Initial Experience With a Percutaneous Approach to Redo Mitral Valve Surgery: Management and Procedural Success

Chirojit Mukherjee, MD,* David Holzhey, MD, PhD,† Meinhard Mende, MD, PhD,‡ Axel Linke, MD, PhD,§ Udo X. Kaisers, MD, PhD,‖ and Joerg Ender, MD, PhD*

Objective: **The purpose of the study was to report the anesthetic management and immediate procedural success in the initial 20 patients undergoing percutaneous transapical mitral valve replacement.**

Design: **Retrospective review of collected data.**

Setting: **University-affiliated heart center.**

Participants: **Twenty patients with mitral regurgitation or stenosis due to a degenerated valve or ring in the mitral position.**

Interventions: **TEE-guided transapical mitral valve replacement under general anesthesia and early extubation by means of an established fast-track protocol.**

Measurements and Main Methods: **Twenty patients underwent transapical mitral valve replacement by a beating heart procedure, avoiding cardiopulmonary bypass. The valve was either deployed due to a previously implanted bioprosthetic valve (valve-in-valve group), which degenerated, or a ring (valve-in-ring group), which predominantly showed regurgitation. There was a significant increase in the mitral valve opening area in stenosed valve pathology from 1.3-1.9 sq. cm ($p = 0.004$), and an increase in ejection fraction from 40% to 45% ($p = 0.52$). In the valve-in-ring group, valve area increased from 2.0 sq. cm to 2.6 sq. cm ($p = 0.21$), with an increase in ejection fraction from 30% to 35% ($p = 0.18$). Eighteen patients underwent successful deployment of the valve. The anesthesia duration for the procedure lasted 185.5 ± 25.4 minutes.**

Conclusions: **There was a significant increase in opening area of the valve and improvement in ejection fraction in this patient group. TEE and fluoroscopy-guided imaging is necessary for the procedure's success and is an evolving alternative treatment for high-risk mitral valve patients who would otherwise be considered inoperable for routine surgery using sternotomy.**

KEY WORDS: percutaneous mitral valve, real-time, 3D transesophageal echocardiography, valve-in-valve, valve-in-ring

TRANSCATHETER AORTIC VALVE REPLACEMENT (TAVR) has been investigated as an alternative method of treatment in patients who were considered inoperable but diagnosed with high-grade symptomatic aortic stenosis.[1,2] TAVR also has been performed in a degenerated bioprosthetic aortic valve with successful outcomes.[3,4] As seen with TAVR, elderly high-risk patients with a degenerated bioprosthetic mitral valve are also being seen in routine clinical practice. Consequently, an alternative method of treatment in this elderly population will be to utilize the minimally invasive transapical approach to deploy the valve. The aim of the study was to report the management and procedural success of valve-in-valve (VIV) or valve-in-ring (VIR) implantation in the mitral position through a transapical approach.

MATERIALS AND METHODS

After approval from the local ethical committee and written informed consent, the authors retrospectively analyzed the patients, during the period of December 2009 to January 2013, undergoing transapical mitral valve replacement (TAMVR). Inclusion criteria and exclusion criteria were decided by the heart valve team comprising 1 cardiologist and 2 cardiac surgeons, who specialized in valve disorders, and 1 imaging specialist who interpreted multidetector computer tomography (MDCT), echocardiography, and cardiac magnetic resonance imaging.

Criteria for repeated mitral surgery were as per the guidelines of the American College of Cardiology/American Heart Association.[5]

Inclusion criteria included (1) patients who have undergone previous mitral valve surgery and presenting with a pre-existing ring or bioprosthetic valve in the mitral position; (2) mitral valves that have undergone degeneration causing either stenosis or regurgitation or a regurgitation or stenosis arising from a previously implanted ring, and the echocardiographic assessment of the valve should have been performed within 30 days of surgical intervention; (3) symptomatic patients arising from his/her stenosis or regurgitation irrespective of comorbid conditions (≥New York Heart Association [NYHA] class II); (4) judged inoperable due to existing medical comorbidities, and after evaluation from the heart valve team, the possibility of the patient benefiting from the percutaneous approach exceeded the risk involved from a conventional approach (either high-risk or medical conditions preventing open-heart surgery); these patients were not likely to have clinical improvement without surgical intervention; and (5) Additive European System for Cardiac Operative Risk Evaluation (EuroSCORE) >10 after they were physically examined by one of the cardiac surgeons.

Exclusion criteria were analogous to the expert consensus document (ECD) for TAVR.[6]

If any of the following criteria existed, the patients were not considered for surgery. These criteria included (1) patient refusal to undergo the innovative surgical method, (2) emergency surgery, (3) hemodynamic instability requiring high

*From the Departments of *Anesthesia and Intensive Medicine, Heart Center Leipzig, †Cardiac Surgery, Heart Center Leipzig, ‡Coordination Center for Clinical Trials, §Cardiology, Heart Center Leipzig, and ‖Anesthesia and Intensive Care Medicine, University of Leipzig, Leipzig, Germany.*

Address reprint requests to Chirojit Mukherjee, MD, Heart Center, University of Leipzig, Department of Anesthesia and Intensive Medicine, Struempellstrasse 39, 04289 Leipzig, Germany. E-mail: chirojit.mukherjee@medizin.uni-leipzig.de

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inotropic support, (4) debilitating respiratory insufficiency, (5) predicted life expectancy less than 12 months due to coexisting noncardiac conditions, (6) presence of tricuspid regurgitation with right heart failure, (7) confirmation of an acute myocardial infarction within 30 days prior to planned procedure, (8) presence of vegetation/thrombus/mass as seen during diagnostic procedures, and (9) inability to perform regular activities due to compromised mental status. However, patients with mitral regurgitation and pulmonary hypertension were not excluded as the procedure was performed on the mitral valve.

Anesthetic Management

All patients underwent general anesthesia for the procedure. The patients were medicated the night before surgery with dipotassium chlorazepate, and midazolam was given orally approximately 1 hour before induction. All patients were induced with fentanyl (10 μg/kg), propofol (3 mg/kg), and rocuronium (0.6 mg/kg). Maintenance of anesthesia was performed with continuous infusion of propofol (3 mg/kg) and remifentanil (0.2 μg/kg/min). The left radial artery usually was punctured for intraoperative blood pressure monitoring. Intubation was performed using a single-lumen endotracheal tube. After placement of the endotracheal tube, a triple-lumen central venous line and an 8.5-Fr sheath were inserted in the right internal jugular vein using ultrasound guidance. A 12-lead ECG and pulse oximetry were used for intraoperative monitoring. Invasive monitoring was comprised of blood pressure and central venous pressure. Transesophageal echocardiography (TEE) was performed in all cases. The institution protocol, as described earlier,[7] required the transfer of the patients to a post-anesthetic care unit (PACU) where they could be fast-tracked[8] if all the required criteria were met. None of the patients was extubated in the operating room.

Anesthetic tasks could be summarized as follows: (1) There was maintenance of core temperature above 36 degrees centigrade using full under-body warming blankets (Bairhugger, Arizant Healthcare, Eden Prairie, MN) from beginning of induction and use of an intravenous fluid heating system to facilitate fast-tracking in this patient population. (2) Before rapid ventricular pacing could be performed, an activated clotting time (ACT) of more than 300 seconds was desirable to prevent formation of any embolic clots by use of heparin at 100 IU/kg body weight. Protamine was substituted in a 1:1 ratio to heparin (dosage based on international units) at the end of the procedure. (3) In contrast to TAVR procedures, the authors used rapid ventricular pacing (RVP) at 120 beats/min to 140 beats/min for valve deployment. (4) Volume and hemodynamic management were assessed by TEE. Use of crystalloids and judicious use of boluses of epinephrine or norepinephrine supported systemic blood pressure during valve deployment. If required, a continuous infusion of inotropes was initiated to maintain the desired mean arterial blood pressure. The therapy of choice was 0.5-μg boluses of epinephrine in incremental doses in patients with valve regurgitation and norepinephrine in patients with stenosis. Continuous infusion of inotropic agents was started if the patients required more than 4 boluses of epinephrine/norepinephrine. A cell-saver system was used to retransfuse any inadvertent loss of blood. (5) PACU focused further on hemodynamic stabilization, early extubation, and pain management. This could be achieved using incremental bolus doses of piritramide and infusion of metamizol on the day of surgery and oral oxycodone for the initial postoperative days if deemed necessary. The patients were transferred to a step-down unit for postoperative surveillance before shifting them to the ward the next day.

Surgical Procedure

All surgery was performed in the hybrid operating room with the facility to initiate cardiopulmonary bypass if required. Anterolateral thoracotomy was performed in the $5^{th}/6^{th}$ intercostal space as per the patient anatomy. The safety net was established before the initiation of surgical intervention, in accordance with the institutional protocol, in the event of an emergency necessitating cardiopulmonary bypass.[9] Apical puncture was performed under echocardiographic control. The puncture site was at that point where the manual dimpling of the apex, caused by the surgeon`s index finger, was seen in TEE at the left ventricular apex (Fig 1). After hemostatic control was achieved using pursestring sutures, the left ventricular puncture was performed, and the Seldinger technique was used to place a J-shaped guidewire and introduce a 9F sheath, which later was replaced by an Amplatzer extra-stiff guidewire (Cook Medical, Bloomington, Indiana). The 24F Ascendra Plus Delivery System (Edwards Lifesciences, Irvine, CA) was used for deployment of the 29-mm Sapien XT valve (Edwards Lifesciences, Irvine, CA). The valve crimping was done in an exact opposite manner compared to aortic position placement (sewing cuff facing left ventricle). The valve was implanted after confirmation of position using rapid ventricular pacing at 120 beats/min to 140 beats/min, under real-time 3D transesophageal echocardiography (RT3D TEE) and fluoroscopy guidance. The valve positioning was generally 2 mm above the degenerated valve/ring towards the atrial side after confirmation by echocardiography. After valve deployment, the retrieval of the sheath and apical closure was performed in the usual manner.

ECHOCARDIOGRAPHIC IMPLICATIONS

The echocardiographic examination was concentrated on parameters that included (1) preoperative and postoperative mitral valve opening area, (2) maximum and mean gradients (preoperative and postoperative), (3) echo guidance during valve deployment, (4) presence or absence of intravalvular and paravalvular leaks, and (5) preoperative and postoperative ejection fraction.

Moreover, a preoperative and postoperative comprehensive examination as per guidelines of ESC/SCA was performed.[10] Echocardiographic control was necessary throughout the procedure. RT3D TEE, using simultaneous multiplane mode starting from the mid-esophageal mitral commissural view, allowed guidance of guidewire insertion through the mitral valve (Fig 2), passage of the applicator device with the mounted valve (Fig 3) during valvuloplasty, and valve deployment (Fig 4) in lateromedial and anteroposterior direction. Preoperative and postoperative comparisons were visibly