Minimally Invasive Transaortic Edge-to-Edge Repair of the Mitral Valve

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Clinically significant mitral regurgitation is often found in conjunction with severe aortic valve stenosis. Adding mitral valve surgery to an aortic valve replacement (AVR) increases the operative risk. However, this increased operative risk may be reduced if, during AVR, a standard double-valve surgery is avoided and AVR isperformed instead with a transaortic edge-to-edge repair of the mitral valve. Utilizing a minimally invasive approach with this technique may further reduce the operative risk when compared to a median sternotomy approach. The procedural technique for this surgery is described in the present report.

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The edge-to-edge repair of the mitral valve was first described by Maisano and colleagues (1). To perform this technique via a transaortic approach is useful in patients with aortic valve disease who have significant mitral regurgitation and are at high risk for a standard double-valve surgery. Utilizing a minimally invasive approach may further reduce the operative risk, as it is associated with less trauma, less use of blood products, and a lower morbidity and mortality when compared to median sternotomy surgery in high-risk patients, such as the elderly (2). The drawbacks to a minimally invasive approach are that it is technically more challenging and therefore has longer operative times. The inclusion criteria at the present authors' institution to perform a transaortic edge-to-edge mitral valve repair during minimally invasive valve surgery are: high-risk patients with aortic valve disease and significant mitral regurgitation, whose mitral regurgitation jet originates in the A2/P2 portions of the mitral valve leaflets, and who lack severe mitral annulus calcification.

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Clinical material and methods

Surgical technique

The patient is placed in the supine position and undergoes anesthetic induction and intubation with a single-lumen endotracheal tube. Intraoperative transesophageal echocardiography (TEE) is performed to evaluate the mitral valve. The mitral regurgitation jet is evaluated in the mid-esophageal four-chamber view at different angles (0º, 60º, 90º, 120º) to determine the origin of the jet. If the jet originates near the area of the A2-P2 portions of the mitral valve leaflets, then the patient is considered a candidate for the transaortic edge-to-edge repair.

A femoral platform is preferred to establish cardiopulmonary bypass (CPB). A 5- to 6-cm transverse minithoracotomy incision is then performed in the second or third intercostal space (Fig. 1), and the lower costochondral cartilage is often transected to allow adequate exposure of the aorta. A retrograde coronary sinus catheter is inserted through a purse-string suture placed in the right atrial appendage. A vent is inserted into the left ventricle via a purse-string suture in the right superior pulmonary vein.

The CPB is initiated at 32-36°C. Venous drainage is augmented with vacuum assistance, applying negative pressures of 30-65 mmHg as needed to decompress the right heart. Trans-incisional direct aortic cross-clamping is performed utilizing a flexible and retractable shaft cross-clamp (Novare Surgical Systems, Cupertino, CA, USA). One dose of antegrade cold blood cardioplegia is administered to establish an

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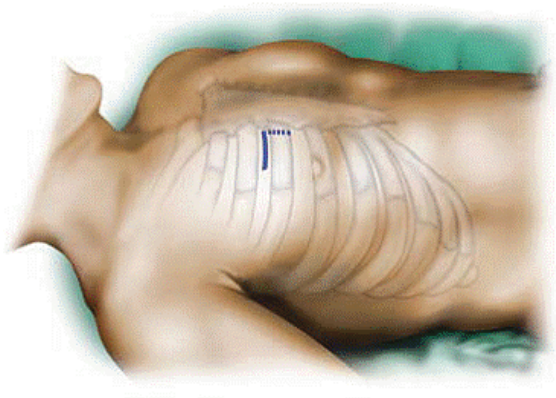

Figure 1: A 5 cm transverse parasternal incision is made over the right second-third intercostal space, and the lower costochondral cartilage is transected.

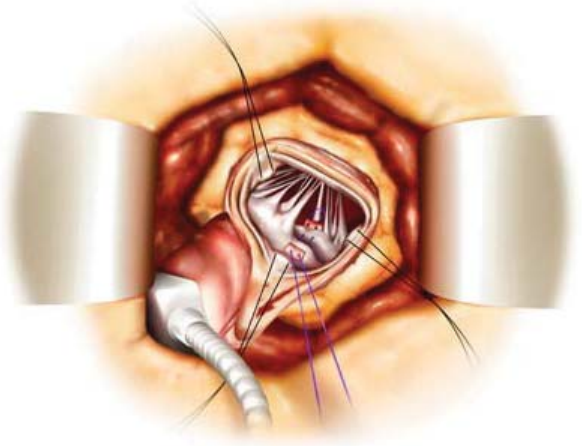

Figure 2: The surgeon's view of a transaortic edge-to-edge mitral repair during minimally invasive valve surgery utilizing a right parasternal approach.

electromechanical arrest of the heart. Thereafter, retrograde cold blood cardioplegia is given throughout the procedure at 20-min intervals. Carbon dioxide is infused into the operative field during the entire procedure.

An inverted U-shaped aortotomy is performed to expose the aortic valve, which is then removed under direct vision. After removal of the aortic valve, the A2 and P2 segments of the mitral valve are identified and an edge-to-edge repair is carried out by placing a 4-0 Prolene (Ethicon, Somerville, NJ, USA) mattress suture reinforced with Teflon pledgets on the ventricular side of the mitral valve, 1 cm from its free edge (Fig. 2). The P2 segment is identified by following its respective chordae and papillary muscles.

Exposure is occasionally distorted due to the left ventricular vent compressing the posterior leaflet. If there is difficulty in viewing the mitral valve, a 5 or 10 mm, 0°, endoscope (Karl Storz, Tuttlingen, Germany) is utilized to aid visualization of the leaflets for suture placement. Thereafter, the aortic valve prosthesis is implanted utilizing standard techniques.

The removal of air from the heart is performed with a root vent under TEE guidance. Prior to unclamping, a ventricular pacing wire is placed. After discontinuing CPB and administering protamine, decannulation is performed. Once hemostasis is obtained, a chest tube is placed in the right pleural space. The transected rib is then reattached to the sternum with a three-hole metal plate (Synthes, West Chester, PA, USA) and a fiberwire is placed in a figure-of-eight fashion. A pericostal suture is also placed to provide further stability to the chest wall. The thoracotomy incision is then closed in four layers to avoid paradoxical chest wall motion.

Discussion

In patients undergoing AVR who have significant mitral regurgitation, performing an edge-to-edge mitral valve repair via a transaortic approach has the advantage of eliminating the need to carry out an atriotomy. The data for this technique are limited to single case reports and small case series, the largest of which involved 20 patients, 13 of whom had AVR and seven who underwent a Bentall operation along with edge-to-edge repair of the mitral valve (3). The latter authors reported an improvement in mitral regurgitation for all patients ($p = 0.002$).

All previous reports detailing this technique have involved its performance via a median sternotomy. The use of this technique has been reported previously by the present authors, via a minimally invasive approach (4,5). Patients with worse outcomes associated with this procedure are those with mitral annular calcification and rheumatic mitral valve disease. Thus, mitral annular calcification is considered to be a contraindication to the edge-to-edge repair.

In conclusion, among patients undergoing minimally invasive AVR who have significant mitral regurgitation which originates in the A2-P2 regions of the mitral valve, and are at a prohibitively high risk for double-valve surgery, the edge-to-edge mitral repair via a transaortic approach may be utilized.

References

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