

Totally Endoscopic Aortic Valve Replacement with Concomitant Trans-Aortic Mitral Valve Repair for Mitral Regurgitation

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Case report

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Abstract

Background

Minimally invasive aortic valve procedures through a hemi-sternotomy or a right anterior mini-thoracotomy have gained popularity over the last several years. Totally endoscopic aortic valve replacement (TEAVR) is an innovative and a less invasive (incision-wise) surgical aortic valve replacement (SAVR) technique. The operative steps of TEAVR have been reported previously from our group. Mitral regurgitation (MR) frequently accompanies aortic valve disease, and sometimes requires repair. Can totally endoscopic surgery be applied in such cases?

Case presentation

We present the surgical technique of a totally endoscopic approach to aortic valve replacement and concomitant mitral valve repair for primary or secondary MR. We used the aortotomy incision and avoided an atriotomy that would result in a prohibited increase in cross-clamp (XC) and cardiopulmonary bypass (CPB) times and an elevation in mortality and morbidity rates. Neochords (artificial chordae tendineae) were used for the repair of primary MR and the edge-to-edge approach was used for the repair of secondary MR.

Conclusion

Totally endoscopic aortic valve replacement and concomitant mitral valve repair can be performed transaortically with reasonable XC and CPB times, and excellent short-term results.

Introduction

While endoscopic mitral and tricuspid valve procedures have become a first line treatment in many centers globally, this is not the case for the aortic valve. Minimally invasive aortic valve replacement or repair, usually is performed through a hemi-sternotomy or through a right anterior mini-thoracotomy. The operative steps of totally endoscopic aortic valve replacement (TEAVR), which is the routine practice at St. Luke's Hospital, Thessaloniki, Greece, has been performed for over a year with more than 100 cases completed [1].

TEAVR is a less invasive (incision-wise) approach, associated with shorter intensive care time and hospital length of stay, and allows patients to return to work earlier compared to classical surgery; however, it is associated with prolonged XC and CPB times, especially during the learning curve of this approach, albeit steep [1]. Primary MR (approximately 3%) or secondary MR (approximately 10%) may be associated with aortic valve disease, particularly in patients with bicuspid aortic valves or in patients with CAD, respectively. In these cases, mitral valve repair can be performed via an aortotomy via a trans-aortic approach simultaneously with TEAVR, thus avoiding an atriotomy that would result in an increase in XC and CPB times.

Here we present our technique of TEAVR and concomitant trans-aortic mitral valve repair for primary or secondary MR. In cases with primary MR (Video 1), artificial chordae tendineae were used to repair the prolapsing/flail mitral valve in which the length was calculated preoperatively by transesophageal echocardiography (TEE), as previously reported [2]. In cases of secondary MR (Video 2), the edge-to-edge repair method was used [3].

Written informed consents for publication of their clinical details and clinical images were obtained from the patients. Copies of the consent forms are available for review by the Editor of this journal.

Case Presentation

This endoscopic approach is performed through a 3 cm right parasternal working incision in the 2nd intercostal space (ICS) and a 10 mm port for the 3D 30 degrees Karl Storz endoscope in the same ICS laterally, anterior to the right anterior axillary line [1]. An extra-extra small Alexis soft tissue protector is deployed through the incision. On full CPB from the groin, the Chitwood clamp is inserted through a separate stab wound incision (3 mm) in the 1st ICS, cephalad to the port of the endoscope, and Custodiol cold crystalloid cardioplegia is given in the aortic root, or directly to the coronary ostia in cases of aortic regurgitation. After the heart is arrested, a right superior pulmonary vein vent is inserted through a separate stab wound incision (3 mm) in the 5th ICS, anterior axillary line. A transverse aortotomy is opened proximal to the fat body of the aorta (3 cm distal to the right coronary artery), the diseased aortic valve is excised and the annulus is debrided and washed. A metal net spreader (Fehling Instruments, DE) is inserted inside the aortic annulus to facilitate exposure of the mitral leaflets.

In cases of secondary MR, a horizontal mattress, teflon buttressed PTFE suture is used to perform an edge-to-edge repair between A2 and P2 using a deep bite of at least 5 to 7 mm (see Fig. 1a and 1b, and Video 2). In cases of primary MR, a second metal net is inserted inside the first one and at the level of the anterior mitral leaflet (see Fig. 2a and Video 1). A prefabricated set of the pre-measured length of PTFE neochords (Seramon chordae loop, Serag Wiessner, DE) are inserted and secured at the fibrous head of the corresponding papillary muscle (Fig. 2b and 2c). The open end of the loops (neochords) are then secured to the free edge of the prolapsing/flail segment of the mitral leaflet (Fig. 2d). Several loops 4 to 5 mm apart in the prolapsing segments are used in order to spread the leaflet tension and to improve the durability of the repair. This type of repair is only applicable for anterior leaflet prolapse (1 out of the first 100 TEAVRs in our experience) and middle scallop (P2) posterior leaflet prolapse (2 out of the first 100 TEAVRs in our experience). Prolapse/flail of the anterolateral (P1) and posteromedial (P3) scallops, and of the two commissures, cannot be repaired with the trans-aortic approach, because these segments are well hidden by the anterior leaflet and its chords. Also marked dilation of the mitral annulus is a relative contradiction of this technique (better managed with an atriotomy in order to perform an annuloplasty). Alternatively, the loop technique with the edge-to-edge approach can be combined to achieve a watertight mitral valve through the trans-aortic approach, but so far, we have not performed this type of repair.

Finally, we proceed with the aortic valve replacement with a conventional mechanical or biological prostheses, as previously described by our group.[1] XC and CPB times for the combined approach is reasonable (below 90 and 120 minutes respectively for primary MR and below 60 and 90 minutes respectively for secondary MR, after the initial learning curve of the technique). Short term follow-up (mean 5,66 months, range: 0,93 – 9,9) of our 13 patients operated with the described technique have been excellent with MR \leq 1+ (mild).

Discussion And Conclusion

Totally endoscopic approaches will increasingly become more popular in the years to come. A successful surgical technique of TEAVR and concomitant totally endoscopic mitral valve repair via a trans-aortic approach is presented. When stand-alone endoscopic mitral repair is performed, this is usually done through a more lateral thoracotomy incision through the 4th ICS [2]. In order to perform a combined aortic valve replacement and a mitral repair through a standard left atriotomy incision, we can place our working incision through the 3rd ICS in the middle clavicular line, which is a compromise for both the endoscopic aortic valve replacement and the mitral repair through a left atriotomy. Such an approach will make the placement of the aortic annular sutures more difficult, due to the fact that the working incision is not aligned with the aortic annulus, and will prolong the XC time in excess of 120 min and the CPB time in excess of 180 min. The aortotomy mitral repair approach presented here, significantly shortens the XC and CPB time to 90 min and 120 min respectively for primary MR and to 60 min and 90 min respectively for secondary MR, thus making it possible to perform double valve (aortic and mitral) totally endoscopic surgery within reasonable XC and CPB time which are comparable to median sternotomy approaches.

Contraindications of the presented technique are:

- a) marked mitral annular dilation - better managed with an annuloplasty procedure through a left atriotomy [4] and
- b) P1 or P3 or commissural flail/prolapse - better managed with the loop technique through a left atriotomy [2, 4] (through a median sternotomy incision if combined with aortic valve disease).

The presented method substantially decreases intensive care times and hospital length of stay, and allows patients to return to work earlier. It should be mentioned that the need for simultaneous aortic and mitral valve surgery is not uncommon, since anterior leaflet prolapse can be found in patients with bicuspid aortic valve [5].

Abbreviations

TEAVR: totally endoscopic aortic valve replacement

SAVR: surgical aortic valve replacement

XC: cross clamp

CPB: cardiopulmonary bypass

MR: mitral regurgitation

TEE: transesophageal echocardiography

ICS: intercostal space

Declarations

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on request.

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Contributions

AP-concept/design, writing of manuscript, NT-data collection, HB-critical revision of article, KDB-critical revision of article. All authors read and approved the final manuscript.

Ethics declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

All patients involved provided written consent to use clinical information for scientific publications.

Competing interests

AP is a consultant for teaching and training for Abbott, Medtronic, LSI SOLUTIONS.

NT, HB, KDB have no competing interests.

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Figures



Figure 1

A successful surgical approach of TEAVR and concomitant trans-aortic mitral valve repair using the edge-to-edge technique for secondary mitral regurgitation: a) schematic drawing and b) endoscopic image.

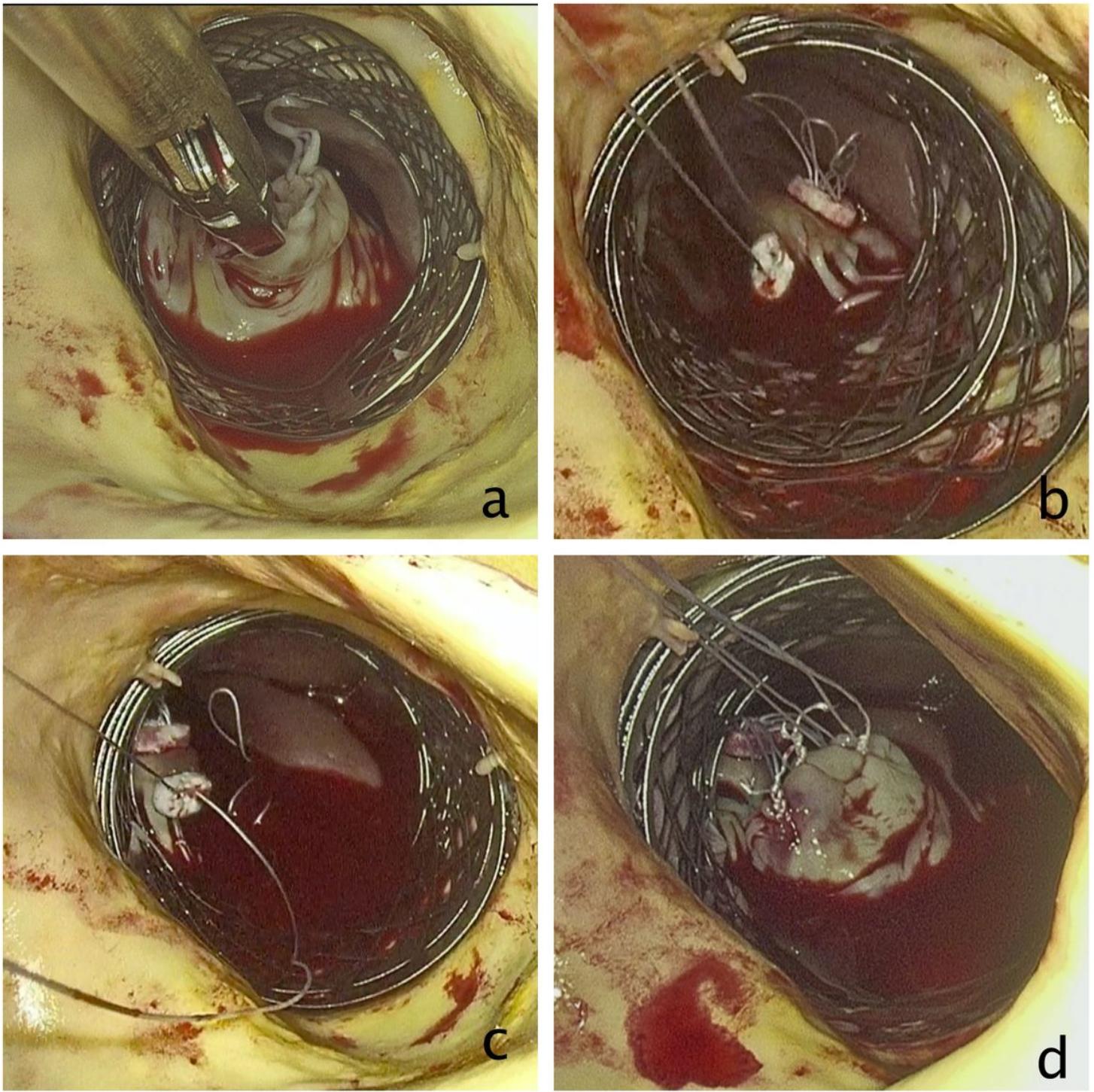


Figure 2

Totally endoscopic trans-aortic mitral repair with 4 neochords to P2 for a flail P2, in combination with TEAVR: a) P2 flail, b) suturing a set of 4 loops size 16 mm to the head of the posteromedial papillary muscle, c) suturing a set of 4 loops size 16 mm to the head of the anterolateral papillary muscle, d) suturing the free edge of 4 loops (2 from the anterolateral and 2 from the posteromedial papillary muscles) to the free edge of the flail P2.

Supplementary Files

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- [Video2JCTS.mp4](#)