

Minimally invasive approach for intracardiac operations with central cannulation

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ABSTRACT

Introduction

Minimally invasive approach for intra-cardiac operations provides quick approach to heart, except rarely for aorta, cannulation is straightforward, exposure of right / left atrium, right ventricle is excellent. Minimally invasive approaches supplemented by avoiding aortic cross clamp / cardioplegic arrest, shortens operative time, post operative recovery, decreases morbidity and mortality.

Material and Methods

The study was conducted in a tertiary care hospital, patients were positioned with right side elevated 15-degree, heart was approached by right mini thoracotomy, usually through 4th intercostal space and repair (direct or patch repair) of atrial septal defect was done on beating heart.

Results

17 patients were included in the study, with more females, mostly in first decade of life. Patients presented with recurrent lower respiratory tract infections, palpitations / dyspnea; audible murmur was clinical finding in all. Echocardiography was the investigation of choice. Heart was approached by right mini-thoracotomy, repair of atrial septal defect was done on beating heart, mitral / tricuspid valve surgery was performed on cardiopulmonary bypass with cross clamped aorta. Aortic cannulation was taxing in some, field of vision was not compromised. In majority post-operative period was uneventful.

Conclusion

In all patients above 4 years of age without active lung disease / previous right thoracotomy, having isolated atrial septal defect, minimally invasive approach to heart supplemented by avoiding aortic cross clamp and cardioplegic arrest helps reduce duration of operative time / postoperative discomfort / mechanical ventilation, shorten post-operative recovery time, eliminate possibility of sternal nonunion, decrease morbidity and mortality, with excellent cosmetic results.

Key words

Right mini-thoracotomy, beating heart, ASD repair

Introduction

Atrial Septal defects (ASDs) account for 10 to 15% of all congenital heart diseases, are among the most common congenital cardiovascular malformations and are often undiagnosed until adulthood. Traditionally, ASD closure has been performed via full sternotomy on cardiopulmonary

bypass and aorta cross clamped. Because of its versatility and familiarity to surgeon's median sternotomy had been the approach of choice, but sternotomy is not without complications, the problem of post sternotomy pain, dehiscence, mediastinitis, osteomyelitis, unstable sternum, bad scar adds to morbidity and mortality in these patients. Alternatives to median sternotomy have gained popularity and now the heart can be approached by (i) right parasternal mini-incision, with aortic and central venous cannulation, (ii) right sub mammary mini-incision with femoral arterial and central venous cannulation, (iii) right sub mammary mini-incision with femoral arterial, right atrial and percutaneous jugular vein cannulation, (iv) parasternal incisions, (v) axillary / mini-thoracotomy with conventional cannulation. Various minimally invasive surgery techniques have emerged in cardiac surgery, and regarding ASD closure includes, mini-sternotomy, mini-thoracotomy, endoscopic, robotic closure as well as beating heart ASD closure. A meta-analysis has demonstrated equivalent safety and efficacy of right anterolateral mini-thoracotomy and as compared to conventional full sternotomy, as well as improved recovery with thoracotomy. Thoracotomy approach to cardiac surgery should not hinder the definitive surgical procedure, access to all chambers should be good, peripheral cannulation should not be needed and median sternotomy should be avoided. Right mini thoracotomy provides excellent access to both atria and right ventricle.

Patients operated on cardiopulmonary bypass with cross clamped aorta have more morbidity and mortality, and studies have shown that longer aortic cross clamp time is independently associated with decreased early survival after cardiac surgery. It is also a fact that perioperative adverse effects caused by myocardial ischemia have not been completely eliminated, and cardioplegic arrest inevitably produces some degree of reperfusion injury.

To overcome the disadvantages of median sternotomy / conventional thoracotomy and prevent reperfusion injury because of aortic cross clamp, the present study has been presented. The focus of the study has been more on ASD only and valve operations are only indicated.

Material and Methods

The study was conducted in the Department of Cardiovascular and Thoracic Surgery (CVTS) Super-Specialty Hospital (SSH) Government Medical College (GMC) Jammu. A detailed

history, through general and systemic examination was contemplated in all. Diagnosis was confirmed by Transthoracic Echocardiography (TTE). All patients had preoperative complete blood count (CBC), Liver / Kidney / Thyroid functions, Coagulation profile, Blood sugar besides EKG and X Ray Chest. Transesophageal echocardiography (TEE), angiography and Cath studies were done in select group only. Patients with previous right thoracotomy, active pulmonary and complex cardiac pathologies were excluded from the study.

Heart was approached through Anterior, Anterolateral and Axillary thoracotomy:

In thoracotomy patient was placed in supine position, right side elevated by 15 degree and a rolled pack placed in interscapular region. Typically, a skin incision was created over the chosen interspace and pleural cavity was usually entered through 4th intercostal space. Thymus was dissected away from surgical field, pericardiotomy done and pericardial stay sutures were placed in a way that aorta is lifted up. Purse string sutures were taken, temperature adjusted, patient heparinized, therapeutic activated clotting time (ACT) achieved, systematic cannulation done, cannulas secured and connected to cardiopulmonary bypass assembly. Patients were put on cardiopulmonary bypass, both cava were snugged, in cases of mitral valve replacement / tricuspid valve annuloplasty, loading dose of cardioplegia was given and then maintenance dose repeated at intervals. In cases of Atrial septal defect, septal repair was performed on beating heart without cross clamping aorta, but aortic root was put on continuous suction during the procedure. Atriotomy was done parallel to atrioventricular groove, septal defect identified, patch / direct repair was done. Before, applying last sutures in the septal defect, left atrial deairing was done with the help of the anesthetists, by holding positive pressure on the lungs to fill left atrium (LA) with blood and expel any air from LA. Right atriotomy was closed back, again deairing done. Patients were weaned off bypass gradually, systematic decannulation started, protamine test dose given,

complete decannulation done, full dose of protamine given. Complete hemostasis achieved, pacing wires placed, intrapericardial / right intrapleural chest tubes placed, secured and connected to underwater seal bags. Ribs approximated and chest wound closed in layers. Patient extubated in OT or ventilated overnight. Pre / intra and post operative adverse events / complications were recorded. After discharge patients were followed in out-patient department.

Results

A total of 17 patients, in the age group of 6 to 46 years (Table-1), mostly in first decade 47.05%, with 58.82% female patients (Table-2), were operated. Recurrent respiratory infections,

palpitations and dyspnea were the common symptoms, murmur was audible in all. TTE was the investigation of choice and 76.47% had atrial septal defect (Table-3). Thoracotomy (Table-4), (Figure-1) and central cannulation (Figure-2) was done in all. 76.47% were operated on perfused beating heart, 23.52% were operated on CPB with aortic cross clamp. Direct closure of atrial septal defect was done in 70% (Table-5). Grossly diseased mitral valve was excised without difficulty, mitral valve replacement and tricuspid valve ring annuloplasty was performed without any compromise in field of vision and space (Figure-3). Length of thoracotomy skin incision in majority ranged from 5 to 7 centimeters. Heart was approached within 15 to 30 minutes, CPB time was less than 30 minutes in all patients operated on perfused beating heart, but was 90 to 150 minutes in patients operated for double valves. Deairing was done from aortic root and left atrium. Weaning from bypass, decannulation, achieving hemostasis, placing intrapleural / pericardial / substernal drainage tubes / pacing wires were smooth. Thoracotomy was closed within 10 to 50 minutes. Patients operated on beating heart did not need conversion to aortic cross clamp. Post operative drainage was negligible, neither needed any added support nor re-exploration. 1 patient 5.88% died all other 94.11% had uneventful recovery. All the survivors were satisfied with early ambulation, less pain, early discharge and excellent cosmetic (Figure-4) results. Patients were followed in outpatient department, post operative echocardiography did not show any residual or recurrent defect.

Discussion

Cardiac operations irrespective of their indications are often forgotten or repressed by young people. Therefore, skin scar is quiet often the only long-lasting reminder of a cardiac

operation. Consequently, we feel obliged to pay the utmost attention to the scar, more so in female patients. Principally for cosmetic reasons alternative operative approaches have been developed with better aesthetic results. ASDs accounts for around 10 to 15 percent of all congenital heart diseases. In isolated and small defects presentation is late. Patients may be asymptomatic, diagnosed incidentally or severely symptomatic. Patients with significant left to right shunt, pulmonary over circulation and other cardiac complications have already earned surgery. Median sternotomy used to be the approach of choice for repair of ASD and such repair was done under cardiopulmonary bypass after aortic cross clamp. However, of late the approach has changed and the alternatives to aortic cross clamp are actively used. Any approach to heart without median sternotomy is referred to as minimally invasive and repair without aortic cross clamp is certainly safe. Early attempts at off-pump and Video-assisted techniques started in the 1960s and 1970s, gained significant traction in mid-1990s. In 1964 Kolosov performed first coronary artery bypass on a beating heart through a thoracotomy, Ankeney advocated off-pump beating heart coronary surgery, minimally invasive mitral valve surgeries through partial sternotomies, and mini-thoracotomy were advocated in mid-1990s. Since its first successful use by Jhon Gibbon in 1953¹, cardiopulmonary bypass (CPB) has been employed by cardiac surgeons to facilitate open heart procedures and the first minimally invasive valve surgery was described in 1996². Further advancements in techniques aid in visualization of intraoperative conditions and ensuring proper deairing³ made beating heart surgery a possibility. The interatrial septum has been of medical interest since 1800s, the first reported paradoxical embolus through an ASD is attributed to Julius Cohnheim. Experimental attempts to close the defect by simple inversion of atrial appendage⁴, and atrial wall invagination⁵, have been reported. First clinical operation using inversion of right atrial appendage to close the ASD was performed in 1949⁶, the first successful open-heart repair under

direct vision using hypothermia and inflow occlusion was performed in 1952⁷, successful ASD repair under CPB was performed in 1953⁸ and the device closure was performed in 1975⁹. Alternative to median sternotomy has been devised to improve cosmetic outcomes without affecting the clinical results and include right anterolateral¹⁰⁻¹¹, posterolateral¹², axillary thoracotomy, trans xiphoid approach without a sternotomy¹³, and right mini-thoracotomy¹⁴.

ASD being more in females has been reported by others also¹⁵, but the number of patients in the present study was less so cannot be compared, so is the age at operation. ASDs are frequently asymptomatic, but in symptomatic patients a soft systolic ejection murmur over pulmonic area, combined with a wide, fixed S2 splitting is characteristic¹⁶, Echocardiographic is diagnostic, subcostal sagittal and coronal views^{17, 18} are best to define the ASDs, but sinus venosus type of defect need further evaluation. All atrial septal defects must be closed if otherwise indicated. Right thoracotomy as an alternative to median sternotomy is in accordance to other studies^{19,20,21,22}, that the incision should be given lower down and chest entered through 4th space is reported²³, entering the chest through 3rd space is also reported. Pericardiotomy done 1 to 3 cm above phrenic nerve is comparable to similarly reported studies^{21, 23}. Upper end pericardial sutures help in getting aorta more anterior is in accordance to other studies^{21, 22, 23, 24}. Aortic and bicaval cannulation can easily be done through thoracotomy approach^{21,22,23,25}, but as observed aortic cannulation may at times be challenging. Minimally invasive operations are a routine now, even Endoscopic and Thoracoscopic repair of ASD has been performed on beating heart^{26, 27}. It is a fact that right thoracotomy approach gives excellent exposure of both atria / right ventricle and it being superior to median sternotomy^{28, 29}. Various approaches to minimally invasive ASD repair have been associated with low rates of morbidity and mortality³⁰. Multiple robust analysis have reported comparable outcomes between minimally invasive and sternotomy approach, and meta-analysis

observing thoracotomy is associated with faster functional recovery, better cosmetic results and is a better choice for select ASD patients³¹.

Conclusion

Thoracotomy is easy to perform, entry to pericardium is quick, so is the closure of wound, access to right / left atrium and right ventricle is excellent, cannulation is straightforward but aortic can be inconvenient, cardiectomy is under vision. Combined with beating heart surgery blood loss, CPB time, pain, post-operative (events) intensive care / hospital stay is less. Morbidity, mortality is decreased return to daily activities is earlier and cosmetic results are excellent. We recommend, if otherwise indicated, heart in all patients with ASD must be approached with right mini-thoracotomy approach, and patch / direct repair of ASD be performed on beating heart.

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Table-1:- Age Distribution of the Patients

Age in years	Number of patients	Percentage
Up to 10	09	52.94

11 to 20	03	17.64
21 to 30	02	11.76
31 to 40	01	5.88
41 to 50	03	17.64

Table-2: Showing Sex Distribution of patients

Sex of the patients	Number of Patients	Percentage
Female	10	58.82
Male	07	41.17

Table-3: Showing Echocardiographic diagnosis of patients

Diagnosis	Number of patients	Percentage
OS-ASD	12	70.58
Mixed Mitral Valve Disease	4	23.52
Associated Tricuspid Valve Disease	02	11.76
OS-ASD with Mitral cleft	01	5.88

Note: More than one pathology was present in a patient.

Table-4: Distribution of Thoracotomy

Type of Thoracotomy	Number of patients	Percentage
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Anterior	12	70.58
Anterolateral	2	11.76
Axillary	3	17.64

Table-5: Showing surgical procedures performed

Surgical procedure done	Number of patients	Percentage
Direct repair of ASD	10	58.82
Patch repair of ASD	03	17.64
Mitral valve replacement	02	11.76
Mitral valve replacement and Tricuspid valve annuloplasty	02	11.76



Figure-1: Showing Axillary Thoracotomy incision

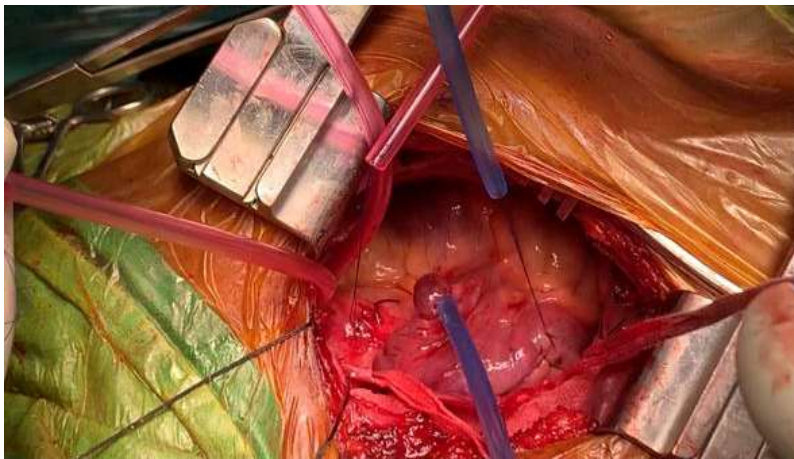


Figure-2: Looping of SVC / IVC and purse strings sutures for Aortic cannulation

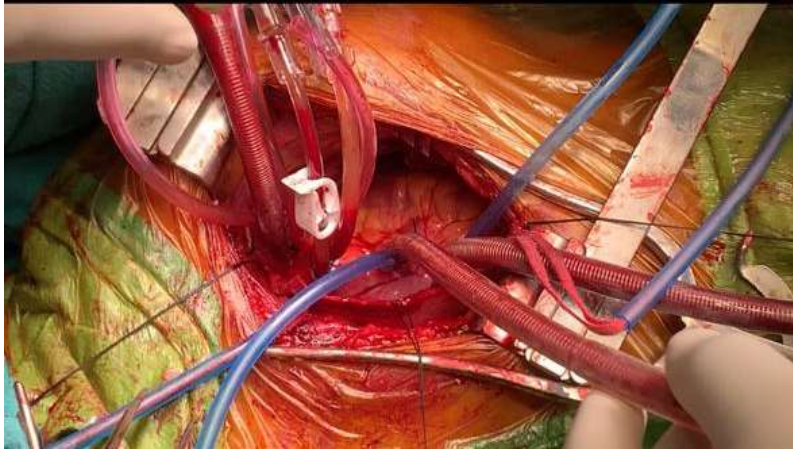


Figure-3: Showing intraoperative cardiopulmonary bypass

Figure-4: Showing pericardial patch repair of ASD on beating heart

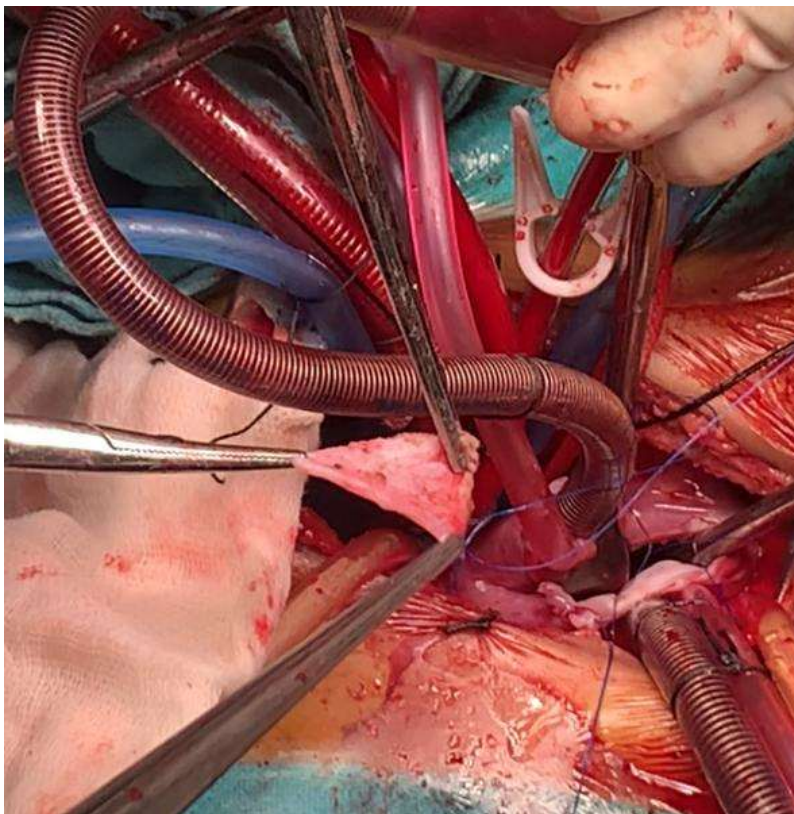


Figure-4: Showing post operative invisible scar

