Clinical Study

The Arrowhead Ministernotomy with Rigid Sternal Plate Fixation: A Minimally Invasive Approach for Surgery of the Ascending Aorta and Aortic Root

Mark J. Russo,1,2 John Gnezda,3 Aurelie Merlo,2 Elizabeth M. Johnson,3 Mohammad Hashmi,3 and Jaishankar Raman4

1 Barnabas Heart Hospitals, Newark Beth Israel Medical Center, 201 Lyons Avenue, Suite G5, Newark, NJ 07112, USA
2 Cardiovascular Clinical Research Unit, Barnabas Heart Hospitals, Newark, NJ 07112, USA
3 Section of Cardiac and Thoracic Surgery, University of Chicago, Chicago, IL 60637, USA
4 Division of Cardiac Surgery, Rush University, Chicago, IL 60612, USA

Correspondence should be addressed to Mark J. Russo; mr2143@gmail.com

Received 27 June 2014; Accepted 5 November 2014; Published 18 November 2014

Academic Editor: Stephen Kavic

Copyright © 2014 Mark J. Russo et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Background. Ministernotomy incisions have been increasingly used in a variety of settings. We describe a novel approach to ministernotomy using arrowhead incision and rigid sternal fixation with a standard sternal plating system. Methods. A small, midline, vertical incision is made from the midportion of the manubrium to a point just above the 4th intercostal mark. The sternum is opened in the shape of an inverted T using two oblique horizontal incisions from the midline to the sternal edges. At the time of chest closure, the three bony segments are aligned and approximated, and titanium plates (Sternalock, Jacksonville, Florida) are used to fix the body of the sternum back together. Results. This case series includes 11 patients who underwent arrowhead ministernotomy with rigid sternal plate fixation for aortic surgery. The procedures performed were axillary cannulation ($n=2$), aortic root replacement ($n=3$), valve sparing root replacement ($n=3$), and replacement of the ascending aorta ($n=11$) and/or hemiarch ($n=2$). Thirty-day mortality was 0%; there were no conversions, strokes, or sternal wound infections. Conclusions. Arrowhead ministernotomy with rigid sternal plate fixation is an adequate minimally invasive approach for surgery of the ascending aorta and aortic root.

1. Introduction

Ministernotomy incisions have been increasingly used in a variety of cardiac surgery settings in an attempt to reduce surgical trauma and hasten patient recovery [1–5]. One of the first described ministernotomy techniques was the T incision [6]. However, despite offering superior exposure, that technique has been avoided after reports of poor healing of the transverse portion [7]. Currently, the J incision technique is the most widely used, although this technique limits exposure. Other less common techniques, such as the “upper V-type” ministernotomy in the second intercostal space, also involve limited exposure [8].

Here we describe a novel approach to ministernotomy by employing two simple but, in our experience, important modifications to the T incision technique. Firstly, the horizontal limb of the inverted T sternotomy is altered to an arrowhead shape. Secondly, rigid sternal fixation by a standard sternal plating system is used to maximize exposure, while limiting risk of sternal complications.

2. Methods

2.1. Preoperative Assessment. Preoperatively, a CT scan is obtained to assess relative location of the aorta to the sternum. If the aortic root is lower than the 4th intercostal space, we favor a full sternotomy.

2.2. Procedure. A small vertical skin incision is made from the midportion of the manubrium to a point just above the 4th intercostal mark. A standard sternal saw is used to
open the sternum vertically, starting at the midline of the
suprasternal notch and finishing at the horizontal limb of
the inverted T (Figure 1). An oscillating saw with a narrow
blade is then used to cut the limbs of the arrowhead from
the midline to the sternal edge of the intercostal spaces. This
configuration allows for a visualization of the aortic root,
the right atrial appendage, and the main pulmonary artery
(Figure 1). The exposure can be further enhanced with the
use of right axillary artery cannulation instead of central
cannulation. This modification allows for better access to the
arch and better antegrade cerebral perfusion. Cardioplegia is
administered using a coronary ostial balloon tipped cannula
(Vitalcor, Westmont, Illinois). Next, a left ventricular vent
is placed through the right superior pulmonary vein. The
surgery on the aorta is then performed in the standard
fashion.

2.3. Chest Closure. At the time of chest closure, care is taken
to align the sternal fragments, ensuring that there is no gap
between the bony edges. Bone reducing forceps are used to
carefully align the bony edges accurately. Firstly, a smaller
pair of bone approximating forceps is placed in the 2nd
intercostal space to get good vertical alignment of the body
of the sternum. Secondly, obliquely placed larger forceps
are placed spanning from the lateral sternal edge at the
3rd intercostal place to the opposite sternal edge at the 5th
interspace in order to align the lower sternal fragment with
the upper two sternal fragments. Finally, simple wires, or a
figure of 8 wires in the manubrium, are used to bring the
sternum together. Rostrocaudal alignment can be achieved by
placing either parasternal wires or a stout suture that extends
from one intercostal space above to one space below the
transverse portion of the sternotomy bilaterally. Alignment
is greatly enhanced, because the segments have a natural
tendency to fit together due to the arrowhead configuration.
Lateral displacement of the segments is inhibited by the
oblique angle of the transverse cuts. Once all three bony
segments are well aligned and approximated, titanium plates
(Sternalock, Biomet Microfixation, Jacksonville, Florida) are
used to fix the body. One “X” shaped plate is used across the
arrowhead junction and a second is used to fix the body of
the sternum (Figure 2). An additional “L” or “box” plate can
be used as needed.

3. Results

This experience includes 11 patients who underwent an
arrowhead approach to aortic surgery. Procedures included
axillary cannulation ($n = 2$), aortic root replacement ($n = 3$),
of combining the excellent surgical exposure of a full sternotomy, with the excellent outcomes of ministernotomies.

**Disclosure**

This paper was presented at 2012 AATS Aortic Symposium, April 26-27, New York, NY.

**Conflict of Interests**

The authors declare that there is no conflict of interests regarding the publication of this paper.

**References**


