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A comparison of minimally invasive and standard aortic valve replacement

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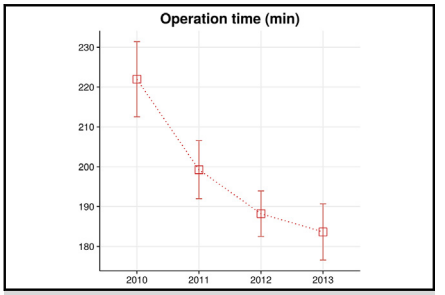
ABSTRACT

Objective: The study objective was to compare aortic valve replacement through a right anterior minithoracotomy with aortic valve replacement through a median sternotomy.

Methods: With propensity score matching, we selected 211 patients after aortic valve replacement through a right anterior minithoracotomy and 211 patients after aortic valve replacement who underwent operation between January 2010 and December 2013. Perioperative outcomes were analyzed, and multivariable logistic regression analysis of risk factors of postoperative morbidity was performed.

Results: For propensity score–matched patients, hospital mortality was 1.0% in the aortic valve replacement through a right anterior minithoracotomy group and 1.4% in the aortic valve replacement group ($P = 1.000$). Stroke occurred in 0.5% versus 1.4% ($P = .615$), myocardial infarction occurred in 1.4% versus 1.9% ($P = 1.000$), and new onset of atrial fibrillation occurred in 12.8% versus 24.2% ($P = .003$) of patients in the aortic valve replacement through a right anterior minithoracotomy and aortic valve replacement groups, respectively. Postoperative drainage was 353.5 ± 248.6 mL versus 544.3 ± 324.5 mL ($P < .001$) and blood transfusion was required for 48.8% versus 67.3% ($P < .001$) of patients in the aortic valve replacement through a right anterior minithoracotomy and aortic valve replacement groups, respectively. Mediastinitis occurred in 2.8% of patients after aortic valve replacement and in 0.0% of patients after aortic valve replacement through a right anterior minithoracotomy surgery ($P = .040$). Intensive care unit stay (1.3 ± 1.2 days vs 2.6 ± 2.6 days) and hospital stay (5.7 ± 1.6 days vs 8.7 ± 4.4 days) were statistically significantly shorter in the aortic valve replacement through a right anterior minithoracotomy group. Aortic valve replacement through a right anterior minithoracotomy surgery resulted in reduced postoperative morbidity (odds ratio, 0.4; $P < .001$) and postoperative bleeding and blood transfusion requirements (odds ratio, 0.4; $P < .001$).

Conclusions: Aortic valve replacement through a right anterior minithoracotomy surgery resulted in a reduced infection rate, diminished postoperative bleeding and blood transfusion requirements, reduced occurrence of new onset of atrial fibrillation, and shorter intensive care unit and hospital stays. (J Thorac Cardiovasc Surg 2016;152:1030-9)



Operation time indicating a learning curve for RT-AVR surgery.

Central Message

RT-AVR surgery results in a reduced complication rate compared with conventional AVR surgery via a median sternotomy.

Perspective

RT-AVR surgery appeared to be feasible, safe, and efficient. Postoperative morbidity was diminished, and the mortality rate was comparable to that of conventional AVR surgery. Minimally invasive AVR surgery should be considered when isolated surgical AVR is indicated, keeping in mind major limitations such as left-sided aortas and right pleural adhesions.

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Abbreviations and Acronyms

AVA = aortic valve area
AVR = aortic valve replacement
CPB = cardiopulmonary bypass
EF = ejection fraction
EuroSCORE = European System for Cardiac Operative Risk Evaluation
ICU = intensive care unit
LCOS = low cardiac output syndrome
MDCT = multidetector computed tomography
PSM = propensity score matching
RT-AVR = aortic valve replacement through a right anterior minithoracotomy

Scanning this QR code will take you to a procedural video.

At the end of the last century, a conventional open procedure using a median sternotomy was the technique of choice in most cardiac surgical centers.[1] Less-invasive surgical treatment of patients with valvular heart disease entered clinical practice in 1996, and since then, it has started to gain worldwide acceptance.[2,3]

Publications describing the safety, efficacy, mortality, and morbidity associated with the minimally invasive right anterior minithoracotomy approach in aortic valve surgery are still relatively scarce in medical literature.[4] Currently, minimally invasive aortic valve surgery becomes an option when surgical aortic valve replacement (AVR) is indicated.[5]

The aim of this study was to answer the question if the perioperative outcomes of patients after minimally invasive aortic valve replacement through a right anterior minithoracotomy (RT-AVR) can be improved compared with patients after a conventional median sternotomy (AVR).

MATERIALS AND METHODS

Study Design

This was an observational cohort study performed in accordance with the Declaration of Helsinki and the consensus guidelines expressed by the Strengthening the Reporting of Observational Studies in Epidemiology statement.[6] Approval from the Institutional Ethical Review Board (Regional Medical Chamber, October 10, 2010) was obtained, and written informed consent was obtained from all patients. The analysis is based on prospectively gathered preoperative data and in-hospital outcomes of 221 patients who underwent RT-AVR surgery between January 2010 and December 2013. The control group consisted of 316 patients who underwent operation during the same period, for whom standard AVR surgery was performed.

Exclusion criteria were emergency operations, including infective endocarditis, previous cardiac surgical procedures, and left ventricle ejection fraction (EF) less than 30%. It was the policy of our department that these higher-risk patients undergo operation through a conventional median sternotomy approach. We applied propensity score matching (PSM) to alleviate differences in preoperative patient characteristics and to create 2 comparable study groups.[7]

The decision to perform RT-AVR was based on preoperative multidetector computed tomography (MDCT) examination applying the methodology described by Glauber and colleagues.[8] Contraindications for RT-AVR surgery were difficult access to the aorta, when the aorta was positioned more to the left side of the chest, a history of right-sided pleural effusion, thorax trauma with rib fracture, and other thorax deformities, all which can suggest the presence of pleural adhesions.[8]

The time of discharge from the intensive care unit (ICU) or hospital was determined by medical judgment and patient threshold for discharge.[9] On the basis of PSM patients, a multivariable logistic regression analysis describing risk factors of postoperative morbidity, bleeding, and blood transfusion requirements was conducted. Because of the low number of particular complications, a dependent variable analyzed in the model was postoperative complications in total. Preoperative comorbidities, patient demographics, surgical technique, hemoglobin concentration 1 day before surgery and at ICU arrival, and length of cardiopulmonary bypass (CPB) were included as independent variables in the model.

Definitions of Perioperative Events

For hospital mortality, we defined death as occurring within 1 month after surgery or during the same hospitalization period if the hospitalization was prolonged more than 1 month.[10] An online calculator (http://www.euroscore.org/calc.html) was used to calculate and predict hospital mortality based on the European System for Cardiac Operative Risk Evaluation (EuroSCORE) II system.[10]

A stroke was defined as new central neurologic deficit persisting more than 72 hours.[11] We recognized perioperative myocardial infarction when ST-segment changes on serial electrocardiograms were observed and troponin I level 24 hours after surgery was at least 1.0 ng/mL.[11] Preoperative renal insufficiency was defined as baseline serum creatinine level greater than 2.0 mg/dL.[12] According to our protocol, blood transfusion was required when the hemoglobin level was less than 8 g/dL.

Surgical Technique

For preoperative planning of the RT-AVR surgery, patients underwent imaging using MDCT (Siemens Healthcare, Erlangen, Germany).[8] For RT-AVR surgery, tracheal intubation was performed with a double-lumen tracheal tube. Vacuum-assisted CPB was instituted by peripheral cannulation of the femoral vessels through a 2- to 3-cm skin incision just below the level of the femoral ligament. The femoral artery usually was cannulated with a 19F or 21F arterial cannula (Bio-Medicus; Medtronic, Minneapolis, Minn), and the femoral vein was cannulated with a 25F venous cannula (Quick Draw, Edwards Lifesciences, Irvine, Calif). Both cannulas were placed using the Seldinger technique under transesophageal echocardiography control. In rare cases when significant peripheral vascular disease was present or femoral vessels were small in diameter, central ascending aortic cannulation was performed with the same arterial cannula.

A 5- to 6-cm transverse incision usually was made over the right third rib, and the chest was entered through the second or third intercostal space on the right side (Video 1). The third costal cartilage usually was transected to avoid rib fracture. At the completion of the operation, the rib was reattached to the sternum. The right internal thoracic vessels were transected and secured. CO_2 insufflation into the right hemithorax was performed with a flow of 5 L/min. The left ventricle vent was placed through the right superior pulmonary vein, an aortic crossclamp was applied through the incision, and antegrade warm blood cardioplegia was delivered through a

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