

# Endoscopic Aortic Valve Replacement

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## ABSTRACT

During the last 8 years, many different approaches for minimally invasive aortic valve surgery have emerged. We have developed a technique that enables total endoscopic aortic valve replacement with port access, via a small right lateral thoracotomy with only soft tissue retraction and minimally invasive aortic crossclamping. The operation is performed under video guidance, since no direct eye vision is possible. We believe this is the first such operation performed in cardiac surgery and that it makes possible broadening of indications for nonsternotomy–video-directed surgery in the future.

## INTRODUCTION

New and innovative approaches have been developed in cardiac surgery over the last 8 years, introducing opportunities to reduce postoperative mortality, morbidity, pain, and costs, improve cosmetic results, and most importantly, show that with each new technique there are advantages over a classic one. Classic aortic valve surgery is a well-developed and documented procedure with 1 incision and 1 technique, with global myocardial ischemia, and with known and predictable dangers and risks. In these years of changes in cardiac surgery, innovations have been introduced also into the area of aortic valve surgery. So we have been left with many variations, many techniques, many kinds of incisions, and new and unknown dangers.

We can classify aortic valve replacement (AVR) surgery based on the type of incision: classic AVR (CAVR) surgery, involving a long skin incision and complete sternotomy, and mini AVR (MAVR), which involves a small skin incision, complete or partial sternotomy, and parasternal approaches with or without cartilage removals. The question is whether the smaller skin incision is really a great advantage. Of course, there is a good cosmetic effect, but the real benefit to the patient should be less or no bone trauma, shorter cardiopulmonary bypass (CPB) time, and shorter aortic cross-clamp (AXT) time. With the invention of off-pump cardiac

artery bypass (OPCAB), there has been great resistance to cardiopulmonary bypass (and its duration); however, the smaller skin incisions meant longer, if not very long, CPB and AXT in comparison to CAVR. In addition, the variety of skin incisions and bone cutting at least at some stage presented even more trauma to the patient than the old sternotomy. Also it is interesting to note how easily the golden truths—good cardiac protection during cardioplegia (such as retrograde cardioplegia), good cardiac decompression, and good de-airing—became less important than the length of the skin incision. In addition, the standard aortic crossclamping with jaw-type aortic clamps was not really changed for AVR, despite the fact that their damage to the calcified aortic wall is not a mystery. Furthermore, new clamp designs even permitted the pulmonary artery crossclamping as a byproduct. Beating heart surgery was invented in coronary artery bypass surgery as a good alternative to global myocardial ischemia; however, only a few serious approaches were considered in attempts to perform beating heart AVR surgery. There exist two alternatives to this challenge at the present stage of knowledge: selective coronary artery cannulation and antegrade perfusion with aortic crossclamping [Savitt 2002] (which was abandoned at least for a few years in the past and is now reinvented) and retrograde coronary sinus cannulation with normothermic oxygenated blood perfusion [Gersak 2000, 2003]—both of these alternatives are making possible AVR surgery on the beating heart.

Perhaps the real mini AVR currently or in the near future would or should include nonsternotomy, small thoracotomy with no rib retraction (or cartilage removal), retraction of soft tissue only, with a constant goal of shortening CPB and AXT.

We are presenting a case of total endoscopic aortic valve replacement in which video directed–only surgery is possible with no direct eye observation, with small right lateral thoracotomy and soft tissue retraction, and with no rib retraction or separation. To the best of our knowledge, this is the first operation performed in this way.

## CASE REPORT

A 41-year-old man was admitted to our institution with aortic insufficiency, normal coronary angiography, and ascending aortic diameter of 3.5 cm. The echocardiography showed mild calcinations in the leaflets, hemodynamically important aortic insufficiency, and ejection fraction of 55% with ascending aortic diameter of 3.5 cm. The decision to perform aortic valve replacement was made and the patient

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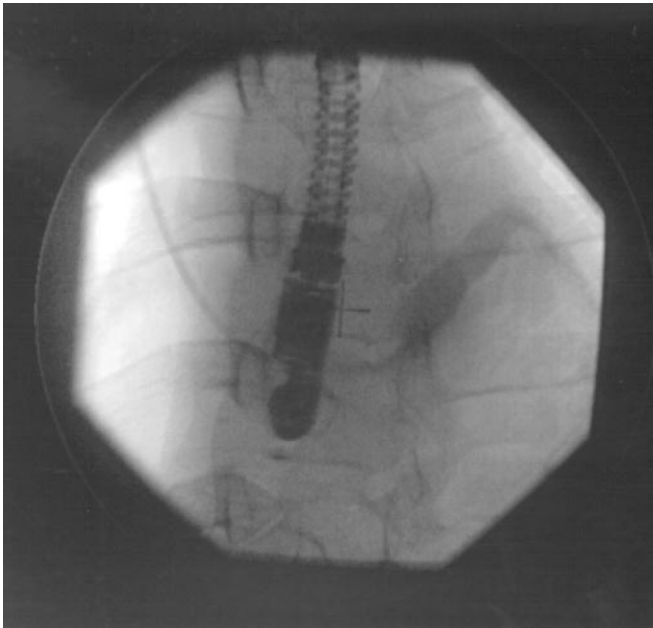


Figure 1. Retrograde coronary sinus catheter, placed through the right internal jugular vein for cardioplegia delivery.

was asked if the endoscopic aortic valve replacement could be the choice for him. He was extremely positive for endoscopic aortic valve replacement.

With the patient under general anesthesia, a retrograde coronary sinus catheter (CardioVations, Somerville, NJ, USA) was introduced under transesophageal echo and fluoroscopic guidance (Figure 1). Then the patient was placed in left recumbent position, slightly more than that for the total endoscopic mitral valve repair or replacement. CPB was established using a 1.5-cm skin incision in the right groin and peripheral cannulation of the right femoral artery (19Fr arterial cannula; CardioVations) and the right femoral vein (25 Fr Quickdraw venous cannula; CardioVations). A right thoracic skin incision (4 cm) was made over the 4th intercostal space, 1.5 cm below the nipple, with two thirds of the skin incision lateral to the lateral clavicular line (Figure 2). Then the soft tissues were mobilized, and a working port of 3.5 cm was established with soft tissue retraction using a soft tissue retractor medium (CardioVations) in the 3rd intercostal space, and a CO<sub>2</sub> line was introduced (3 L/min). A 5-mm camera port was introduced in the same intercostal space. No rib retraction was used throughout the procedure. The aortic clamp port was established in the 2nd intercostal space with a 11.5-mm thoracic port. When the CPB started and vacuum-assisted venous drainage was established, the pericardium was opened above the ascending aorta and a guide wire for a portaclamp (Cardio Life Research, Brussels, Belgium) was introduced through the port. The wire was guided through the transverse sinus and grabbed with the forceps and later fed out of the thorax through the port. Both arms of the portaclamp were mounted on the wire, introduced into the thorax, and put below and above the aorta (this made paral-

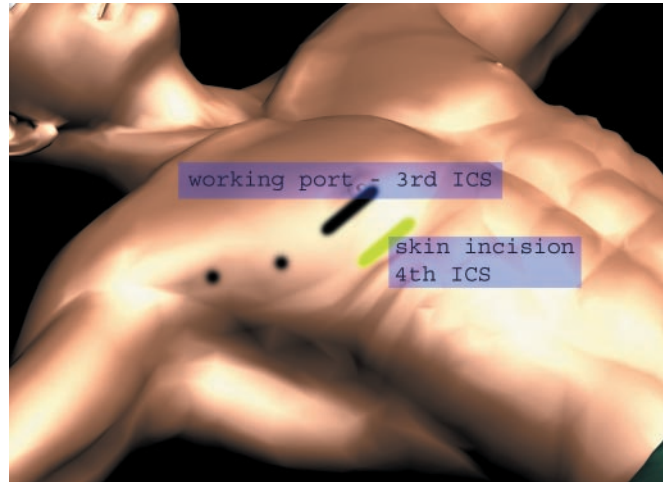


Figure 2. Incisions and port placements for endoscopic aortic valve replacement.

lel aortic clamp arm positioning possible prior to clamping). A left ventricular vent was introduced through the right superior pulmonary vein into the left ventricle, and a small 14 Fr catheter was used for additional right atrial drainage. Stay sutures for the pericardium exposed the aortic root well, and the aorta was crossclamped, with immediate cold blood cardioplegia. A 6 Fr needle was used to decompress the aorta during retrograde cardioplegia; at the end of cardioplegia the needle was removed and the aorta was opened with a transverse cut around, 2 cm above the aortic valve. Stay sutures for all 3 commissures were used to expose the aortic valve better and all 3 cusps were excised. The aortic valve was measured, and it was determined appropriate to implant a 23-mm artificial aortic valve (St. Jude, Minneapolis, MN, USA). Then the pledgeted 2/0 Ethibond sutures (Ethicon, Somerville, NJ, USA) were used from the ventricular side and directly mounted on the artificial aortic valve. The valve was put into the thorax and sutures were tied with a knot pusher (CardioVations). The mobility of the leaflets was tested, the sutures were cut, and the aorta was sutured back with 4/0 polypropylene inverted mattress sutures (Ethicon) and 1 additional 5/0 polypropylene running suture. Before the sutures were completely tied, the heart was filled with blood, the left lung was inflated, and a transesophageal echocardiographic image was used to see if any additional air was left in the left heart. At the end the sutures were tied down, a temporary pacemaker wire was put on the muscular layer of the left ventricle, and the aorta was declamped. The heart was fibrillating, but because of the small incision it was not possible to introduce the defibrillating pads into the thorax, and the external defibrillation was not effective due to collapsed lungs. The aorta was crossclamped again, an additional dose of cardioplegia was given for 5 minutes, and the aorta was declamped again. The heart restored normal sinus rhythm immediately and maintained the pressure, and the CPB weaning was not a problem. The aortic crossclamp time was 180 minutes and the CPB time was 230 minutes.



Figure 3. Patient 6 days after the operation.

A Blake drain (Johnson & Johnson, New Brunswick, NJ, USA) was put below the heart and into the right thorax, the portaclamp was removed, interrupted pericardial sutures were used to close the pericardium, cannulas were removed, and the incisions were closed with layered sutures.

The patient was transferred into the intensive care unit, extubated after 15 minutes, transferred to the general ward the next morning, and discharged to home 6 days after the operation (Figure 3). The controlled transthoracic echocardiography showed good cardiac function, no periprosthetic leakage, and no thoracic or pericardial fluid.

## DISCUSSION

To our knowledge, this is the first totally endoscopic aortic valve replacement in history. We say *totally* although a small incision has to be made to put the aortic valve into the thorax; otherwise, in all other aspects, this procedure is possible under only endoscopic vision. No direct visualization is possible with this small incision and without rib retraction, and in addition a 30° endoscopic camera has to be used to see all parts of the aortic valve. This valve is parallel to the working line, in contrast to the mitral valve, which is partially perpendicular and mobile. However, this position does not prevent the surgeon from working under endoscopic vision, because the camera port is in the 2nd intercostal space, one space above the working port for this procedure.

We are aware of so-called minimally invasive aortic valve surgery, with partial sternotomy, parasternal medial approach, with or without cartilage removal. All of these techniques have to use bone retractors, and surgery is performed under direct eye visualization.

The good results from port-access mitral valve surgery [Vanermen 2000, Greco 2002] encouraged us to also do the aortic valve replacement this way. There is less post-operative pain if only soft tissue is retracted, less bleeding, faster rehabilitation, and faster return to normal life activities. Cosmetic effect is excellent, the scar small and not visible; especially in women, this type of incision is desirable.

Of course we believe this is just the first step toward wider spread of endoscopic aortic valve surgery, but at the same time we believe that with a new generation of instruments for CPB and visualization techniques, this procedure will be performed more frequently and perhaps reach the same popularity and achieve the same good results as the port-access mitral valve operations.

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