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A simplified minimally invasive approach to mitral valve surgery - optimal access under direct vision

A. Amiri, E.M. Delmo Walter, R. Hetzer

Department of Cardiothoracic and Vascular Surgery, Deutsches Herzzentrum Berlin, Berlin, Germany

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ABSTRACT

With increasing enthusiasm in minimally invasive surgery, several approaches and access are being performed with great precision. In this report, we illustrate and describe a minimal invasive approach to mitral valve surgery with optimal access under direct vision, the indications and patient selection, the surgical techniques, its advantages over the other approaches, and its simplicity and reproducibility.

Keywords: *mitral valve repair, minimally-invasive approach, anterolateral thoracotomy, cardiopulmonary bypass, myocardial protection.*

INTRODUCTION

Over the past decade, minimally invasive approaches to mitral valve surgery have been commonly used at many centers around the world with excellent short- and long-term outcomes (1-5). There has been great enthusiasm about their performance because they have proven to be at least as good and safe as the standard sternotomy approach, even in elderly patients. A variety of approaches (6-8) have been reported, aimed at reducing surgical trauma and postoperative morbidity while remaining safe and effective. Some approaches have been aided by the use of thoracoscopy, specially designed retractors and surgical clamps as well as special instruments for long-distance knot-tying. The right thoracotomy approach has been the most appealing, for reasons of cosmesis and reduced trauma.

However minimally invasive mitral valve surgery (MIMVS) is performed, the most important consideration is that the approach must yield results equal to or better than those of the approaches it modifies or replaces. There has been increasing interest in simplifying the operation so that it can be widely applied to benefit patients.

This report illustrates a simplified, reproducible minimally invasive approach with optimal access to and exposure of the mitral valve (MV) under direct vision.

Patient selection

We applied this approach to all patients with moderate and severe MV insufficiency and/or stenosis of various etiologies, with no concomitant coronary artery disease or aortic valve regurgitation. Even complex re-

Corresponding author:
Aref Amiri, MD
Deutsches Herzzentrum Berlin
Augustenburger Platz 1
13353 Berlin, Germany
e-mail: amiri@dhzb.de

pair procedures for severe bileaflet prolapse in patients with Barlow's disease can be successfully performed through this approach. MV surgery using any commercially available prostheses can be performed with the same reliability in patients in whom the mitral valve is not amenable to repair. It is also a useful alternative for patients requiring MV procedures after a previous cardiac operation, particularly in those with patent coronary artery bypasses or previous aortic valve replacement. This may also be applied in patients who had had surgeries via right thoracotomy approach.

Assessment of mitral valve lesions

The degree of MV insufficiency or stenosis is estimated by means of standard echocardiographic measurements. Assessment of MV function includes measurement of the mitral annulus, evaluation of leaflet mobility and coaptation, determination of mitral valve orifice area, mitral flow assessment using continuous wave Doppler, and valve anatomy evaluation as to valve thickness and pliability and morphology of the subvalvular apparatus.

Standard guideline in MIMVS using the simplified approach

Because the mitral valve is a posterior structure, excellent exposure can be established through the right anterolateral thoracotomy.

A simplified right anterolateral thoracotomy approach includes a 10-12 cm incision, either direct aortic or peripheral arterial cannulation and direct bicaval canulation, with standard retractors.

Surgical technique

Under general anesthesia using a double lumen endotracheal tube, the patient is placed in left lateral position with the chest elevated to about 45-60° (*Figure 1A*). The right arm is placed over the head at approximately 120° with the elbow joint in the right-angle position. The operating table is rotated leftwards and the patient is bent at the 12th thoracic vertebra. Transcutaneous defibrillation pads (Philips Multifunction Electrode Pads, Philips, Amsterdam, The Netherlands) are placed at the left lateral chest wall and right shoulder.

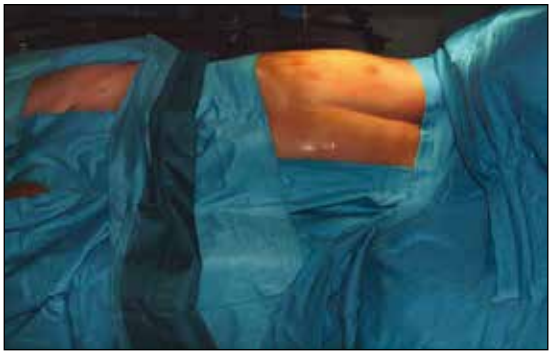

Figure 1A - *Position of the patient.*

Figure 1B - *Anterolateral thoracotomy incision (10-12 cm) at the 5th intercostal space.*

A 10-12 cm skin incision over the fifth anterolateral intercostal space is made beginning in the skin fold below the right breast (*Figure 1B*).

The right lung is deflated and the chest cavity is entered without division or resection of any bone. Standard chest retractors are used and, under direct vision, the pericardium is incised parallel and approximately 3-4 cm anterior to the phrenic nerve. Several pericardial edge retention sutures are placed anteriorly and posteriorly. This pro-

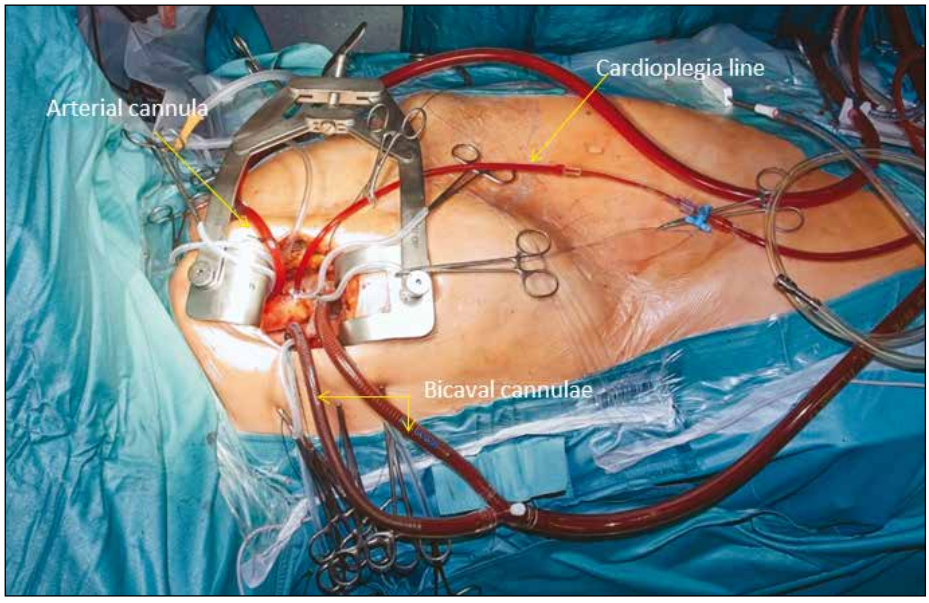

Figure 1C - *Optimal exposure of intracardiac structures with aortic and bicaval cannulation within the same incision.*

vides optimal and excellent visualization and access to the ascending aorta and superior vena cava. Heparin is administered and arterial cannulation is performed either directly in the ascending aorta or in the common femoral artery (only in patients with a small and narrow chest) with direct bicaval cannulation with caval snares (*Figure 1C*). Adequate myocardial protection is achieved with intermittent blood cardioplegia through a cardioplegia needle in the aortic root. The ease and handling of myocardial protection provides no difficulty and is comparable when the approach is through a standard median sternotomy.

After clamping the ascending aorta with a straight clamp having a flexible handle, the left atrium is opened by incising the interatrial groove with a vent cardiotomy sucker placed directly towards the left pulmonary veins. A retractor is placed to elevate the interatrial septum, exposing the mitral valve, and the valve is meticulously inspected to determine the precise nature of the lesion. Leaflet coaptation is assessed with transvalvular saline injection under pressure. Using a nerve hook, leaflet coaptation and the presence of sufficient tissues along the coaptation plane are evaluated. Depending on the results of this evaluation, mitral valve repair or replacement is performed under direct vision, using precisely the same approach as in a conventional median sternotomy.

Mitral valve repair

Modified Gerbode plication plasty (9) is applied for posterior leaflet prolapse, ruptured chordae and in ischemic mitral insufficiency (MI).

Prolapse can occur anywhere along the posterior leaflet but is most commonly found in the region of P2, which may lead to chordal rupture. In this technique, the flail segment is plicated towards the left ventricle in a V-shaped fashion with interrupted mattress sutures using double-ended 3-0 polypropylene with untreated autologous pericardial pledgets. Hence, the P1 segment is attached to the P3 segment**.** When competence and size are satisfactory a strip of untreated autologous pericardium is sutured continuously onto the posterior annulus without further annular narrowing.

Modified Paneth-Hetzer posterior annulus shortening technique (9) is utilized for severe annular dilatation and ischemic MI. This is performed by running a pericardial-pledgeted 3-0 polypropylene suture through the fibrous body of the trigone and tying it. Then it is run along the annulus from one trigone towards the middle of the posterior annulus. The same is done on the opposite trigone.

These sutures are then tied over an appropriately sized Ziemer-Hetzer valve sizer to prevent over-narrowing of the valve orifice. The valve is then tested with saline injection for competence. Using the same needles, both sutures are passed onto an autologous pericardial strip. Then, with a continuous suture, the pericardial strip is attached to the posterior annulus from the midsegment towards the trigone. The leaflet coaptation is tested by a forceful injection of saline through the valve, to look for residual regurgitation. We also use this technique in anterior leaflet prolapse; the then wider coaptation plane will eliminate prolapse.

Evaluation of the adequacy of repair

After MV repair, it is obligatory to assess the valve function before closure of the atrium and separation from cardiopulmonary bypass (CPB). This is done by transvalvular saline injection with a bulb syringe under pressure. Any remaining areas contributing to significant incompetence must be attended to before closure of the atrium.

Once de-airing has been completed and extracorporeal circulation is discontinued, the repair result must be further evaluated with intraoperative transesophageal echocardiography (TEE) in order to test for inadequate mitral opening area, residual incompetence, myocardial ischemia due to coronary kinking and presence of the systolic anterior motion (SAM) phenomenon.

Immediate and prompt correction must be made if the repair is shown to be unsatisfactory. Regardless of the underlying pathology and techniques used, no patient should be discharged from the operating room with more than minimal MI.

Mitral valve replacement

If it is established that the mitral valve lesion is not amenable to repair, the valve is replaced, with either a mechanical or biological prosthesis, in accordance with the patient's wishes.

In both procedures, no specially designed instruments are required, and the knots may be tied by hand or with a knot pusher. Several strategies of knot tying have been learned with experience, such as having the assistant hold up the annular sutures during knot tying.

After completion of the procedure, the left ventricle is vented with a catheter positioned across the valve and the atriotomy is closed.

Concomitant Maze procedure with radiofrequency ablation may also be performed, when necessary. Caval snares are snugged tight when tricuspid valve reconstruction (double-orifice-valve technique) (10) or closure of patent foramen ovale are performed, and these procedures are done through right atriotomy.

Throughout the procedure, a vacuum-assisted venous drain in the heart-lung machine is used and carbon dioxide is infused into the operative field to decrease the chance of air embolism. Complete evacuation of intracardiac air is performed through the aortic root and left atrium and confirmed by TEE. Temporary atrial and ventricular pacing wires are placed before releasing the aortic clamp. Defibrillation, when necessary, is administered through the external defibrillator pads.

Once the hemodynamic status is stable, cardiopulmonary bypass is discontinued and

decannulation is performed. Transesophageal echocardiography is mandatory at the moment to document the repair results or prosthetic function.

The right pleural space and mediastinum are drained through the 7th intercostal space with two chest tubes and the intercostal spaces are closed with five or six pericostal sutures.

CONCLUSION

This simplified minimally invasive approach to mitral valve surgery with optimal access to all cardiac structures and optimal exposure of the mitral valve under direct vision offers distinct advantages, including direct aortic root and caval cannulation performed with ease and without obscuring the operative field, optimal exposure and overview of the operative field, controlled myocardial protection, and adequate de-airing.

Although the skin incision is 5-8 cm longer than in the conventional minimally invasive technique, besides providing good cosmesis and an acceptable postoperative scar, it outweighs the placement of additional skin incisions for the other cannulae or the aortic clamp, and obviously avoids the potential complications related to femoral vessel cannulation. Additionally, standard aortic cross-clamping and antegrade cardioplegia delivery obviate the need for specialized endovascular occlusive balloons, hence avoiding the potential complications associated with balloon malposition or migration (11).

This simplified approach combines good cosmesis with optimal exposure of the mitral valve and all the cardiac structures, is readily applicable and is not associated with a steep learning curve because one employs conventional cannulation and clamping techniques.

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