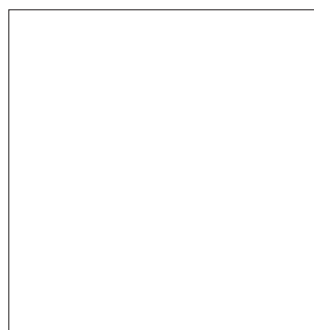


Fig.1a.

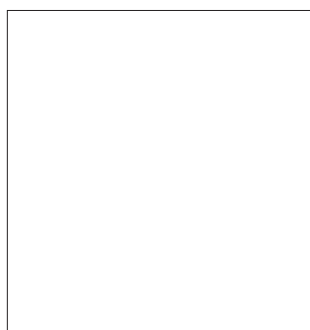


Fig.1b.

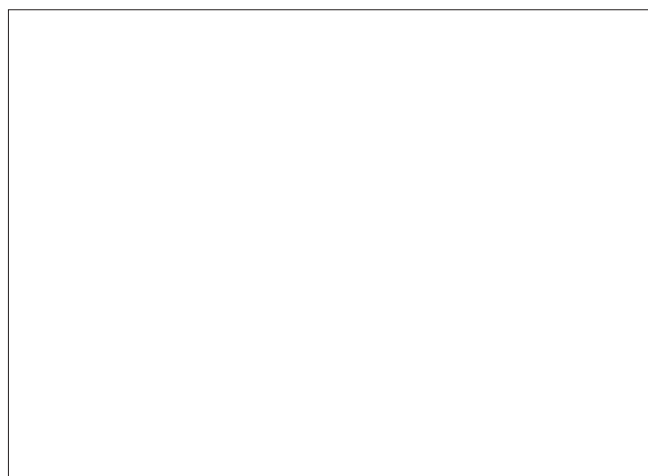


Fig.1c.

Fig.1. (a) Lower sternotomy incision; (b) incision well covered with clothes worn; (c) measurements shown.

surgery. This increased the ease of cross clamping and cardioplegia. Cardiopulmonary bypass was instituted by femoral arterial cannulation through a transverse incision in the groin crease. Superior venacaval cannulation was performed through a purse string on the right atrial appendage and passing a straight cannula into the cava. Inferior venacaval cannulation is made easier by dividing the pericardium towards the right and downwards into the pericardial well. A stay suture was then applied deep in the well and mild traction applied towards the surface. Cannulation was effected by a right angle cannula so that it stays out of the surgical field. No special cannulas, retractors or instruments were used during the conduct of the operation. The patient's temperature was allowed to drift. Application of cross clamp and institution of antegrade cold blood cardioplegia were done in the conventional way. Closures of ASD were performed by either direct suture or a pericardial patch when necessary. De-airing was affected by passive filling of the left atrium and by gentle agitation of the heart before completing the procedure. This was supplemented by a modified valsalva manoeuvre to remove air from the pulmonary veins and active suction of the aortic root through the side arm of cardioplegia cannula. Right atrial closure was performed after removing the aortic cross clamp on a beating heart. Patient was fully rewarmed before being weaned off cardiopulmonary bypass.

Statistical Analysis

The SPSS package, version 8.0, was used for statistical analysis. Associations between qualitative variables were performed using the chi-square method. Quantitative variables were compared using the Mann-Whitney *U* test. Results are expressed as mean with standard error and the range given. Results were considered significant if the *P* value was less than 0.05.

Results

A total of 8 patients underwent minimally invasive repair of atrial septal defects during the 12-month period (Group 1). Two (25%) had a direct suture repair while 6 (75%) had pericardial patch repairs. The details of these patients including demographics, operative data, days in hospital and follow-up are summarised in Table II. On comparing the two groups (Table III), the time taken for surgery was more for Group 1 compared to Group 2. On comparing cross clamp times and bypass times, the time taken was shorter in Group 1. The differences, however, did not reach statistical significance (Fig. 2).

Loss of blood was minimal and there were no blood transfusions in either of the groups. Three patients in Group 2 developed atrial fibrillation in the postoperative phase against none in Group 1. Comparisons were also

TABLE II: DESCRIPTIVE STATISTICS OF PATIENTS UNDERGOING MINIMALLY INVASIVE REPAIR OF ATRIAL SEPTAL DEFECT

Patient no.	Age (y)	Sex	Height (cm)	Weight (kg)	Size of incision (cm)	Incision/height ratio	Surgical time (min)	Bypass time (min)	X-clamp time (min)	Time to extubation (min)	Days in hospital	Length of follow-up (mo)
1	17	M	174.5	74.2	9	0.05	175	56	32	155	8	20.8
2	23	F	163	56.3	10	0.06	170	45	27	200	6	16.3
3	29	F	166	50.4	9	0.05	175	50	29	260	5	14.5
4	37	F	159	48.1	9	0.06	215	43	23	185	5	15.5
5	23	F	155	50.1	6.5	0.04	185	54	27	0	8	13.2
6	17	F	152.7	40.1	6	0.04	150	45	16	160	5	15.4
7	36	F	149	49.8	6	0.04	155	50	29	315	5	23.7
8	32	F	157	53.9	6	0.06	145	39	20	80	6	11.0

TABLE III: COMPARISON OF OPERATIVE DATA

Variable	Minimally invasive Mean $\pm$ SE (range)	Conventional Mean $\pm$ SE (range)	P value
Surgical time (min)	178.75 $\pm$ 9.0 (145 to 215)	158.85 $\pm$ 8.0 (95 to 290)	0.070
Cross clamp time (min)	25.63 $\pm$ 1.93 (16 to 32)	27.73 $\pm$ 1.80 (16 to 62)	0.796
Bypass time (min)	47.75 $\pm$ 2.03 (39 to 56)	52.85 $\pm$ 2.69 (33 to 93)	0.436
Time to extubation (min)	176.88 $\pm$ 32.73 (0 to 315)	156.73 $\pm$ 42.45 (0 to 840)	0.347
Hospital stay (days)	6.00 $\pm$ 0.46 (5 to 8)	7.04 $\pm$ 0.31 (5 to 11)	0.084

SE: standard error

made for wound infections and atelectasis of the lung in the immediate postoperative period, which too did not show any difference. Transthoracic echocardiograms performed before discharge showed no residual shunts in any of the patients. At follow-up of 1 year, there was no significant difference seen in the incidence of sternal pain or scar hypertrophy and keloid formation. There was also no change in rhythm noted for patients in Group 1. The results are summarised in Table IV.

Discussion

Surgical repair of ASD has been performed with such low morbidity and mortality that the emphasis is now on better cosmetic outcome. Median sternotomy has been the conventional approach for repairs of these conditions. It has now fallen into disrepute because of the ugly scar¹ it leaves and the stigmata of cardiac disease.² Various alternative approaches have been tried with varying degrees of success. Anterior thoracotomy, bilateral submammary incisions, the Y incision, the trans-sternal and the parasternal approaches have all been tried and accepted by different groups.³⁻⁸ The later inclusions have been the video-assisted

TABLE IV: COMPARISON OF EARLY AND LATE COMPLICATIONS

Variable	Minimally invasive (n = 8)	Conventional (n = 26)	P value
Atrial fibrillation	0	3	0.314
Respiratory infection	0	3	0.314
Wound infection	0	2	0.419
Sternal pain	0	3	0.314
Scar hypertrophy	2	4	0.533

cardiac surgery (VACS) and the catheter-based techniques.

Though conceptually attractive, VACS⁹ has its own drawbacks. Not only does it need a mini thoracotomy (the manipulating incision), it also needs incisions for thoracoscopic ports.^{10,11} Cardiopulmonary bypass requires femoral and usually an additional cannulation like the jugular vein. Most series reported are direct suture repairs of small ASD and no fall back measure exists for large ASD or other associated pathologies. The ideal solution would be the development of catheter-based techniques like the buttoned or the double umbrella devices. However, they are still under development and awaiting approval. The indications are stringent and they can be used only when the defects are small and have a nice rim around. Device migration has also been described.¹²⁻¹⁵

An anterior thoracotomy is considered a good alternative in females because it gets hidden in the submammary crease or under the clothing.^{4,16} However, this is obviously not the best route for males for the above stated reasons. The disadvantages inherent in a thoracotomy are also well described. The exposure is slower and requires division of muscles of the anterior chest wall and sometimes the rib. Post-thoracotomy pain may result as a consequence of rib retraction, including injury to the rib articulation joints, ligamentous strain, rib fractures and intercostal nerve injury. Breast maldevelopment and loss of sensation in the nipple area are also well known.¹⁷ Modifications are being tried to overcome this, which increase the time and complexity of exposure.¹⁸ The difficulty of improving access in an emergency should also be borne in mind.

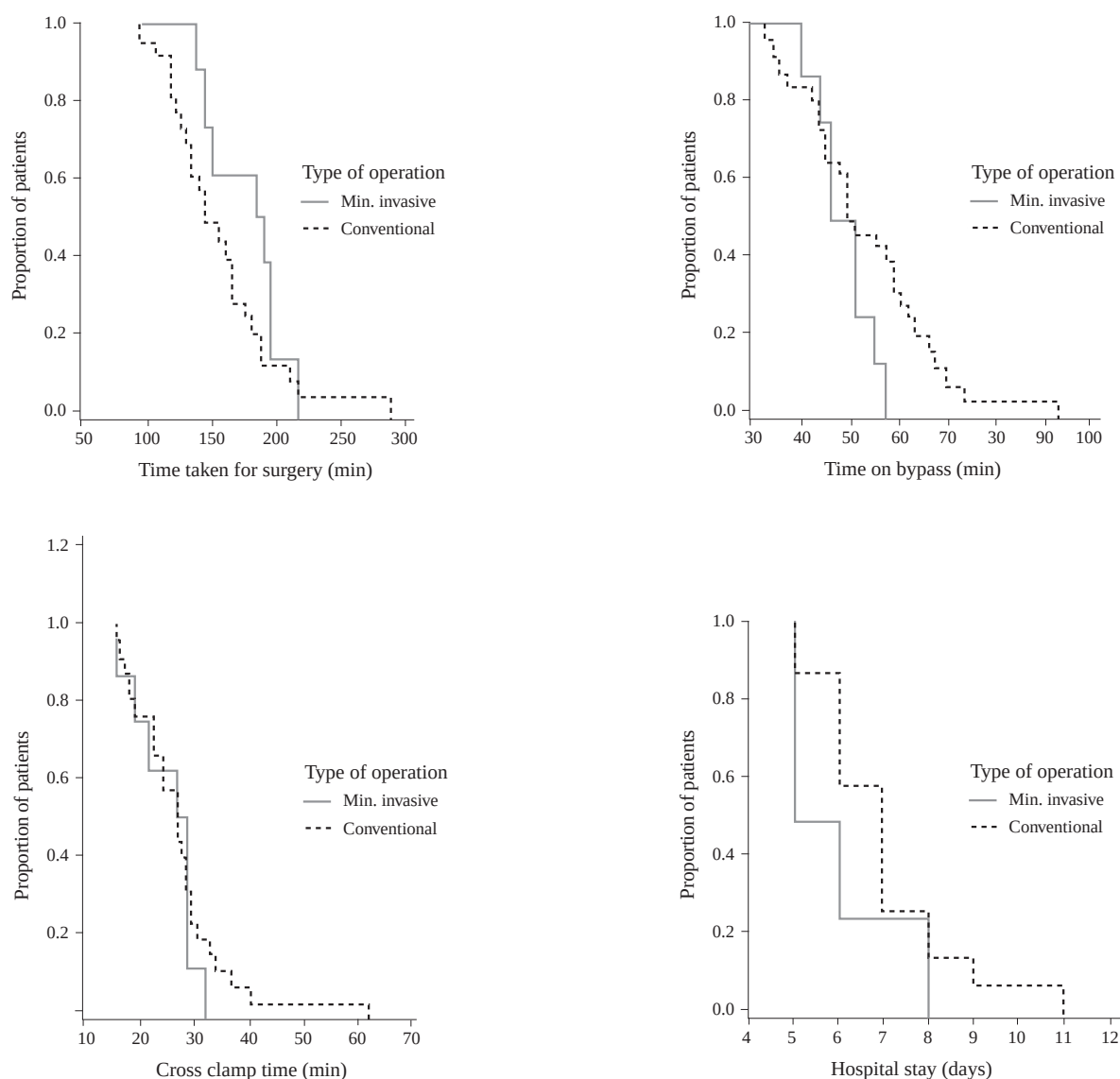


Fig. 2. Graphic representation of comparison of various phases of surgery and length of stay in hospital.

The advantage of a median sternotomy is that, it is the most common and the direct port of access for repair of almost all the common cardiac conditions.⁴ A vast cadre of surgeons are trained and are comfortable doing this. The more significant advantage is that it is possible to deal with any surprising findings like partial anomalous pulmonary venous return or mitral valve abnormalities after exposure of the heart.¹² A lower partial sternotomy gives an acceptable cosmetic appearance without compromising any of the advantages of a full median sternotomy. This has been well described in the paediatric population.¹⁹⁻²¹ Modifications of this with extension into the intercostal spaces have been described to perform almost all intracardiac surgeries.¹ An intact manubrium helps in the alignment of the cut edges of the sternum and also decreases postoperative pain. Respiratory mechanics are not interfered with, thereby,

accelerating recovery and decreasing length of stay. Direct aortic cannulation is possible in most of the patients through a lower partial sternotomy as we found in the later cases we did. This makes it truly minimally invasive, both cosmetically and as regards to trauma during surgery. The ease of conversion into a full sternotomy in case of an emergency gives added credence to this approach.

Cannulation of the femoral artery for cardiopulmonary bypass is described in almost all minimally invasive techniques of ASD repair. A transverse incision is preferred, not only because of the ease of exposure but also because of better healing and appearance of the scar. The long-term effects of these are not known and follow-up of these patients are important to know the true worth of these procedures.¹² Myocardial protection and de-airing are the next important hurdle. Most of the repairs through a

thoracotomy use cardiac fibrillation for myocardial protection and to avoid air embolism. Though animal experiments have shown that the myocardium is well preserved during cardiac fibrillation, the possibility of accidental defibrillation during surgery and the inherent risk of air embolism are well documented. Aortic cross clamping and cardioplegia become difficult and often require special instruments in procedures done through thoracotomies. In contrast, our technique allows every step of the procedure to be done as under conventional and controlled conditions. Control over de-airing is also lost in repairs through thoracotomies when the lungs are inflated for de-airing, unlike procedures through a sternotomy.

Conclusion

A full median sternotomy is not necessary for performing a surgical closure of ASD. The same results can be achieved with no greater surgical difficulty and better patient comfort using a lower partial sternotomy. The improved cosmetic appearance, both in males and females, is an added factor to emphasize this method.

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