Computed Tomography Helps to Plan Minimally Invasive Aortic Valve Replacement Operations

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Background. **This study evaluated the role of multidetector computed tomography (MDCT) in preparation for minimally invasive aortic valve replacement (MIAVR).**

Methods. **An analysis of 187 patients scheduled for MIAVR between June 2009 and December 2014 was conducted. In the study group (n = 86), MDCT of the thorax, aorta, and femoral arteries was performed before the operation. In the control group (n = 101), patients qualified for MIAVR without receiving preoperative MDCT.**

Results. **The surgical strategy was changed preoperatively in 12.8% of patients from the study group and in 2.0% of patients from the control group ($p = 0.010$) and intraoperatively in 9.9% of patients from the control group and in none from the study group ($p = 0.002$). No conversion to median sternotomy was necessary in the study group; among the controls, there were 4.0% conversions. On the basis of the MDCT measurements, optimal access to the aortic valve was achieved when the angle between the aortic valve plane and the line to the second intercostal space was 91.9 ± 10.0 degrees and to the third intercostal space was 94.0 ± 1.4 degrees, with the distance to the valve being 94.8 ± 13.8 mm and 84.5 ± 9.9 mm for the second and third intercostal spaces, respectively. The right atrium covering the site of the aortotomy was present in 42.9% of cases when MIAVR had been performed through the third intercostal space and in 1.3% when through the second intercostal space ($p = 0.001$).**

Conclusions. **Preoperative MDCT of the thorax, aorta, and femoral arteries makes it possible to plan MIAVR operations.**

(Ann Thorac Surg 2016;■:■–■)
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The right minithoracotomy approach for aortic valve replacement (MIAVR) has emerged as a feasible and effective surgical technique for even elderly and high-risk patients with severe aortic stenosis. It reduces complication rates, improves the cosmetic result, and generally increases patient satisfaction [1, 2].

Multidetector computed tomography (MDCT) allows for precise cardiac and vascular imaging that can be used to plan minimally invasive aortic valve operations [2–4]. The aim of this study was to evaluate the influence of preoperative MDCT examination on the strategy of aortic valve operations through a right minithoracotomy, particularly to analyze complications and conversion rates.

Patients and Methods

The study was performed in accordance with the Declaration of Helsinki. The Jagiellonian University of Cracow Institutional Review Board approved the study. Written informed consent was obtained from every patient.

Accepted for publication Oct 26, 2015.

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Study Population

Adults who required aortic valve replacement because of isolated aortic valve pathology were eligible for study enrollment. Exclusion criteria included planned concomitant procedures, previous cardiac surgical procedures, and emergency operations.

We reviewed prospectively gathered data of 192 patients with isolated aortic valve pathology who had been scheduled for MIAVR between June 2009 and December 2014 at John Paul II Hospital in Cracow. The study group included 87 patients scheduled consecutively for MIAVR from June 2009 until September 2011 who underwent preoperative MDCT examinations of the thorax, aorta, and femoral arteries. The control group included 105 patients scheduled consecutively for MIAVR from October 2011 until December 2014, for whom a minimally invasive operation was planned without a preoperative MDCT examination. The primary surgical strategy for all patients in both groups consisted of aortic valve replacement through a right minithoracotomy with retrograde cardiopulmonary bypass (CPB) through the femoral vessels.

MIAVR Through Right Minithoracotomy

For CPB, usually the left femoral artery was cannulated with a Bio-Medicus 17F to 21F arterial cannula (Medtronic, Minneapolis, MN), and the left femoral vein was

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Published by Elsevier

0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2015.10.076

Abbreviations and Acronyms

AV = aortic valve
AVR = aortic valve replacement
COPD = chronic obstructive pulmonary disease
CPB = cardiopulmonary bypass
ICS = intercostal space
II is = second intercostal space
MDCT = multidetector computed tomography
MIAVR = minimally invasive aortic valve replacement
TAVI = transfemoral aortic valve implantation

cannulated with a Quick Draw 25F venous cannula (Edwards Lifesciences, Irvine, CA) with the aid of transesophageal echocardiography. In cases of significant peripheral vascular disease or the presence of an abdominal aortic aneurysm, central ascending aortic cannulation was performed.

A 5- to 6-cm transverse parasternal incision was made over the right third rib and the chest was entered through the second or third intercostal space (ICS). The ascending aorta was cross-clamped through the thoracotomy, and antegrade warm blood cardioplegia was administered through the aortic root, with repeated doses directly to the coronary ostia. The aortic valve replacement was performed using the standard technique.

MDCT Examination

For preoperative planning, patients underwent imaging through MDCT (Siemens Healthcare, Erlangen, Germany). Three-dimensional and two-dimensional sagittal reconstructions were generated. MDCT was electrocardiogram gated, acquisition was retrospective with tube current modulation, slice thickness was 0.6 mm, 110 mL of contrast was used, and the radiation dose was 15.8 mSv.

The protocol of MDCT examination consisted of the following measurements: angle between the aortic annulus plane and a line drawn from the aortic annulus plane to the second ICS (Fig 1A), distance between the middle point of the aortic annulus plane and the second ICS, (Fig 2A), angle between the aortic annulus plane and a line drawn from the aortic annulus plane to the third ICS (Fig 1B), distance between the middle point of the aortic annulus plane and the third ICS (Fig 2B), distance to the potential aortic cannulation place from the second (Fig 2A) and third (Fig 2B) ICS, which was hypothetically located 15 mm below the innominate artery.

The frequency of anatomical position of the right atrium covering the site of the aortotomy was analyzed. The presence of ascending aorta calcifications, abdominal aortic aneurysm with thrombus, and femoral arteries calcifications, all of which can change the strategy of aortic valve surgery, was analyzed.

Clinical Variables and Perioperative Events

We analyzed preoperative patient characteristics and clinical variables such as hospital mortality, prolonged mechanical lung ventilation, renal insufficiency, perioperative myocardial infarction, stroke, reoperations for bleeding, operation times, and intensive care unit and hospital lengths of stay.

Hospital mortality was defined as death for any reason during the same hospitalization period or occurring within 30 days after the operation. Prolonged mechanical lung ventilation was the necessity to use mechanical lung ventilation for more than 24 hours [5]. Renal insufficiency was recognized when the baseline serum creatinine level was above 177 μmol/L or 2.0 mg/dL [6]. Glomerular filtration rate before and after MDCT was calculated according to the Modification of Diet in Renal Disease

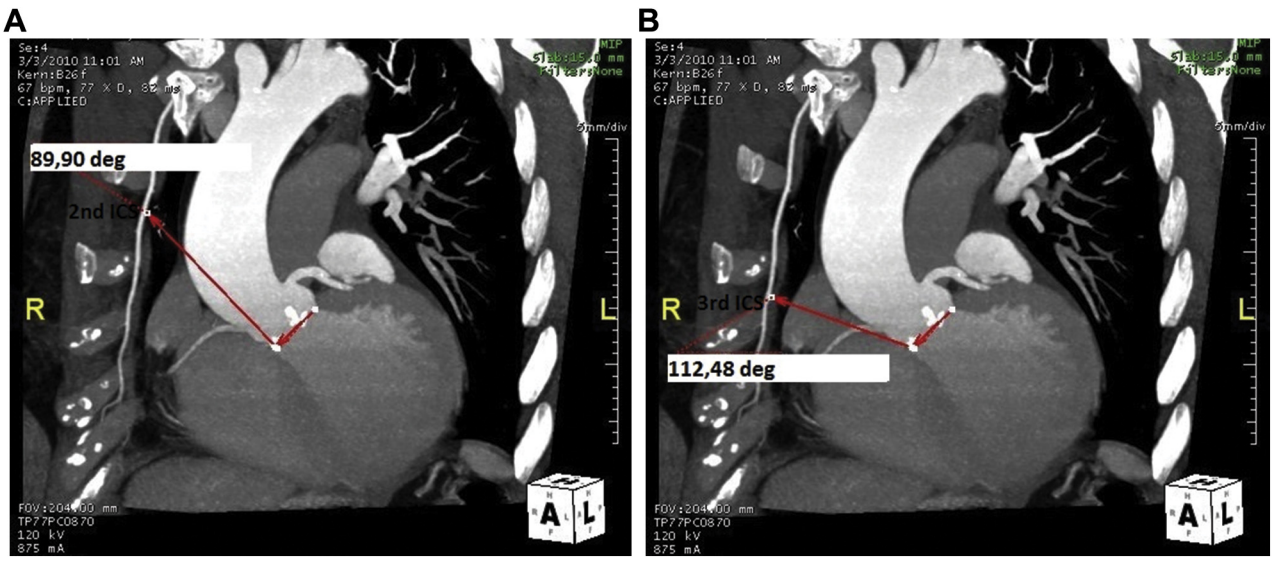

Fig 1. Angle between the aortic valve plane and a line from the aortic valve plane to the (A) second and (B) third intercostal space.

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