Outcomes of peripheral perfusion with balloon aortic clamping for totally endoscopic robotic mitral valve repair

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Objective: Although the technique of totally endoscopic robotic mitral valve repair (TERMR) has been well described, few reports have examined the results of peripheral perfusion with balloon clamping. We analyzed the outcomes of TERMR performed using this strategy.

Methods: A total of 108 consecutive patients underwent TERMR by a 2-surgeon team. The preoperative evaluation included chest computed tomography and abdominal and pelvis computed tomography. Additional procedures included appendage exclusion in 96, patent foramen ovale closure in 29, cryoablation in 16, tricuspid valve repair in 2, and septal myectomy in 2. The mean patient age was 59 years (range, 21-86). Central venous drainage was obtained with a long cannula. Arterial return was achieved with femoral cannulation, when possible. An endoballoon catheter was placed through the femoral artery. Transesophageal echocardiography was used to position all catheters.

Results: Femoral artery perfusion was possible in 103 of 108 patients (95.3%). The subclavian artery was used in 5 patients (4.6%) with contraindications to retrograde perfusion. An endoballoon clamp was placed by way of the femoral artery. In 105 of 108 patients (97.2%), endoaortic occlusion was successfully used; the mean crossclamp time was 87.4 minutes. The coronary sinus cardioplegia catheter was placed successfully in 81 of the 108 patients (75%). Postoperatively, no or mild inotropic support was needed in 94 (87%) and moderate support in 14 (13.0%). Of the 108 patients, 55 (50.9%) were extubated in the operating room. No hospital mortality, aortic injury, vascular complications, or wound infections occurred. Complications included 2 strokes (no residual deficit) (1.8%) and atrial fibrillation in 18 (16.7%). The median hospital stay was 4 days. Eighty patients (74.1%) were discharged by postoperative day 5.

Conclusions: A preoperative image-guided perfusion strategy and aortic balloon clamping permit routine TERMR with excellent myocardial preservation and minimal complications. (J Thorac Cardiovasc Surg 2014;148:2769-72)

ACD

Advances in techniques, combined with an increasing demand for less invasive mitral valve surgery, have resulted in robotic mitral valve repair evolving into a useful surgical option that allows for precise and durable repair with smaller surgical incisions.[1-4] The first report of robotic-assisted mitral valve surgery used a minithoracotomy approach,[5] with subsequent investigators confirming the feasibility of this technique.[6-11] During the previous decade, 2 distinct perfusion and crossclamping approaches to robotic mitral repair have been used—one that relies on external aortic crossclamping and one that uses endoballoon technology (Edwards Lifesciences, Irvine, Calif) for aortic clamping. Several large groups have continued to use minithoractomy with external aortic crossclamping as a mainstay approach.[1,12] A second perfusion and clamping paradigm for robotic repair has evolved to a totally endoscopic approach (totally endoscopic robotic mitral valve repair [TERMR]) with the working port sized to only accept a single finger. Advocates of this approach have tended to rely on endoballoon clamping, because this technique avoids the necessity of placing a needle in the ascending aorta for cardioplegia delivery and aortic root venting. Although Murphy and colleagues[13] initially described this technique, few current era reports of TERMR with endoaortic balloon occlusion have been published.[2,10,14] The purpose of the present study was to analyze our outcomes with an imaging-guided peripheral perfusion strategy with balloon aortic clamping for TERMR.

METHODS

From May 2011 to September 2013, 108 consecutive patients underwent TERMR by a dedicated 2-surgeon team. A 3-month hiatus (October 29, 2012 to January 2013) occurred owing to infrastructure losses

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Disclosures: Dr Grossi has development agreements with Edwards Lifesciences but none associated with the technology discussed in the present report. All other authors have nothing to disclose with regard to commercial support.

Presented at the Florida Valve International, Transforming Valvular Therapy, Miami, Fla, March 7-9, 2014.

Received for publication March 10, 2014; revisions received April 18, 2014; accepted for publication May 16, 2014; available ahead of print June 18, 2014.

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0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2014.05.035

Abbreviations and Acronyms

LIMV = less-invasive mitral valve surgery
TEE = transesophageal echocardiography
TERMR = totally endoscopic robotic mitral valve repair

from Hurricane Sandy. All TERMRs were performed using the da Vinci Si Surgical System (Intuitive Surgical, Inc, Sunnyvale, Calif). Our dedicated robotic surgery team consisted of 2 experienced mitral valve surgeons, 1 cardiac anesthesiologist, 1 perfusionist, and 2 operating room nurses.[15] Both surgeons had extensive previous experience with the balloon aortic clamping technology. Our routine preoperative workup strategy included vascular evaluation with chest computed tomography angiography in 95 of 108 patients (88%) and abdominal and/or pelvic computed tomography angiography in 98 (90.7%). All patients also underwent intraoperative transesophageal echocardiography (TEE), performed either by the cardiac anesthesiologist or the dedicated operating room echocardiologist. The average patient age was 59 years (range, 21-86); 19 patients (17.6%) were >70 years old; 41 (38%) were women. In addition to TERMR, other robotic procedures performed at the time of repair included oversewing of the left atrial appendage in 96, patent foramen ovale closure in 29, cryoablation in 16, tricuspid valve repair in 2, and septal myectomy in 2. Of the 108 patients, 4 (3.7%) had previously undergone cardiac surgery—2 coronary artery bypass grafting, 1 coronary artery bypass grafting and aortic valve replacement, and 1 atrial septal defect closure. Aortic insufficiency was absent in 88 patients (81.4%), 13 (12.0%) had mild aortic insufficiency, and 7 (6.5%) had mild to moderate aortic insufficiency. All patients, except for 1, underwent placement of a band annuloplasty device with an interrupted suture technique. The average band size was 34.4 mm (range, 26-38). The patient and procedural demographics are listed in Table 1.

In all cases, central venous drainage was obtained with a long cannula introduced through the femoral vein. Arterial return was achieved with small femoral artery cutdown for exposure and cannulation.[16] An endoballoon catheter was placed through the femoral arterial return cannula; this catheter provided aortic occlusion, antegrade cardioplegia, and root venting. Additionally, a coronary sinus cardioplegia catheter was introduced through the internal jugular vein. With routine placement, our anesthesia team was very proficient at this technique, adding minimal time to the operation. All catheters were placed using the Seldinger technique, and TEE was used to position the catheters; fluoroscopy was not used.[17] At the end of the case and after removal of the femoral cannula, the artery was repaired with 6-0 polypropylene suture.

RESULTS

Retrograde perfusion by way of the femoral artery was achieved in 103 of the 108 patients (95.4%). Retrograde perfusion was not used in the presence of mobile aortic atheroma, extensively calcified aortas, occlusive peripheral vascular disease, iliac vessel dissection, or a small vessel size (<6 mm). Antegrade perfusion by way of the subclavian artery was used in 5 patients (4.6%). Of the 108 patients, 105 (97.2%) had an endoballoon catheter placed by way of the femoral arterial return cannula. The mean cardiopulmonary bypass time was 123 minutes (range, 60-229), and the mean crossclamp time was 87 minutes (range, 30-178). Three operations were performed with ventricular fibrillation. A coronary sinus cardioplegia catheter was successfully placed in 81 patients (75.0%), and retrograde cardioplegia was delivered in 79 (73.1%). Del Nido cardioplegia was the preferred cardioplegia; we began using it in May 2013, and it has since been used consecutively in 34 patients (31.5%).

Of the 108 patients, 55 (50.9%) were extubated in the operating room, and 104 (96.3%) were extubated within 24 hours. Of the last 50 patients in this group, 40 (80.0%) were extubated in the operating room. Postoperatively, no inotropic support was needed in 58 patients (53.7%), mild support was used in 36 (33.3%), and moderate support in 14 (13.0%). One patient required intra-aortic balloon pump placement postoperatively for decreased left ventricular function, recovered, and was discharged with an ejection fraction of 50%. No ventricular assist devices were used. No hospital mortalities occurred. No aortic injuries or peripheral vascular complications and no wound infections developed. Three patients (2.8%) developed a groin seroma. Two minor strokes (1.8%) occurred, without residual defects. One patient experienced transient left-sided numbness; magnetic resonance imaging revealed an acute infarct of the anterior and middle cerebral artery watershed territories. Another patient experienced partial aphasia for 24 hours; a small embolic infarct of the left posterior parietal lobe was noted on magnetic resonance imaging. Both of these patients had undergone retrograde perfusion and endoaortic balloon occlusion. Both patients had required complex repairs, with long cardiopulmonary bypass (229 and 152 minutes) and crossclamp (113 and 161 minutes) times. Eighteen patients (16.7%) developed atrial fibrillation. One patient was returned to the operating room because of postoperative bleeding; right thoracotomy was performed using the initial working port incision, and the patient was cannulated femorally. Exploration revealed a right atrial tear, which was repaired with pledgets. The median hospital length of stay was 4 days, and 80 patients (74.1%) were discharged by postoperative day 5.

In addition to these patient-related complications, 2 isolated robot incidents occurred that did not result in adverse patient outcomes. The first occurred when a fluid-filled canister spilled onto the robot tower at the beginning of the case and incapacitated a control board. A replacement tower was swapped in, and the case was continued as planned. Another robotic event occurred when the robot was accidentally unplugged during left atrial closure. The instruments were withdrawn, the robot restarted, and the procedure continued within 4 minutes.

DISCUSSION

Two primary approaches for robotic mitral valve surgery are currently favored: minithoracotomy with external aortic crossclamping[1,12,18-21] and total endoscopic mitral repair using endoballoon technology.[2,10,13] Our findings have confirmed the safety of an image-guided retrograde