

## RIGHT MINITHORACOTOMY: IS IT GOING TO BE THE ROUTINE APPROACH FOR SECUNDUM ASD SURGICAL CLOSURE?

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### ABSTRACT

**Background:** Ostium secundum ASD used to be surgically closed using the standard median sternotomy, Improvement in surgical techniques encouraged many surgeons to use minimally invasive approaches as an alternative to the conventional one.

**Aim of the work:** To evaluate the outcome and effectiveness of the right anterior thoracotomy approach as an alternative for the median sternotomy for surgical repair of secundum ASD.

**Methods:** This is a prospective observational study done on 50 adult patients diagnosed with ASD of ostium secundum type, indicated for surgery and not amenable to device closure. They were divided into two equal groups: group I, represented 25 patient who underwent ASD repair through conventional median sternotomy (CMS), and group II represented 25 patients underwent right minithoracotomy (RMT). Comparison between groups was done regarding clamp time, bypass time, ventilation time and ICU and hospital stay.

**Results:** Our study showed that RMT patients had significantly smaller incision, less time of mechanical ventilation, less ICU and hospital stay, though having more bypass time when compared with the conventional median sternotomy. No operative or in hospital mortality with excellent patient satisfaction.

**Conclusions:** RMT used for surgical closure of secundum ASD is a safe and effective procedure showing many advantages over sternotomy, and can be used as a routine approach for such cases.

**Key words:** ostium secundum, atrial septal defect, right mini thoracotomy, cardiac surgery, minimally invasive.

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### INTRODUCTION:

Although percutaneous device closure is widely used nowadays as the treatment of choice for closure of ostium secundum atrial septal defect ASD, it is still not suitable for many patients. Moreover, it has a reported rate of complications of 1.1-3.5% and some of these complications may be fatal and needs urgent surgery as migration. Minimal invasive congenital heart surgery, especially elective ones, is gaining more popularity due to its better cosmetic appearance, no sternal complications and shorter hospital stay<sup>[1]</sup>.

Median sternotomy has been considered as the approach of choice in both adult and congenital heart surgeries for many decades. However, it was regarded as a displeasing scar in some patients as young adult females, so much attention is paid nowadays towards the cosmetic appearance of scars post cardiac surgery. This led to evolution of alternative approaches to cardiac surgery as thoracotomies: posterolateral or antero-lateral, ministernotomy, and axillary incisions<sup>[2]</sup>.

In the recent era, more interest is gained towards more application of minimal invasive procedures in cardiac surgery. This mandates operating these procedures through a relatively small incision. Nowadays many cardiac surgeries are done through these incisions as coronary artery bypass grafting, valvular procedures and congenital heart surgeries. Among the benefits offered by these approaches is the lower trauma of surgery, low pain and discomfort post-operatively, and rapid recovery<sup>[3]</sup>.

Recently, the technological industrial advancement provides more methods of cannulation strategies for CPB, and more endoscopic instruments for these approaches which helped surgeons to overcome learning curves of these techniques more rapidly and increased their surgical performance<sup>[4]</sup>.

In the past few decades, surgical repair of ASD became more popular, and total endoscopic repair was found to be safe. More progression in competition with the potentially alternative methods of intervention led to more adoption of those minimal invasive approaches used in ASD repair. In many centers, conventional median sternotomy was abandoned and replaced by the different alternatives of less invasive approaches as thoracotomies, ministernotomies, and totally endoscopic repairs<sup>[5]</sup>.

Despite conventional median sternotomy in adults has a low mortality rate of 0-1%, low morbidity rate and recurrence rate of less than 1% , many patient are seeking for a better cosmetic, and more psychologically pleasing scar appearance. The shift from sternotomies to a small, less than 5 cm chest incisions has gained more popularity for this reason. This shift showed equivalency regarding mortality, morbidity and outcome. Consequently, more surgeons started shifting to minimal invasive approaches for ASD repair<sup>[5]</sup>.

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## PATIENT AND METHODOLOGY:

Between January 2019 and December 2021, fifty patients underwent surgical closure of ASD at National Heart Institute (NHI). Patients were divided into two groups: Group I containing 25 patients operated upon through CMS, and group II containing 25 patients of RMT.

### *Preoperative and Diagnosis:*

Our study was concerned with adult patient with age more than 18 years and weight more than 45 kg, with congenital heart disease, ostium secundum atrial septal defect, for patients not amenable for device closure. Exclusion criteria for mini-thoracotomy were:

1. Patients amenable for device closure.
2. Presence of other concomitant cardiac lesions or abnormalities.
3. Patient not willing to accept two incisions in case of failed procedure were excluded from the study.
4. Redo cardiac patients or right chest previous operations.
5. Severely Impaired Dilated RV, TAPSE less than < 1.5.
6. Severe Pulmonary HTN, PAP >70.
7. Peripheral vascular disease of the iliac or femoral vessels.

All patients were evaluated by transthoracic echocardiography preoperatively. Coronary angiography was performed in patients over 40 years of age, but no significant coronary artery disease was found. Routine CT aortography was performed for assessment of the femoral vessels size and calcific plaques.

### *Operative technique:*

Group (I): CMS, conventional median sternotomy group, incision was 20 to 25 cm long extending from the supra sternal notch

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down to the xiphoid process. Aorto-bicaval cannulation with application of tapes around both cavae. Vent was applied through upper superior pulmonary vein. ASD and Tricuspid valve exposure was done through the standard right atriotomy incision 2 cm away and parallel to the atrioventricular groove, and tricuspid valve annuloplasty was done on beating heart when indicated.

Group (II): RMT, right mini thoracotomy group, right sub-mammary

incision of 5–7 cm long was done at the 4<sup>th</sup> intercostal space, with peripheral femoro-femoral cannulation under transesophageal echo guidance. Double stage femoral vein cannula was used. Vessel loupes were applied. Antegrade cardioplegia was done through long shafted double way cannula. Vent was applied through upper superior pulmonary vein.

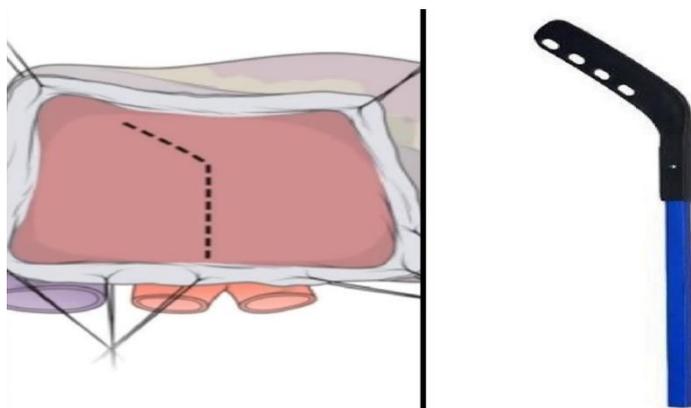


Figure (1): showing Hockey stick incision of the right atrium.  
Nguyen TC. Minimally Invasive ASD Repair: Step-by-Step Guide. February 2018. doi:10.25373/ctsnet.5904877.

Tricuspid valve and ASD exposure was done through a hockey stick right atriotomy perpendicular to the septum and extended towards the right atrial appendage figure (1). Nylon tape was applied around the venous

cannula retracting it away from the field of the ASD opening figure (2). Tricuspid valve annuloplasty, if indicated, was done on arrested heart.



*Figure (2): showing a nylon tape wrapped around the venous cannula allowing for better exposure of the ASD. (picture taken intra-operatively at National Heart Institute)*

### ***Anesthetic techniques and myocardial protection:***

#### **Premedication:**

5 minutes before surgery we start with 0.05-0.1 mg/kg of midazolam and 1 µg/kg of fentanyl were administered intravenously (IV).

#### **Monitoring:**

The electrocardiogram (ECG) ECG leads attached to the back of the patient to avoid slippage during surgery. Other standard noninvasive monitors include pulse oximetry, temperature probe or oropharyngeally and capnogram.

Invasive monitoring through arterial line in the radial artery to assess the arterial blood pressure.

Intra operative transesophageal echocardiography (TEE) was performed in all patients for the setup of both arterial and venous cannulation in the RMT group that proceeded under TEE guidance and for monitoring for cardiac function and confirm deaeration intra operatively for both groups.

#### **Intraoperative management:**

Induction of anesthesia, general anesthesia by intravenous injection of opioids based anesthesia, fentanyl 3-5 mcg/kg. Inhalational agent, either sevoflurane or isoflurane are used in 1-2 minimal alveolar concentration.

Neuromuscular bundle blockade is achieved by administering 0.5-1 mg/kg of atracurium IV before intubation. Anesthesia is maintained by infusion of fentanyl, atracurium and sevoflurane as we were planning for fast track extubation.

#### **Myocardial protection:**

Myocardial protection using intermittent perfusion of antegrade Del Nido cardioplegia solution in aortic root into the aortic root were conducted in both groups.

Intercostal block after ending of the surgery showed significant increases in arterial oxygen saturation (Sao<sub>2</sub>) and peak expiratory flow rate (PEFR) as well as provided sustained analgesia, leading to improvement in respiratory mechanics improving chances for fast track extubation. Bupivacaine 1.5 - 2.3 mg/kg, magnesium 100 mg, dexamethasone 2 mg provide post operative analgesia for 18-20 hours.

#### **Statistical analysis:**

Statistical presentation and analysis of data of the present study were conducted, using the mean, standard deviation and chi-square test by SPSS V.16. P value is considered significant when the test value equals to or less than 0.05.

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### **RESULTS:**

Regarding the preoperative characteristics and patients demographics, there was no statistically significant difference between the two groups, also there was no statistically significant difference between the two groups regarding the patients preoperative echo data, as shown in Table 1.

There was no statistically significant difference between the two groups regarding the type of operation, as shown in Table 2

There was a statistically significant difference between the two groups regarding the total bypass time in favor of group I, while cross-clamp time, and consequently, the reperfusion time; all were of no statistically significant difference as shown in Table 3.

There was no statistically significant difference between the two groups regarding Weaning of bypass, as shown in Table 4. In no cases conversion of the incision to median sternotomy was needed in group II.

Regarding ICU events, bleeding was higher in median sternotomy group, while

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mechanical ventilation time and ICU stay was significantly lower in RMT group. (Table 5) with the same percentage of re-exploration for bleeding.

Regarding hospital follow up events CMS group had higher superficial wound infection while in RMT group total stay was lower with the same ejection fraction pre-

discharge with no residual shunt in both groups. Regarding femoral cannulation we did not obtain any complication. There was a statistically significant difference between the two groups regarding the hospital stay in favor of group II with  $4.73 \pm 2.13$  days, (Table 6).

Table (1): Patients Demographics and preoperative clinical characteristics.

	I	II	P-value
Age	29.9±6.50	28.8±6.17	0.66
Male sex	10/15(40%)	9/16 (36%)	0.78
Body S. area (m2)	1.88±0.2	1.91±0.25	0.43
DM	1 (4%)	2 (8%)	0.56
HTN	3 (12%)	2 (8%)	0.65
Hepatitis c	2 (8%)	3 (12%)	0.65
Tricuspid disease	5 (20 %)	3(12%)	0.78
NYHA class III	15 (60 %)	16 (64 %)	0.78
NYHA class IV	10 (40%)	9 (36%)	0.78
EF (%)	60.48±6.32	61.36±5.87	0.63

Table (2): incidence of tricuspid repair in both groups.

	I	II	p Value
ASD repair	21 (84 %)	24(96%)	0.39
ASD and Tricuspid repair	4 (16 %)	1(4%)	0.16

Table (3): Cardiopulmonary bypass data in both groups.

	I	II	p Value
Total bypass	50.9±12.6	64.9±11.4	< 0.001
Cross clamp time	37.7±9.3	40.1±9.1	0.82
Reperfusion time	13.2±3.3	15.1±3.6	0.04

Table (4): Weaning of bypass.

	I	II	p Value
Spontaneous recovery	4 (16%)	5 (20%)	0.72
D.C. shock (no/patient)	5 (20 %)	3(12%)	0.78
Blood transfusion	3(12%)	1 (4%)	0.31
Conversion to sternotomy	Not applicable	0 (0%)	Not applicable

Table (5): Major ICU events.

	I	II	p Value
Blood loss 24hr	430±230.04	262±124.40	< 0.001
Reopening for bleeding	1 (4%)	0 (0%)	0.32
Duration of Inotropes/hrs	9.82±3.05	7.04±4.07	0.07
M. ventilation /hrs	7.52±2.84	5±2.81	< 0.001
Total ICU stay / days	2.48±0.65	1.92±0.64	< 0.001

Table (6): Postoperative complications among the two studied groups.

	I	II	p Value
Superficial Wound infection	4 (16%)	2 (8%)	0.39
Deep sternal infection	0 (0%)	Not applicable	Not applicable
EF (%)	59.08±16.32	58.76±15.6	0.85
Hospital stay	6.93±1.98	4.73±2.13	<0.001

## DISCUSSION:

With the continuous progress of catheter based therapeutic techniques, still the secundum ASD represents the only type that can be closed by this technique. Even in this defect there is several factors that threatens the success of it, as deficient rims to house the device, and the presence of aneurysm of inter atrial septum.<sup>[6&7]</sup>

### Positioning:

Regarding the patient position, through our study the patients underwent conventional sternotomy were lying in supine position while patient in group II were lying with the right hemi thorax elevated 30 degrees. Same was reported by Vivek et al and Nicola et al in their studies as they positioned their patients in the same manner.<sup>[1&8]</sup>

### Central vs Peripheral cannulation:

Venous cannulation, we used to cannulate the femoral vein first in order not to obstacle the femoral artery cannula, we used one double stage venous femoral cannula to secure venous drainage. Other studies suggested bicaval cannulation through two cannulas femoral and internal

jugular venous positioned in the SVC and inferior vena cava (IVC) under transesophageal echocardiography (TEE) guidance<sup>[5]</sup>.

Arterial cannulation, femoral artery was cannulated directly in 20 cases (80%) and using a prosthetic tube graft 8 mm in diameter in 5 cases (20%).Same results were obtained by other studies.<sup>[9-11]</sup>

### Peripheral cannulation:

In our study we did not obtain any complication from the femoral cannulation. Among the possible complications of this cannulation is arterial dissection, embolism, wound infection, leg ischemia, lymphocele, fistula and femoral vessels stenosis.<sup>[12]</sup> Some studies showed incidence of peripheral leg ischemia which was attributed to cannulation of small diameter femoral vessels, missing the common femoral or undiagnosed vascular lesion of the femoral artery.<sup>[13]</sup>

### Instrumentation:

In our study we did not use the long shafted instruments used in valvular surgery, only the Chitwood type cross clamp, which make this technique easily applicable in

many centers with low costs, same philosophy was adopted by Chen et al in their study. However they used special minimally invasive instruments for the procedure, they also confirm that simple instruments are enough for performing the surgery. Only Chitwood type transthoracic aortic clamp was important to replace the conventional one.<sup>[1]</sup> Other studies reported usage of an endoaortic balloon clamp into the proximal ascending aorta.<sup>[5]</sup>

#### **Learning curve of surgical technique:**

Usually the resistance to adoption of new surgical techniques arises from the learning curve it requires to master this technique. There was definitely a rising learning curve in our study which led to less time needed to complete the procedure and on table extubation of five cases from the last ten cases done on this study. This was also elicited by Wadhew et al in their study with rising up learning curve.<sup>[1, 10&11]</sup>

#### **Cardiopulmonary bypass (CPB) and aortic cross-clamping times:**

In our study bypass time was significantly higher in group RMT than sternotomy group. This is attributed to the fact that opening the pericardial sac and further steps of the procedure were done after establishing CPB. On the other hand, clamp time was almost the same in both groups owing to the same surgical steps of pericardial patch closure of the defect once approached. This finding was in accordance with many studies<sup>[12&14]</sup>. This runs in the same line with a study done by Shahrukh et al who showed a bypass time of mean 69.9 minutes<sup>[15]</sup>. Other studies showed that bypass time was similar comparing minimal invasive approach to sternotomy, with clamp time slightly higher in minimal invasive one than sternotomy. ( $65 \pm 23$  Vs  $62 \pm 22$  minutes)<sup>(1)</sup>.

#### **Conversion to full sternotomy:**

In our study there was no patients who needed conversion from RAT to full

sternotomy. This runs in the same direction with a study done by Juan et al, comparing sub-mammary incision with axillary incision in repair of ASD in a study containing 20 patients. They did not get any conversion rate to full sternotomy.<sup>[16]</sup> Other study done by William et al, containing 68 patient with no cases of conversion<sup>[17]</sup>. In a study containing 33 patients operated upon through RAT compared to trans catheter closure, no conversion cases were reported<sup>[18]</sup>.

#### **Blood loss and need of transfusion**

Our study showed that blood loss was significantly higher in Group I compared to group II. We reported  $262 \pm 124.40$  ml blood loss during the first 24 hours post operatively in RAT group with no cases needed re-exploration for bleeding compared to only one patient in sternotomy group. Other studies showed  $140 \pm 57$  mL<sup>[14]</sup>. In a similar study done by Narihiro I et al, comparing RAT with sternotomy, showed the same results in 21 patients included in the study. They compared intra operative blood loss in both groups and was found to be significantly less in RAT group  $88 \pm 52$  mL vs  $208 \pm 141$  mL.<sup>[18]</sup>

#### **Duration of ICU stay and mechanical ventilation:**

Our study showed that patients operated upon through RAT has a significantly less time of mechanical ventilation than sternotomy ones, even we had 5 patients in the last 10 cases were extubated on table 5.

This may be attributed to a rising learning curve which included surgeons as well as anesthetists' difference in time of ventilation between the two groups was about two hours. Consequently, this was reflected on ICU stay time and total hospital stay which was significantly lower in RMT group. This is almost a constant finding in all studies discussing the minimal invasive approach and comparing it to the conventional one, even in valvular

surgeries<sup>[12&4]</sup>. According to Svensson et al.; they reported a higher proportion of patients extubated in the operating theater<sup>[11]</sup>.

### Cosmetic effects:

One of the most important outcome of minimally invasive approaches is the cosmetic appearance and obtaining a pleasant scar. Demographic data of our study showed that 64% of patients were

females with mean age  $28.8 \pm 6.17$  years, with a scar post operatively of 7-8 cm hidden under the breast which gave them an excellent cosmetic appearance and patient satisfaction. Many centers started to use the minimal invasive technique for closure of ASD with good outcome and efficiency same as median sternotomy with better patient satisfaction and pleasing cosmetic scar appearance<sup>[12-14]</sup>.



*Figure (3): showing scar appearance immediate post operative.*

### Duration of hospital stay and functional recovery

One of the most favorable outcomes of less invasive approaches is to reduce surgical aggression and consequently, enhance the early functional recovery. In our study the average hospital stay was 4.73 (Table 6) for RMT. This approach noticed to universally decrease the hospital stay, and most of authors observed same results regarding the duration of hospitalization<sup>[5&12-14]</sup>.

### Mortality:

Regarding mortality we did not obtain any in-hospital mortality in both groups. This is in accordance with many studies evaluating the outcome and efficacy of minimally invasive approach and renders the RMT approach as a safe and effective one for secundum ASD repair<sup>[12,14,15&18]</sup>

### Limitation:

Among the limitations of our study is the small number of cases and single center experience. Long term follow up in the future studies is needed.

### Conclusion

From our experience we conclude that right anterior mini thoracotomy is a safe approach when compared to conventional full sternotomy in secundum ASD repair. It provides adequate exposure reproducible technique, and secures better advantages to conventional approach regarding patient satisfaction and hospital cost effectiveness. Consequently, it shall be considered as the standard approach of choice for surgical closure of secundum ASD.

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## الشق الصدري الأيمن النصفي: هل سيصبح المنهج الروتيني في حالات الأغلاق الجراحي للثقب بينة الأذنين للقلب؟

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1 قسم جراحة القلب والصدر معهد القلب 2 قسم القلب بمعهد القلب 3 قسم التخدير بمعهد القلب

الخلفية: يعد الثقب بين الأذنين من أكثر العيوب شيوعاً، و كان عادة ما يغلق جراحياً باستخدام القص الكامل لعظمة القص، وقد شجع التحسن في التقنيات الجراحية العديد من الجراحين على استخدام الأساليب الأقل تدخلاً كبديل للطريقة التقليدية.

الهدف من العمل: تقييم نتيجة وفعالية أسلوب شق الصدر الأمامي الأيمن كبديل للقص الطولي الكامل لعظمة القص في حالات للإصلاح الجراحي للثقب بين الأذنين.

الطريقة: هذه دراسة قائمة على الملاحظة تم إجراؤها على 50 مريضاً تم تشخيصهم على أنهم بالغون يعانون من ثقب بين الأذنين، موصوف للجراحة وغير قابل لإغلاق بالجهاز عن طريق القسطرة. تم تقسيمهم إلى مجموعتين: المجموعة الأولى التي تحتوي على 25 مريضاً خضعوا للإصلاح من خلال قص عظمة القص الطولي ، والمجموعة الثانية التي تحتوي على 25 مريضاً خضعوا لقص الصدر الأمامي الأيمن.

نتائج: أظهرت دراستنا أن مرضى شق الصدر الجانبي لديهم شق أصغر بشكل ملحوظ ، ووقت أقل لجهاز التنفسي الصناعي، ووحدة العناية المركزة والإقامة في المستشفى.

الاستنتاجات: استخدام شق الصدر الجانبي للإغلاق الجراحي للثقب بين الأذنين هو إجراء آمن وفعال يظهر العديد من المزايا، ويمكن استخدامه كنهج روتيني لمثل هذه الحالات.