Muscle Sparing Mini-thoractomy for Cardiac Surgery: Surgical Technique

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Key Words

Minimally invasive; Muscle sparing; Mitral valve repair; Endocarditis

Central Picture Legend. Muscle sparing mini-three port thoracotomy for cardiac surgery.

Central Message

Muscle sparing small incisional approach for cardiac surgery can be performed safe for some selected patients.
Introduction

Minimal thoracotomy incisional approach has been introduced as a feasible option for the cardiac surgery. Concerns on the thoracic muscle cutting, however, have been argued as which may slow down the postoperative recovery. In this regard, we report our separated 3-port thoracotomy approach techniques with minimizing muscle cutting for the cardiac surgery (IRB: 9-2023-0076, June 22nd 2023, with a waiver of individual consent).

Procedures

Under left lateral semi-decubitus position, skin incisions were drawn at 2nd (5mm, anterior axillary line [AXL]), 3rd (10mm, mid-axillary line [MXL]) and 4th (20mm, AXL) intercostal spaces. This approach is our default setting, but there have been minor modifications of the locations such as 2nd (5mm, AXL), 4th (10mm, MXL) and 5th (20mm, AXL) for patients with small chest wall (CT, Supplementary figure 1). For better visualization and lesser instrumental interference, a vertical direction towards the mitral valve (MV) for the camera port (10mm) and distance more than 3cm between each port were primarily regarded to draw incisions (Supplementary figure 2). Except main utility port (20mm), thoracic wall muscles were all divided only. A virtual illustration is depicted in Figure 1.

After the setting of these approach, cardiopulmonary bypass was established. All the following procedures were performed under scope-assist. The left ventricular venting catheter and cardioplegia line were inserted through main working port (20mm). Thereafter,
detachable aortic clamp was inserted through the 10mm port (MXL) to be parallel to the
transverse sinus. Del Nido cardioplegia (mixture of 80% crystalloid solution and 20%
oxygenated blood) was administered with an antegrade manner through ascending aorta.
After the left or right atriotomy, the MV repair, atrial septal defect closure or mass removal
procedures were performed (Supplementary figure 3). Utilized techniques for the MV repair
were new artificial chorda placement, the anterolateral or posteromedial commissure
closures, indentation closures and annuloplasty ring insertions depending on the individual
MR pathologies. Here we upload a video clip of an infective endocarditis case using this
technique to treat a 27-year-old female (Video).

From Jun 2022 to Mar 2023, we have utilized this approach for 9 patients (Table 1).
There was no mortality nor neurologic deficit. In two cases (#2 and #8), we experienced
sternotomy conversion. In one case (#2), whole procedure performed successfully through
similar approach above, but the right atrial appendage was largely torn during the
cardioplegic line removal. In another case (#8), mass-like lesion was sawn in the
intraoperative trans-esophageal echocardiography, and we clamped again the aorta to re-open
left atrium through sternotomy. The mass, however, was revealed as a folded left atrium
superior wall due to the left atrial appendage clipping. There was no further complication in
both patients. For some cases (#3, #5 and #9), we used this approach for the cosmetic purpose
(Supplementary figure 4).

The study was approved by the institutional ethics committee/review board (study
number 9-2023-0076), and the requirement for informed patient consent was waived in view
of the retrospective nature of the study.
Discussion

For better perioperative recovery, indication of minimal incisional approach for the cardiac surgery has been recently expanded. Instead of splitting sternum, thoracotomy or hemi-sternotomy are common methods for the minimal incisional cardiac surgery. A 5~6cm of incision on the right 4th intercostal space is frequent method to enter the atria of heart. This thoracotomy offers many benefits such as avoiding hemorrhage from the sternum and providing vision parallel to the MV as well as cosmetic gain. The thoracic wall muscles, however, must be cut and separated for this approach, and the pleura is to be opened same size (5~6cm) as well. From this reason, there is an argument that the thoracotomy wound may bring more pain compared with the sternotomy. In some case, the direct vision through this incision is troublesome, or the body of scope often interferes movements of surgical instruments in the single large port system.

To overcome these limitations, we modified thoracotomy incision in the purpose of shortening incision length, minimizing muscle cutting, and separating video scope port. We think our technique has advantages as follows: (1) Except main 20mm incision, thoracic wall muscles can be saved without cutting. (2) As three thoracotomy ports can be placed in triangular shape, movement of surgical instruments became more effective without interference from the scope. (3) The procedure may be helpful for patients who require cosmetic consideration such as young women.

The disadvantage of minimal incisional cardiac surgery is longer cardiopulmonary bypass and cardiac ischemic times than the cardiac surgery with conventional sternotomy. However, the hurdle may be overcome as single del Nido enables 90 minutes of continuing procedures. In our case series, cardiac ischemic time was longer than 100 minutes in first 3
cases. Although it took longer than usual thoracotomy cases, there was no case developing postoperative heart failure. In addition, the surgical time has been gradually deescalated as the surgical team accumulate experiences. This muscle sparing small incisional approach for cardiac surgery may be feasible for some selected young patients. Our technique, however, may not be appropriate for patients with old age, heart failure or other co-morbid conditions because it may require more cardiac ischemic time than the usual thoracotomy approach.
Table 1. Details of patients with muscle-sparing thoracotomy cardiac surgery

<table>
<thead>
<tr>
<th>Number</th>
<th>Age</th>
<th>Sex</th>
<th>Disease</th>
<th>Procedures</th>
<th>ACC Time</th>
<th>CPB Time</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>43</td>
<td>M</td>
<td>Myxoma</td>
<td>Myxoma removal</td>
<td>90</td>
<td>228</td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td>43</td>
<td>M</td>
<td>Degenerative MR</td>
<td>Mitral annuloplasty, Neochoorda formation at P2</td>
<td>207</td>
<td>368</td>
<td>Sternotomy</td>
</tr>
<tr>
<td>#3</td>
<td>27</td>
<td>F</td>
<td>Endocarditis</td>
<td>Mitral annuloplasty, Neochoorda formation at P1, lateral commissuroplasty, A2-A3 indentation repair</td>
<td>190</td>
<td>296</td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>63</td>
<td>F</td>
<td>Degenerative MR</td>
<td>Mitral annuloplasty, Neochoorda formation at P1</td>
<td>132</td>
<td>217</td>
<td></td>
</tr>
<tr>
<td>#5</td>
<td>18</td>
<td>M</td>
<td>Atrial septal defect</td>
<td>Patch repair</td>
<td>87</td>
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</tr>
<tr>
<td>#6</td>
<td>43</td>
<td>M</td>
<td>Myxoma</td>
<td>Myxoma removal</td>
<td>48</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>#7</td>
<td>61</td>
<td>F</td>
<td>TR, Afib</td>
<td>Tricuspid annuloplasty, Afib ablation</td>
<td>101</td>
<td>212</td>
<td></td>
</tr>
<tr>
<td>#8</td>
<td>82</td>
<td>F</td>
<td>Myxoma, Afib</td>
<td>Myxoma removal, Afib ablation</td>
<td>68</td>
<td>300</td>
<td>Sternotomy</td>
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<tr>
<td>#9</td>
<td>26</td>
<td>M</td>
<td>Endocarditis</td>
<td>A3 primary repair, Medial commissuroplasty</td>
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<td>203</td>
<td></td>
</tr>
</tbody>
</table>

* Abbreviations: ACC, aortic cross clamp; CPB, cardiopulmonary bypass; MR, mitral regurgitation; TR, tricuspid regurgitation; Afib, atrial fibrillation
**Figure Legends**

Video. Mitral valve repair through mini-three port thoracotomy for a patient with infective endocarditis.

Figure 1. Muscle sparing mini-three port thoracotomy for cardiac surgery.
Supplementary Figure Legends

Supplementary figure 1. Preoperative computed tomography (CT) images to determine working port location. When the intercostal spaces were small, the main incision was made at the 5th intercostal space to avoid instrumental interference.

A. Preoperative CT scan for a male patient with main incision at 4th intercostal space
B. Preoperative CT scan for a female patient with main incision at 5th intercostal space

Supplementary figure 2. Incision of the muscle sparing mini-three port thoracotomy for cardiac surgery

Supplementary figure 3. Mitral repair for infective endocarditis.

A. Infective mitral valve
B. After removal of vegetation and infected leaflet
C. Mitral valve repair was completed.

Supplementary figure 4. Wound pictures at the first out-patient clinics.

A. Surgical wound for a high school student.
B. Surgical wound for a 27-year-old female
C. Surgical wound for a young male with tattoo
Reference


