Bracket Ministernotomy For Adult Atrial Septal Defect Repair
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Citation

Abstract
Arterial cannulation is sometimes more difficult in adult patients due to a highly positioned ascending aorta in the classical T-shaped lower mini-sternotomy approach. Excessive traction of the aorta during the cannulation may cause lacerations which requires alternative cannulation or increase in skin incision and sternotomy. We performed a 8 to 10 cm skin incision between 2 cm below sternal angle and 3 cm above xiphoid. Sternal division was done with an oscillating saw. Two additional sternal divisions were done towards both right 2nd and 4th or 5th intercostal space. The final shape of the sternal division resembled a square bracket. This type of sternal incision provides adequate surgical exposure for performing safe ascending aorta and bicalve cannulation.

INTRODUCTION
Minimally invasive surgical approaches used in cardiac operations have been reported widely in both adult (1,2,3) and pediatric (4) populations. The primary advantages are both in cosmetic result and comfort for the patient and less postoperative pain as well as a shorter hospital stay, which also has cost implications. Approaches in the adult population have largely involved anterior thoracotomy and minimal sternal division of either upper or lower sternum with or without video assistance. Lower T-shaped ministernotomy is frequently used in many centers (5). This approach allows for standard great vessel cannulations for cardiopulmonary bypass (CPB). But sometimes the ascending aorta cannulation becomes extremely difficult due to a highly positioned ascending aorta. Aortic lacerations can develop during the ascending aorta cannula insertion and therefore special instrumentation or alternative arterial cannulations are required.

Inexperienced surgeons may require an extension of skin incision. We propose a square bracket sternotomy, which provides easy access for ascending aorta and superior and inferior vena cava cannulations.

SURGICAL TECHNIQUE
All patients were positioned in supine position. A 8 to 10 cm skin incision was done between 2 cm below the sternal angle and 3 cm above the xiphoid process of the sternum. Minimal skin flaps were raised in the prepectoral plane. Incision on the body of the sternum was marked by electrocautery. Sternal division was done by an oscillation saw. Two additional sternal divisions were done towards both right 2nd and 4th or 5th intercostal space. The final shape of the sternal division resembled a square bracket. The right internal thoracic artery laceration was avoided during the additional sternum division. (Figure 1)
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Figure 1
Figure 1: Bracket Sternotomy. A 8 to 10 cm skin incision was done between 2 cm below the sternal angle and 3 cm above the xiphoid process of the sternum. Two additional sternal divisions were done towards both right 2 and 4 or 5 intercostal space. The final shape of sternal division resembled a square bracket.

The anterior ligamentous attachments of the pericardium to the sternum and thymus were mobilized so that superior aspect of the pericardium over the aorta and right ventricle could be pulled anteriorly towards the skin incision. The diaphragmatic attachments were also mobilized laterally particularly on the right side to facilitate cannulation of the inferior vena cava. Then the small retractor was placed. The previously mobilized pericardium was opened to the right of the midline based over the right ventricular atrioventricular groove and continued superiorly over the aorta. Pericardial stay sutures were placed.

We mostly suspended pericardial stay suture to the skin incision to improve surgical exposure. The superior portion of pericardium over the ascending aorta was sutured to the posterior table of the sternum to both elevate the aorta and pull it laterally and superiorly in order to facilitate cannulation. Our bracket sternotomy allows easy access for ascending aorta cannulation without extensive traction of the aorta. A purse suture was placed on the right atrial appendage for superior vena cava cannulation. A purse for inferior vena cava can easily be placed on the right atrium. Both caval cannulations were done without any difficulty and additional incision through the sternal incision. CPB was established. Purse suture of the aortic vent needle could easily be placed on the undistended heart, which improved surgical exposure of the ascending aorta. The aorta was cross-clamped through the incision and antegrade cardioplegia was given through the aortic root. The atrial septal defect repair was performed through the right atriotomy. De-airing of the heart could be done from the left ventricular apex that was easily reached by gently retracting the heart towards the right. Decannulation could easily be done. A single mediastinal drain was placed after creating a tunnel below the xiphoid part of the sternum. Two sternal wires were placed in the figure of eight. The skin incision was closed in standard manner. We have successfully performed an atrial septal defect repair operation through a bracket sternotomy in an adult patient without any complications.

DISCUSSION
Improved patient comfort and recovery result from minimally invasive approach seen in the adult patients (1). Having an intact thoracic cage postoperatively should be advantageous for pulmonary mechanics and pain management in these patients, resulting in a measurable difference in recovery time in a large number of patients. Many centers have been using ministernotomy because of these advantages. Mini-sternotomy approaches provide good cosmetic results which is also very important not only for young female but also for many adult male patients. Because the cosmetic effects of the surgical incision are becoming less objectionable to a majority of the patients, an increasing number of intra-cardiac repair procedures (such as valve and congenital heart disease) are now being performed in many centers. Several alternative incisions have also been developed. Anterior thoracotomy through infra mammary skin fold incision and with video assistance port access incisions are the alternatives of mini-sternotomy approach. There is the concern, particularly in the prepubescent girls, of distorting growing breast tissue (2). It may however, be possible in younger children to avoid potential pectoral distortion by performing the skin incision more laterally on the chest wall and sparing the overlying muscle.

Adult women are usually have less chest wall distortion after infra-mammary approaches but it does not always allow cannulation of central great vessels or cardioplegic arrest for intracardiac defects. Therefore, many surgeons prefer lower ministernotomy approaches for cardiac operations. The ascending aorta can easily be cannulated through T-shaped
lower ministernotomy especially in children because the great vessels are more elastic and can easily be retracted during the ascending aorta cannulations. But as the patient gets older, the heart elongates in the chest (\textsuperscript{4}) and safe ascending aorta cannulation becomes extremely difficult. Ascending aorta lacerations can develop during the retraction of aorta for cannulation. Some surgeons have used alternative arterial cannulation points such as femoral or brachial arteries. If ascending aorta laceration develops during the cannulations, most surgeons increase both skin and sternal incisions to repair the ascending aorta and to control excessive bleeding. It is highly likely that many surgeons who are interested in ministernotomy have experienced these complications several times, especially in adult patients. In this regard, we have changed our sternotomy policy in our department.

We have started using slightly higher localized skin incision to perform bracket sternotomy. Ascending aorta and bi-caval cannulations can easily and safely be performed for establishing CPB. Adequate mobilization of right side of sternotomy by division towards the right 2\textsuperscript{nd} intercostal space and right 4\textsuperscript{th} or 5\textsuperscript{th} intercostal space not only provides adequate surgical exposure but also prevents fracture of left side of sternum in most patients. Intact left side sternum may cause less pain in the postoperative period and helps fixation of sternum.

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