Facilitated Aortic Valve Replacement with Complete Sternotomy and Minimal Skin Incision Using Endoscopy: A Case of Surgical Report

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Although median sternotomy is the accepted approach to the heart for cardiac surgery, minimally invasive approaches including partial sternotomies have recently been developed. However, such strategies might lead to sternal overriding, instability, and fracture or division of the internal thoracic arteries. Furthermore, a full sternotomy would be required to address unpredictable intra- or postoperative complications. This article describes minimally invasive aortic valve replacement via full sternotomy and minimal skin incision using an endoscope.

Keywords: minimally invasive surgery, aortic valve replacement, heart valve surgery

Introduction

Minimally invasive approaches to cardiac surgery are attracting increasing interest. Minimally invasive aortic valve replacement using approaches such as parasternal mini thoracotomy, partial upper or lower sternotomy, and horizontal transverse sternotomy have been reported during the past two decades. However, horizontally dividing the sternum confers a risk of damage to the internal thoracic arteries. Furthermore, parasternal thoracotomy or transverse sternotomy are painful, and conversion to full sternotomy is impossible. Therefore, it is most frequently performed through an L- or J-shaped partial upper sternotomy, which requires an additional lateral incision of the sternum. However, lateral incisions such as L- or J-shaped partial sternotomies can also result in sternal overriding, instability, or fracture and full sternotomy would be required in the event of unpredictable intraoperative complications. Good exposure via a full sternotomy is necessary for safe cardiac surgery and to cope with potential intraoperative complications. Especially, this facile minimally invasive surgery should allow a practicing surgeon to continue to use familiar tools and approaches for aortic valve surgery. Here, we describe modified minimally invasive aortic valve replacement via a full sternotomy using an endoscope and a minimal skin incision. These strategies offered good exposure and safety, as well as a cosmetic benefit for the patient.

Case Report

A 68-year-old man (weight, 90 kg; height, 190 cm) was referred to our institution with a diagnosis of aortic stenosis and a chief complaint of progressively increasing dyspnea. Echocardiography confirmed severe aortic valve stenosis with a maximal transvalvular gradient of 106 mmHg, a cusp opening area of 0.6 cm², and good left ventricular function (ejection fraction 65%). Coronary angiography showed no stenosis of the coronary artery.
and the mean aortic valve gradient determined by cardiac catheterization was 50 mmHg. Systolic and mean pulmonary artery pressures were 23 mmHg and 12 mmHg, respectively. A resting electrocardiogram showed a normal sinus rhythm without ischemic change.

The patient was prepared for elective aortic valve replacement via a median sternotomy with a downward 6-cm skin incision starting from 5 cm below the sternal notch and standard monitoring (Fig. 1). The subcutaneous tissues were mobilized from the anterior portion of the sternum, and the linea alba was not opened. The upper two-thirds of the sternum were divided at the midline using an oscillating sternal saw. We also applied a long rigid endoscope with a 30° field of view (Hopkins II; Karl Storz, Tuttingen, Germany) through the skin incision for the chest tube to avoid damaging the subcutaneous tissue (Fig. 2). This method enabled a full sternotomy to be performed through a minimal skin incision, and the spreader (Mercedes; Geister, Tuttingen, Germany) provided adequate sternal distraction. The pericardium was opened longitudinally and sutured to the wound with strong traction to help expose the aorta and right atrial appendage (Fig. 3). Cardiopulmonary bypass was established after cannulation of the right atrium and ascending aorta. Cardiac arrest was established with antegrade infusion of cold crystalloid cardioplegia via the aortic root under systemic mild hypothermia at 33°C. The left ventricle was vented through the right upper pulmonary vein. The aortic valve was a tricuspid with severely calcified cusps, but without severe calcifications on the aortic annular ring. We completely excised the aortic calcified cusps via an oblique aortotomy to the non-coronary sinus. Resection of the valve and placement of the sutures were performed with conventional instruments without endoscopic instruments or knot-pusher. A 25-mm tissue valve (Hancock II; Medtronic, Minneapolis, Minnesota, USA) was implanted into the aorta using a standard technique (twelve interrupted pledgeted sutures with 2–0 Ethibond [Ethicon, Inc., Somerville, New Jersey, USA] in the supraannular position for a stented bioprosthesis). De-arching of the heart through the aortic and left ventricle vents was confirmed by transeosophageal echocardiographic monitoring. The patient was weaned from cardiopulmonary bypass without difficulty. The periods of aortic cross-clamping and cardiopulmonary bypass were 60 min and 86 min, respectively. Atrial and ventricular pacing wires were inserted, and a single mediastinal chest drain was inserted via the incision through which the endoscope had been used for the full sternotomy. The sternotomy was closed with six wires, and then the fascia and soft tissues were closed in layers. The total operation time was 235 min. The postoperative hemodynamics were stable without inotropic support, and he was extubated after a few hours. He stayed in the intensive and intermediate care unit for two days. The patient recovered remarkably well with an uneventful postoperative course, and he was discharged from the hospital on postoperative day 14 without wound...
Minimally Invasive Aortic Valve Surgery with Endoscope

Discussion

Minimally invasive procedures frequently imply limited access or limited control. Moreover, minimally invasive cardiac operations propose using incisions that are foreign to many practicing surgeons, and involve cannulation of structures, such as the femoral artery or vein. We approached the aortic valve via a full sternotomy and a small skin incision using an endoscope. Aortic valve replacement was achieved using standard equipment except for the endoscope, and good exposure was obtained with standard aortic and right atrial cannulation to establish the cardiopulmonary bypass. Our experience has shown that a full median sternotomy can be achieved using an oscillating saw even through a 6-cm skin incision. Furthermore, the endoscope helps to avoid the risk of damage to substernal tissues such as the lungs and great vessels. Once a full sternotomy has been completed, exposure of the aortic valve is comparable to that achieved using conventional procedures. However, the average addition of operating time has been 15–30 minutes due to thorough hemostasis that is required before sternotomy and closure of the sternum.

In our operation, aortic valve was easily visualized through a minimal skin incision. However, if the exposure is difficult to operate an aortic valve surgery, visualization was improved by allowing the surgeon access to working over the right shoulder of the patient, allowing him or her to “look down the barrel” of the aortic valves. If an aortic valve is normally visualized through a limited skin incision, aortic valve replacement can proceed in a normal fashion with familiar tools.4

Maneuvers to remove air are greatly aided by transesophageal echocardiography. Gentle shaking of the heart is usually effective to remove air from the atrium or ventricle with transesophageal echocardiographic monitoring. Gundry and colleagues reported that forceps handles could reach all area of the heart, even through a limited incision, to juggle the heart.5

This minimally invasive approach offers several benefits.6,7 Because the smaller skin incision does not permit excessive spreading of the sternum, potential disruption of the costovertebral junctions or paravertebral hemorrhage is avoided.8 The upper abdominal discomfort associated with opening the linea alba is avoided. Furthermore, a minimal skin incision with full sternotomy provides better cosmetic results, and a postoperatively stable sternum and intraoperative complications can be easily addressed. Only the remaining skin needs to be opened to fully expose the entire mediastinum.

Disclosure Statement

The authors declare no conflicts of interest or relationships with industry.

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