

Video Presentation

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Technical Details of Dacron Patch Closure of Ostium Secundum Atrial Septal Defect via Limited Right Anterolateral Thoracotomy under Normothermic Cardiopulmonary Bypass and Cardioplegic Arrest: A Video Presentation

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Abstract

A 23-year-old female patient with a large ostium secundum atrial septal defect not amenable for device closure underwent surgical closure of atrial septal defect via a limited right anterolateral thoracotomy approach under normothermic cardiopulmonary bypass and St. Thomas (II) based cold blood cardioplegia. Postoperative recovery was uneventful. The safeguards and pitfalls of limited right anterolateral thoracotomy have been highlighted.

Introduction

Atrial septal defect (ASD) remains one of the most common congenital heart diseases¹. Presently, transcatheter device closure is the preferred technique for management of ostium secundum atrial septal defects and patients who are unsuitable for device closure (e.g. large secundum defects with limited septal margins, and ASD with severe pulmonary arterial hypertension) are referred for surgical closure²⁻¹⁰.

The surgical closure of atrial septal defect is a low-risk, and high-benefit procedure. Although median sternotomy has been the conventional approach for correction of ostium secundum atrial septal defect, several ingenious surgical techniques have been developed during the last 30 years with the aim of combining good functional and cosmetic results, especially in females and scar is the only residue for a lifetime¹¹⁻¹⁴.

The techniques include video and robotic assisted totally thoracoscopic approach, limited right anterolateral thoracotomy technique, right vertical infra-axillary thoracotomy, limited right anterolateral thoracotomy with partial sternal-split incision^{9,14-20}.

There are three methods of minimally invasive surgery for closure of ASD in small children: i) video and robotic assisted totally endoscopic surgery or minithoracotomy using femoral arterial cannulation; ii) totally endoscopic surgery using transthoracic aortic cannulation through the incision; and iii) thoracotomy using aortic cannulation through the incision^{16,17,19}. During the past 30 years, minimally invasive surgical techniques have been applied more and more widely in both adult and pediatric population, especially in female patients^{11,12,20-28}.

In our department, both limited right anterolateral thoracotomy and totally thoracoscopic approach have been used by the corresponding author for the correction of atrial septal defect. Limited right anterolateral thoracotomy approach has been advocated by several investigators over many years and has been used as a safe and cosmetic alternative to ministernotomy especially in female patients^{14,23,29,30}.

Literature documents excellent results for all types of atrial septal defects with limited right anterolateral thoracotomy approach compared with median sternotomy^{12,23,31}. Analysis of the published literature documents the following advantages of limited right anterolateral thoracotomy.

1. The technique can be applied to all types of atrial septal defect without increasing total operating time, cardiopulmonary bypass time, cross-clamp time, and mortality;
2. It has reduced blood transfusions, postoperative chest drainage, intensive care unit stay, and hospital stay;
3. Femoral cannulation is not necessary, thus avoiding femoral arterial injury^{32,33};
4. The technique is easy to learn and practice compared with other minimally invasive approaches i.e. thoracoscope and robotic technology³⁴;
5. It provides adequate exposure of the ascending aorta and both venae cavae as well as improves the visualization of the right atrium during surgery. The cannulation procedures are similar to median sternotomy;
6. It does not require special instruments and does not increase costs as required in video and robotic assisted totally endoscopic surgeries. Thus, it is economical and practical; and
7. Provides an excellent cosmetic result, and comfort shortens hospital stays compared to conventional sternotomy, thus reducing total costs.

The issue of asymmetrical breast development for female children can be minimized to a great extent by appropriate placement of surgical incision³⁵. Whether, minimally invasive approaches actually reduce postoperative pain and bleeding and improve respiratory function remains controversial^{11,12,20-29,36}.

A 23-year-old female patient presented with recurrent palpitation and shortness of breath (New York Heart Association Functional Class-III) for the past 4-years. Clinically, she had cardiomegaly, left parasternal heave, and systolic ejection murmur (flow murmur) of grade III/VI intensity over the left 2nd and 3rd intercostal spaces. There

was fixed splitting of the 2nd heart sound in the pulmonary artery. She was referred to our institution with a probable diagnosis of ostium secundum atrial septal defect one year prior to the hospital admission.

Cross-sectional echocardiography confirmed the diagnosis of a large ostium secundum atrial septal defect, without pulmonary hypertension, and no evidence of mitral or tricuspid regurgitation or right ventricular outflow tract obstruction.

We report here-in the successful surgical repair of a large ostium secundum atrial septal defect using a Dacron polyester patch via limited right anterolateral thoracotomy under normothermic cardiopulmonary bypass and cold blood cardioplegia.

Surgical Techniques

Position of the patient

The patient was placed in the semilateral decubitus position with the right-side elevated to 30°-50°; the right arm was suspended over the head and wrapped to avoid traction on the brachial plexus. Both groins were prepared in case of inadvertent injury to the cardiac chambers and/or great vessels during surgery and requirement of urgent institution of cardiopulmonary bypass.

The incision and surgical approach

A long submammary incision extending from the costochondral junction to anterior axillary line (approximate 5-6 cm) was made. The breast tissue was dissected off the pectoral muscle posterior to the breast capsule, avoiding injury, and the chest was entered through the right 5th intercostal space. The intercostal muscles were divided deep posteriorly to avoid fracture of the ribs. The right lung was retracted posteriorly with a large wet sponge for adequate surgical exposure. Right phrenic pedicle was identified.

Pericardiotomy

The pericardium was opened 2.0 cm anterior to the phrenic nerve using scissors vertically in between stay sutures, superiorly, just below the origin of brachiocephalic artery, and inferiorly, till the inferior cavoatrial junction. The thymus overlying the pericardium was subtotally excised to facilitate exposure during subsequent aortic cannulation.

Exposure of the cardiac chambers and great vessels

Multiple silk stay sutures were placed on the incised posterior pericardial edge. Anteriorly, the stay sutures were placed deep within the pericardial cavity approximately 2-3 cm away from the pericardial edge to facilitate exposure of the right atrium and great vessels.

Retraction of the right atrial appendage

It is of paramount importance to perform the following maneuvers to facilitate exposure of the ascending aorta: i) the patient was placed at about 30° Trendelenburg position; ii) the table was rotated slightly anteriorly; iii) the right atrial appendage was held in a Beck's vascular clamp, its tip was incised and a 5-0 polypropylene (Johnson and Johnson Ltd., Ethicon, LLC, San Lorenzo, USA) suture was used for purse-stringing the same for subsequent venous cannulation.

Aortic and cardioplegic cannulation

Following systemic heparinization, purse-string sutures were placed in the ascending aorta at appropriate location for subsequent aortic and cardioplegic cannulation. It is important to place two concentric purse-string sutures for aortic cannulation to avoid accidental tear during aortic cannulation. A 21-Fr angled aortic cannula and a root cardioplegic cannula were placed.

Cannulation of the superior caval vein

The superior caval vein was cannulated through the right atrial appendage and was isolated using an umbilical tape.

Cannulation of the inferior caval vein

Under cardiopulmonary bypass with the heart decompressed the inferior caval vein was isolated using an umbilical tape. A 5-0 polypropylene suture was placed 1 cm above the inferior cavoatrial junction and the inferior caval vein was cannulated using a 32 Fr straight venous cannula.

Placement of aortic cross clamp and administration of cardioplegia

Following aortic cross-clamping, myocardial protection was achieved by antegrade administration of St. Thomas II based cold blood cardioplegia and topical iced saline.

Right atriotomy and exposure of the atrial septal defect

The right atrium was opened vertically about 2-2.5 cm posterior to the right atrioventricular groove in between stay sutures. It is important to place the right atrial incision slightly posteriorly to limit the right atriotomy.

Dacron patch closure of the atrial septal defect

After retracting the right atrial margins, the margins of the atrial septal defect was identified. It is important not to insert the intracardiac sucker much inside the septal defect to prevent intracardiac air entrapment and air embolism. The margins of the atrial septal defect were measured and an appropriate sized Dacron polyester patch (Bard® Savage® filamentous knitted polyester fabric,

Bard Peripheral Vascular Inc., Tempe, AZ, USA) was sutured using 4-0 polypropylene suture (Johnson and Johnson Ltd., Ethicon, LLC, San Lorenzo, USA). Extreme precautions were taken to fill the left sided cardiac chambers with saline and manual ventilation before tying the knot.

Closure of right atriotomy

The right atrium was closed in two layers: horizontal mattress and over and over continuous suture of 5-0 polypropylene.

Release of aortic cross-clamp and restoration of myocardial perfusion

Following restoration of ventilation, the aortic cross-clamp was released and myocardial perfusion was restored. Two ventricular pacing wires were inserted at this stage on bypass with the heart partially collapsed.

Aortic and venous decannulation and wound closure

Extreme precautions need to be excised while decannulating the cardioplegia cannula and aortic cannula to prevent inadvertent accidents. After securing hemostasis, the pericardium was loosely approximated. Two intercostal drains were placed with the posterior drain being placed intrapericardially and the anterior drain being placed posteriorly in the diaphragmatic recess.

The wound was closed in layers. No.2 Ethibond for pericostal, '0' and 2-0 vicryl sutures for chest wall and soft tissues. Aortic cross-clamp and cardiopulmonary bypass times were 22 minutes and 45 minutes respectively.

Short- and Long-term Results

She was extubated within two hours after surgery and postoperative recovery was uneventful. Postoperative blood loss was 50 ml in 24-hours. After surgery the patient was in normal sinus rhythm and recovery was uneventful. At 24th month follow-up she was asymptomatic in New York Heart Association Functional Class-I. Two-dimensional echocardiography revealed normal biventricular function with intact atrial septation and no mitral or tricuspid regurgitation.

Safeguards and Pitfalls of Limited Right Anterolateral Thoracotomy for Closure of Atrial Septal Defects

The following points are of utmost importance in preventing complications arising out of this approach:

1. Employment of submammary incision, well below the breast tissue, may be on the 6th rib is important to ensure normal breast development and avoid future deformity of the chest wall in the pre-adolescent patients. In patients with well-developed breasts, the submammary groove was used for the skin incision³⁰.

- In adult females, the incision should be submammary and the breast capsule should be lifted up from the pectoral muscles without causing injury to approach 5th intercostal space.
- The incision should not be extended too laterally and latissimus dorsi muscle should not be divided. Thus, innervation of the lateral breast and nipple is preserved.
- Division of the mammary vessels can be avoided by separating pleural tissue from the 4th and 5th ribs.
- Placement of pericardial incision well above (≈ 2 cm) the right phrenic pedicle and avoidance of cautery is recommended to avoid phrenic nerve injury as has been reported by some investigators³¹.
- Use of Trendelenburg position, slight anterior rotation, partial thymic excision, use of double concentric aortic purse string suture avoids aortic / cardioplegic cannulation related accidents.
- A persistent left superior caval vein can be drained by transatrial cannulation with a balloon occluding catheter or after atriotomy by placing an intracardiac sucker near the coronary sinus.
- Avoidance of placement of intracardiac sucker beyond the atrial septal margin to prevent intracardiac air entrapment.
- It is mandatory to allow the left heart to fill with blood before completely closing the atrial septal defect.
- Only the aortic root is de-aired before releasing the aortic cross-clamp.
- Placement of ventricular pacing wires on the empty heart during cardiopulmonary bypass prevents injury to the ventricular muscles and coronaries.
- External defibrillation paddles, if available are helpful and superior due to difficulties in placing internal paddles correctly in some patients.
- Defibrillation can be performed with small, specially designed internal paddles or with preoperatively fixed external paddles.

Conclusions

Surgical repair of atrial septal defect via limited right anterolateral thoracotomy is an expedient, safe and effective technique provided extreme precautions are taken during cannulation of the aorta and cardioplegia, decannulation and intracardiac de-airing.

Poor ventricular exposure requires special strategies regarding de-airing, pacing wire insertion and defibrillation. Submammary incision in adult females with

well developed breast, retro breast capsular dissection for surgical approach are of paramount importance to prevent its injury. Limited right anterolateral thoracotomy approach was chosen due to young age, cosmetic reasons and patients' choice. We used a Dacron patch instead of pericardial patch, so that the pericardial cavity could be closed on completion of surgery. Secondly, patients with an anterolateral thoracotomy for closure of atrial septal defect have less adhesion in the case of secondary operation for acquired heart disease later in life. Knowledge of this cosmetic surgical approach should contribute to the armamentarium of cardiac surgeon faced with surgical closure of atrial septal defect.

Declaration of conflicting interests

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