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Hundred plus Minimally Access Cardiac Surgery: Our Experience

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Abstract

Background: Minimally invasive procedures lead to less scarring resulting in better cosmetic outcomes. This has resulted in increased patient interest in such procedures and this has motivated surgeons to pursue newer and improved techniques for Minimally invasive cardiac surgery (MICS). Obviously, with the advent of MICS the techniques to achieve it also needed to be changed and upgraded which includes access for cannulation for cardiopulmonary bypass (CPB). Right internal jugular vein percutaneous cannulation, together with the direct surgical cannulation of femoral vessels with minithoracotomy/ministernotomy proves to be a safe and effective tool in patients with body weight of above 20 kg for minimally access cardiac surgery. We use this technique for Atrial septal defect (ASD) closure, aortic valve replacement (AVR), redo Tricuspid valve replacement (TVR) and mitral valve replacement (MVR). Here, we describe our experience with minimally invasive approach using total peripheral cannulation and an anterior mini-thoracotomy (6 cm or less) incision for ASD closure, AVR, TVR and MVR. **Methods:** The preoperative variables, intraoperative data and postoperative outcomes of patients undergoing minimally invasive ASD closure, AVR, TVR and MVR with total peripheral cannulation were collected and analyzed. **Results:** Between May 2014 to May 2019 we performed minimally invasive closure of atrial septal defects, AVR, TVR and MVR with total peripheral cannulation in 103 patients. There were 64 females and 39 males Mean age was 25 years (range 8 - 58 years), Spectrum of procedures include ASD closure in 81 patients (78.6%), AVR via minithoracotomy in 13 patients (12.6%) and AVR via ministernotomy in 3 patients (2.9%), redo TVR in 5 (4.8%), MVR in 1 patient (0.97%). Average cardiopulmonary bypass (CPB) time was 46 minutes (range 22 - 78 min) and average aortic cross-clamp time (AoX) 26 min (range 12 -

45 min) in ASD closure group. In AVR group average CPB time was 91 min (range 72 - 120 min) and AoX time 76.5 min (range 65 - 109 min). In TVR group average CPB time 54 min (range 45 - 67 min) on beating heart. Only one MVR done in this period and CPB time was 82 min and AoX time was 65 min. The mean length of stay in intensive care unit was 1.8 days in ASD closure, 2 days in AVR group when in TVR group 3.5 days, and hospital stay was 3 days in ASD closure group, 4 days in AVR group and 7 days in TVR group. The only one patient who underwent MVR died in 12th post operative day from sepsis. There was one late mortality in AVR group after reoperation for prosthetic valve endocarditis at 3 months from first operation. **Conclusion:** ASD closure, AVR, TVR and MVR with mini invasive approach is safe with very few manageable preoperative complications and good patient satisfaction.

Keywords

Minimal Invasive Cardiac Surgery, Cosmetic Outcome,
Total Peripheral Cannulation

1. Introduction

The field of minimally invasive cardiac surgery has undergone rapid transformation over recent years. Surgical approaches in cardiac surgery have changed considerably during the last 2 decades [1] [2] [3]. A routine median sternotomy, which has been the conventional approach for many years, has been progressively abandoned in many centres in favour of minimally invasive approaches [4] [5].

Since last 7 - 8 years we started minimally invasive approaches for treating simple congenital heart defects (CHDs) and single valve replacement both in children and adults, with the aim of combining excellent functional and cosmetic results [5] [6].

In this review, we provide a summary of our experience in minimally invasive approaches for closing ostium secundum atrial septal defects (ASD II), Aortic valve replacement, tricuspid valve replacement and mitral valve replacement using total peripheral cannulation (TPC) and an anterior mini-thoracotomy (6 cm or less) incision.

2. Materials and Methods

Our review of the medical records, of the Clinical Investigation Committee of Institute of medicine-approved computerized hospital data and of the procedures followed were in accordance with the institutional guidelines for retrospective record review and protection of patient confidentiality. Individual consent was not obtained from patients enrolled in this study.

We reviewed the hospital course and the follow-up of patients who underwent

ASD II closure, AVR, TVR and MVR using minimally invasive techniques from May 2014 to May 2019.

In this period we performed minimally invasive closure of ASD, AVR, TVR and MVR with total peripheral cannulation in 103 patients. There were 64 females and 39 males Mean age was 25 years (range 8 - 58 years), Spectrum of procedures include ASD closure in 81 patients (78.6%), AVR via minithoracotomy in 13 patients (12.6%) and AVR via ministernotomy in 3 patients (2.9%), redo TVR in 5 (4.8%), MVR in 1 patient (0.97%).

At the beginning of our experience, we used larger incision (more then 6 - 7 cm) with a right anterior (RA) minithoracotomy. With the goal of obtaining patient satisfaction with the best cosmetic surgical result (**Figure 1**). From the beginning of 2014, we began right lateral (RL) minithoracotomy with smaller incision (6 or less mm) in our minimally invasive surgical approach. The TPC was initially used in selected patients with a body weight above 30 kg; subsequently, it was also applied in smaller patients. Our more recent protocol includes the routine use of femoral arterial, femoralvenous cannulation and percutaneous cannulation of the internal jugular vein in patients with a body weight ≥20 kg (**Figure 2**).

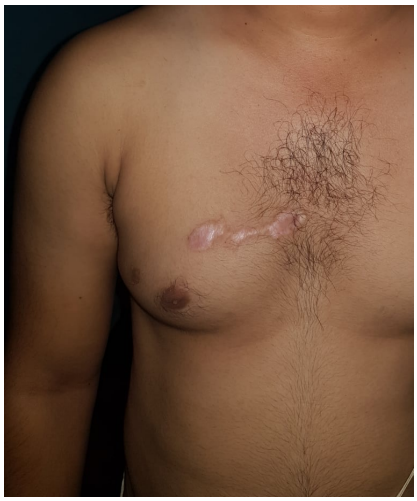

Figure 1. Right Anterior Mini Thoracotomy.

Figure 2. Jugular Canulation.

2.1. Anterior Mini Thoracotomy with Total Peripheral Cannulation

The patients were kept in a supine position, anesthetized and intubated. The right sided internal jugular venous cannula was placed by the anesthesiologist by seldinger technique under ultrasonic guidance. Then the patients were repositioned in supine position with right side up by 30 degrees. A Sub-mammary incision of 6 cm or less was made on the right side and dissection was continued (**Figure 3**). Right pleural space was entered at 4th intercostal space. Heparinization was done. Femoral artery and femoral vein were cannulated (**Figure 4**). Percardiotomy was made. Pericardial patch was prepared. Cardiopulmonary bypass was established. Aortic cross clamp was applied. Ante-grade cardioplegia was given and heart was arrested in diastole. Both the cavaewere snared. Right atrium was opened 2 cm lateral to the atrioventricular groove extending from right atrium appendage superiorly to anterior to the Inferior Vena Cava inferiorly. ASD was closed with autologous pericardial patch or tricuspid valve was replaced by biological valve, RA was closed in 2 layers. In cases of AVR mini-thoracotomy was done in 3rd intercostal space, after heart was arrested aortotomy was done and aortic valve was replaced by mechanical valve. Similarly in a

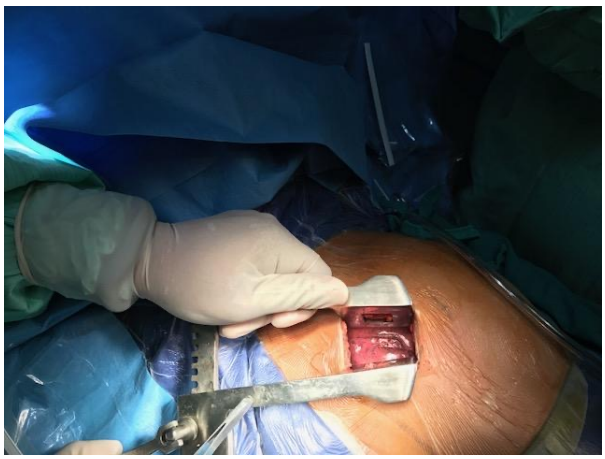

Figure 3. Sub mammary incision.

Figure 4. Femoral Canulation.

case of MVR left atrium was opened between right superior and inferior veins and valve was replaced with bileaflet mechanical valve. Root was vented and heart was desired. Heart was weaned off of cardiopulmonary bypass. Venous and arterial decannulation was done. Hemostasis was secured. Chest was closed over a right pleural drain. Groin wound was closed.

2.2. Ministernotmy

This approach was used for AVR in 3 patients.

In this approach, a 5 - 6 cm long skin incision is performed in the midline between the second and fourth ribs. Percardiotomy was made. Cannulation techniques and other surgical steps are similar as per the minithoracotomy approach.

Standard Intensive care was provided to the patients. All the vital parameters, amount of drains recorded. Decision to transfer the patient out of Intensive care unit and hospital was made by the operating team based on the patient's general condition, amount of drain, inotropic requirement and X-ray findings. Operative field was inspected for any local complications.

At the time of discharge from the hospital, a 2-dimensional echocardiogram with Doppler examination was routinely performed in all patients. As part of our programme, all patients were followed with a physical examination 1 month, 3 month and 1 year after surgery to assess their clinical status and the quality of the surgical result. Girls who had an RA minithoracotomy at a prepubescent age were checked clinically with the aim of evaluating breast development.

Satisfaction with the cosmetic result of the minimally invasive approach was evaluated in all patients by means of direct contact with the patient (clinical examination) or via a phone interview.

3. Results

Between May 2014 to May 2019 we performed minimally invasive closure of atrial septal defects, AVR, TVR and MVR with total peripheral cannulation in 103 patients. There were 64 females and 39 males Mean age was 25 years (range 8 - 58 years), Spectrum of procedures include ASD closure in 81 patients (78.6%), AVR via minithoracotomy in 13 patients (12.6%) and AVR via ministernotomy in 3 patients (2.9%), redo TVR in 5 (4.8%), MVR in 1 patient (0.97%). Average cardiopulmonary bypass (CPB) time was 46 minutes (range 22 - 78 min) and average aortic cross-clamp time (AoX) 26 min (range 12 - 45 min) in ASD closure group. In AVR group average CPB time was 91 min (range 72 - 120 min) and AoX time 76.5 min (range 65 - 109 min). In TVR group average CPB time 54 min (range 45 - 67 min) on beating heart. Only one MVR done in this period and CPB time was 82 min and AoX time was 65 min.

The mean length of stay in intensive care unit was 1.8 days in ASD closure, 2 days in AVR group when in TVR group 3.5 days, and hospital stay was 3 days in ASD closure group 4 days in AVR group and 7 days in TVR group. The only one

patient who underwent MVR died in 12th post operative day from sepsis. There was one late mortality in AVR group after reoperation for prosthetic valve endocarditis at 3 months from first operation. Remaining patients post operatively, were extremely satisfied with the small incision.

There were 4 cases had peripheral to central cannulation conversions from right internal jugular vein to superior vena cava in ASD group. In 6 patients had problem in aortic cross clamping so in these cases aortic cross clamp was reapplied to achieve cardiac arrest. In 3 cases had femoral artery injury during cannulation, in these cases femoral artery was repaired immediately and cannulation was done proximally. In 1 case had massive bleeding from cardioplegia cannulation side after taking out the cannula, which was repaired successfully. Two cases had undergone femoral artery repair on next day of surgery for absence of distal pulse, limbs were saved. Two had re-exploration for increased drain in ASD group and 2 in AVR group. There was one case of femoral vein thrombosis in the postoperative follow up.

4. Discussion

Median sternotomy is the conventional approach in cardiac surgery, but it often yields poor cosmetic results. In fact, especially in young female patients, unsightly midline scars cause displeasure and psychological distress [6] [7] [8]. With the aid of new technological advances in surgical instrumentation and in the perfusion technique, as well as competition from catheterization-based percutaneous procedures, many authors proposed the repair of simple congenital heart defects (mainly atrial septal defects) via a ministernotomy [9]. The inferior division of the lower half of the sternum ensures good access to the heart structures and to the great vessels for cannulation and guarantees better postoperative chest stability, in addition, it has the theoretical advantages of faster recovery. These improvements in recovery may reflect the fact that the upper sternum (manubrium) is not divided during minimally invasive surgery, thus allowing the entire upper thoracic clavicular-sternal joint area to remain undisturbed, as opposed to being stretched during a full sternotomy [10].

With improvements in minimally access cardiac surgery the rightminithoracotomy or right submammary incision has been advocated for many years. It has been used as an alternative to a ministernotomy, particularly in the female gender for cosmetic reasons, and has steadily gained popularity for treatment of CHD due to the combined advantages of good cosmetic and functional results [11]. Because of the risk of damage to the mammary gland in prepubescent girls, this approach was typically reserved for post-pubescent females in whom the location of the mammary gland is known and a sub-mammary incision can be made [12].

The utilization of peripheral cannulation for remote CPB avoided the insertion of arterial and venous cannulas into the chest incision, which sometimes may result in problems, especially in older patients due to the distance between

the incision and the mediastinal structure. Some surgeons have resorted to femoral cannulation, especially in young children, owing to the high likelihood of femoral vessel injury [13]. Similarly right anterior minithoracotomy for replacing isolated aortic valve, mitral valve and redo tricuspid valve replacement with peripheral cannulation has shown good results compared with sternotomy [14] [15] [16].

Data from our experience showed that we were able to safely use a peripheral cannulation technique with a very low incidence of intra/postoperative complications.

Minim the overall incidence of postoperative complications and of the need for further surgical interventions was low. We demonstrated that, with experience, we were able, with time, to progressively decrease the length of postoperative hospitalization. We believe that the main reason for a faster discharge could be related to a more prompt recovery due to our less invasive, minimally invasive approach, characterized by reduced skin incisions and by the close attention that we pay to the dissection of muscle planes (sparing almost all muscles), with particular attention to staying away from the mammary gland and from the major pectoralis muscle. Eventually, we were able to show a progressive and significant reduction of hospital costs, by reducing the hospitalization time. We had a very high overall satisfaction rate concerning the cosmetic results of the surgery.

5. Conclusions

In conclusion, ASD closure, AVR, TVR and MVR with mini-invasive approach is safe with very few manageable perioperative complications and good patient satisfaction. Minimally invasive approach provides a good visualization of cardiac and vascular structures is associated with a lower incidence of postoperative morbidities and can possibly facilitate future resolution of other heart diseases requiring a midline full sternotomy (avoidance of re-sternotomy).

We believe that these data can be a stimulus for other cardiac institutions of developing countries to use these simple, easily reproducible techniques, which are extremely important for improving the quality of our surgical treatment.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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