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Techniques

Open Transcatheter Mitral Valve Implantation Into the Native Mitral Valve for Inoperable "Big MAC"

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Because of the growing population of older adult patients, the prevalence of severe mitral annulus calcification ("big MAC") is increasing. The surgical techniques used to treat big MACs are technically demanding; despite the technical aspect, up to one-third of patients are considered too high risk for conventional surgery but are candidates for the coulisse technique, which is a procedure that implants a transcatheter valve into a native mitral annulus. The anterior leaflet is unfolded, thus reducing the risk of obstructing the left ventricular outflow tract and for paravalvular leak and avoiding valve migration. Preoperative planning, based on a computed tomography scan, is mandatory. ***(Tex Heart Inst J. 2022;49(6):e207491)***

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Because of the growing population of older adult patients with calcified mitral valves, the prevalence of severe mitral annulus calcification ("big MAC") is increasing. Surgical mitral valve repair or replacement remains the gold standard for the treatment of mitral valve diseases, but surgical treatment in cases of big MAC is very demanding, even for those with experience.[1] Such treatment techniques include annular debridement, deep periannular suture placement, ultrasonic pulverization, or intravalvular prosthesis placement.[2] Although this procedure is technically demanding, up to one-third of patients are considered too high risk for conventional surgery and thus are candidates for the surgical technique described herein.[3]

The satisfying results of transcatheter aortic valve implantations encourage use of this technique with other types of nonaortic valve pathologies, but transcatheter mitral valve implantation (TMVI) in native annuli remains a challenging procedure and is associated with higher periprocedural failure or mortality rate.[4,5]

This report describes a reproducible technique for an open TMVI in a native mitral valve with severely calcified mitral valve annulus (big MAC) for patients who are technically not suitable for a conventional surgical approach.

Technique

Preoperative Considerations

When implanting a transcatheter valve into a native mitral valve annulus, certain challenges must be anticipated, such as paravalvular leakage (PVL), valve migration, and left ventricular outflow tract (LVOT) obstruction. Preoperative planning, based on a computed tomography (CT) scan, is mandatory. The measurement of the mitral valve is performed axially corrected to evaluate the suitability of a TMVI in a native mitral valve annulus. Certain important measurements must be taken: mitral valve annulus diameters (anterior-posterior distance as well as commissure-to-commissure distance), the diameter of the LVOT, and the thickness of the intraventricular septum.

The Sapien XT or 3 transcatheter aortic valve prosthesis (Edwards Lifesciences) is the favored instrument for the TMVI procedure because its stent frame is shorter, which decreases the risk of LVOT obstruction or a conflict with the ventricular

septum, especially in patients with hypertrophic left ventricular myocardium or septum. Other prostheses, such as CoreValve (Medtronic) or Perceval (LivaNova, PLC), are unsuitable for this approach because of their total height, which would cause hemodynamic turbulences in the LVOT or in the atrium, depending on the positioning of the prostheses. In all cases presented in this study, an Sapien 29-mm valve was used. The valve should be crimped on a transapical delivery system in mitral position, which corresponds to the orientation for a transapical transcatheter aortic valve implantation procedure. Thus, the skirt of the prosthesis is positioned toward the left atrium.

Surgical Strategy

Surgery is carried out in routine fashion through median sternotomy. Cardiopulmonary bypass is initiated with bicaval venous cannulation. Cardiac arrest is established through antegrade and retrograde cardioplegia. After opening the left atrium through the interatrial groove, the mitral valve pathology is evaluated. The anterior leaflet is split in the mid (A2) segment (Fig. 1A) and folded back like a stage backdrop to the commissures (Fig. 1B). The commissures are closed with the corresponding tips of the folded A2 segments with 5-0 Prolene (Ethicon; Johnson & Johnson MedTech; Fig. 1B, Fig. 2A, and Fig. 2B). Thus, the distance between the commissures is reduced, and a stronger anchor is created to avoid PVL in this region. The creation of a coulisse pivots the A2 segments, in this way, stretching them apart and preventing them from being pushed further into the ventricle (Fig. 2A and Fig. 2B). By this means, the risk of LVOT obstruction is reduced. In cases of a cleft in the mitral leaflet, it is advisable to close it before transcatheter valve implantation to diminish the risk of PVL and provide a proper landing zone (Fig. 2A).

Thereafter, 5 to 7 pledgeted sutures are placed in noncalcified areas around the annulus, similar in way and type to sutures used for conventional mitral valve prosthesis (Fig. 2A).

The transcatheter aortic valve is loaded on a transapical delivery system in a mitral orientation. Before crimping, 1 commissure is marked with a Prolene suture to allow the correct positioning of the transcatheter valve, similar to the implantation of a conventional biological mitral valve prosthesis (Fig. 2C).

The transcatheter prosthesis is implanted via balloon dilatation and then additionally fixed with the ring sutures (Fig. 2D).

Intraoperative transesophageal echocardiography is recommended to evaluate for early paravalvular insufficiency or, even worse, valve migration, which should be prevented by the ring sutures.

The big advantage of this technique is that there is no need for additional sealing material to anchor the valve prosthesis. No grafts, felts, or other materials were used to prevent PVL; instead, the preserved anterior leaflet of the native mitral valve was used. Of the 5 patients included in this study, only 1 experienced a minimal PVL at 1-year follow-up.

At the 4-year follow-up, flow CT angiography failed to show subvalvular leaflet thrombosis or valve calcification or PVL (Fig. 3).

One patient—with a EuroSCORE II of 11 and preoperative catecholamine support, right heart failure, and pulmonary hypertension (systolic pulmonary pressure of 98 mm Hg), history of stroke and colon cancer (ra-

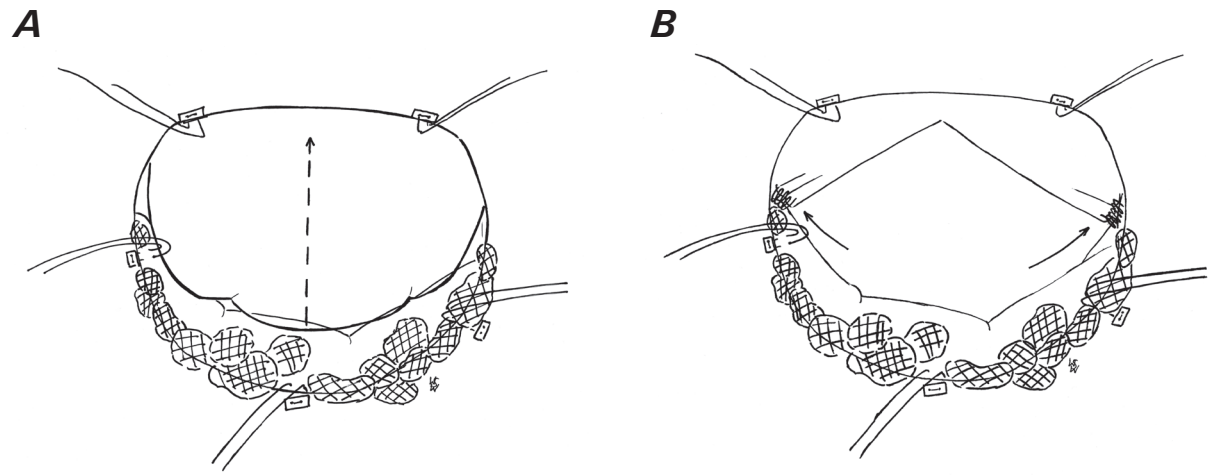

Fig. 1 *Sketch of the coulisse technique.* ***A****) Sketch shows the mitral valve with the anterior leaflet in place and the calcification of the annulus (clearly marked in the posterior annulus). First, the supporting sutures for the transcatheter valve prosthesis are placed around the annulus, wherever there is a spot with less calcification. The next step is to split the anterior leaflet (marked with the dotted arrow).* ***B****) The 2 parts of the leaflet unfolded like a stage backdrop to the commissures (follow the arrows in the sketch), and the commissures are closed with the corresponding tips of the folded A2 segments.*

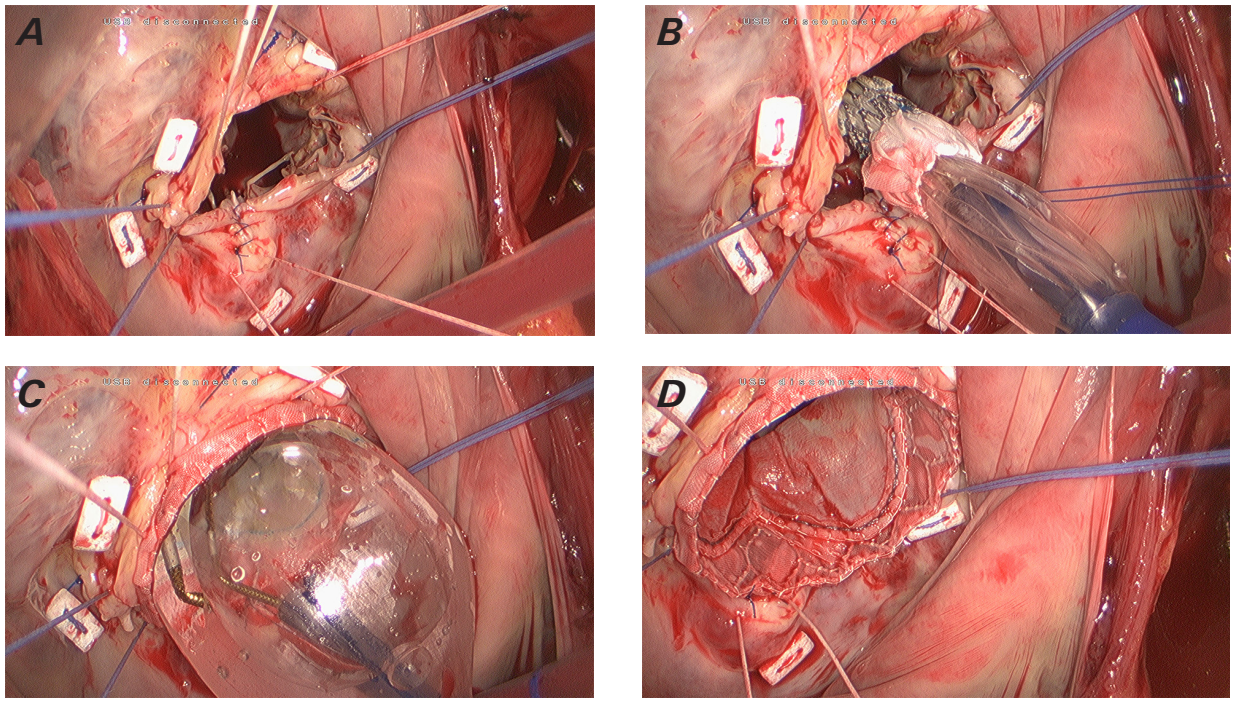

Fig. 2 *Intraoperative pictures of the transcatheter mitral valve implantation.* ***A****) This figure shows the prepared coulisse for the valve implantation. According to Fig. 1B, the leaflet is folded to the commissures and the commissures are closed with the folded A2 segment. The support sutures are placed around the annulus.* ***B****) The next step is to insert the crimped transcatheter valve into the mitral valve annulus. One commissure of the crimped valve is marked with 5-0 Prolene to enable correct anatomical positioning.* ***C****) After the valve is in the correct position, the balloon is expanded.* ***D****) Shown is the successful implanted transcatheter valve after a functional test of the leaflet mobility using saline flush.*

Supplemental motion image is available for Figure 2.

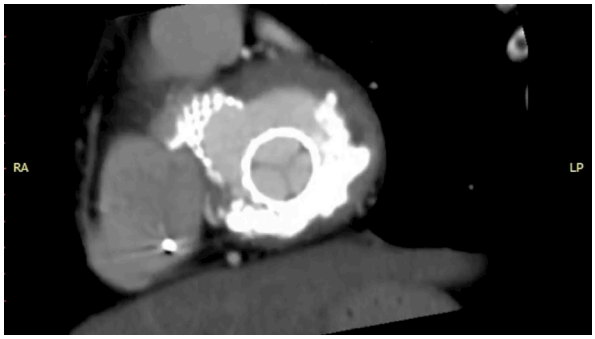

Fig. 3 *A flow computed tomography angiography scan at the 4-year follow-up shows excellent valve performance, intact leaflet motion, and no subvalvular leaflet thrombosis.*

Supplemental motion image is available for Figure 3.

LP, left posterior; RA, right anterior.

diochemotherapy), acute kidney injury, history of aortic valve replacement (mechanical), diabetes, and chronic obstructive pulmonary disease—died 1 day after surgery.

The 4 remaining patients underwent the 1-year follow-up without showing any valvular complications, such as degeneration or motion of the bioprosthesis.

Discussion

Big MAC is one of the biggest challenges in cardiac surgery, as reflected by longer bypass time and higher mortality. There are various techniques published to address this complex pathology, but there are a considerable number of patients who cannot be treated with these techniques at all.[2,6] The variety and complexity of the mitral valve annulus calcification in relation to the intraventricular septum, LVOT, and annulus size and shape require an experienced surgeon as well as rather complex operation methods; nevertheless, when these conditions are met, there remains a high risk of PVL. Current operation strategies, such as resection and reconstruction of the mitral valve annulus, extra-anatomical solutions with a conduit from the left ventricle to the left atrium, or placement of the mitral valve prosthesis supra-annulary into the left atrium, are technically demanding and are often not suitable in frail and older adult patients.[6,7]

Over the years, transcatheter techniques have been developed as excellent solutions for patients who are frail or who have high surgical risk regarding degenerated aortic valves; however, regarding the mitral valve, transcatheter prostheses have greater limitations because

the anatomy is often unfavorable for such a technique. However, there are some patients in whom classical transcatheter techniques are suitable, but to use such techniques, several parameters, such as size and shape of the valve, the relationship between the LVOT and the left ventricular septum, and the length of the stent-graft of the implanted valve, need to be assessed to avoid PVL or, even worse, valve migration, which often leads to patient death.[8,9]

The coulisse technique combines the positive aspects of both the surgical and transcatheter strategies. This technique is not restricted to a certain annulus size or shape, because as the anterior leaflet splits and folds, the annulus of the mitral valve can be shaped and sized individually to create a good anchor in the commissural area for implantation of the transcatheter valve. Fixing the anterior leaflet to the annulus leads to a considerable reduction in the incidence of a PVL and the risk of LVOT obstruction through the remaining native anterior leaflet. The use of additional annulus sutures to fix the transcatheter valve further reduces the risk of valve migration to almost 0.

The coulisse technique is suitable even in frail and high-risk patients with big MAC and who have considerable surgical risk, compared with the common and more well-known operation techniques, which are more invasive and complex. Of course, the anatomical relationship between the LVOT, left ventricular septum, and annulus must be addressed and measured in the preoperative CT scan before proceeding with the procedure; it is not recommended that this technique be used if there is a rather short distance between LVOT and mitral valve annulus or a hypertrophic intraventricular septum. Compared with other transcatheter techniques, a large annulus is not a contraindication for this technique. The limitation of this technique, however, is that the use of cardiopulmonary bypass is mandatory, so it cannot be performed completely without mechanical support.

However, given the satisfying results, with no valve migration and no incidence of PVLs, this technique is absolutely recommendable for high-risk patients with big MACs who are not suitable for conventional big MAC surgery.

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References

1. Hosseini S, Samiei N, Mestres CA. The mitral annular stone: a surgical challenge. *Eur J Cardiothorac Surg*. 2015;48(5):805. doi:10.1093/ejcts/ezv030
2. Eleid MF, Foley TA, Said SM, Pislaru SV, Rihal CS. Severe mitral annular calcification: multimodality imaging for therapeutic strategies and interventions. *JACC Cardiovasc Imaging*. 2016;9(11):1318-1337. doi:10.1016/j.jcmg.2016.09.001
3. Iung B, Baron G, Butchart EG, et al. A prospective survey of patients with valvular heart disease in Europe: the Euro Heart Survey on valvular heart disease. *Eur Heart J*. 2003;24(13):1231-1243. doi:10.1016/s0195-668x(03)00201-x
4. Puri R, Abdul-Jawad Altisent O, del Trigo M, et al. Transcatheter mitral valve implantation for inoperable severely calcified native mitral valve disease: a systematic review. *Catheter Cardiovasc Interv*. 2016;87(3):540-548. doi:10.1002/ccd.26262
5. Wilbring M, Alexiou K, Tugtekin SM, et al. Pushing the limits-further evolutions of transcatheter valve procedures in the mitral position, including valve-in-valve, valve-in-ring, and valve-in-native-ring. *J Thorac Cardiovasc Surg*. 2014;147(1):210-219. doi:10.1016/j.jtcvs.2013.09.021
6. Carpentier AF, Pellerin M, Fuzellier JF, Relland JY. Extensive calcification of the mitral valve annulus: pathology and surgical management. *J Thorac Cardiovasc Surg*. 1996:111(4):718-729. doi:10.1016/s0022-5223(96)70332-x
7. Casselman FP, Gillinov AM, McDonald ML, Cosgrove DM III. Use of the anterior mitral leaflet to reinforce the posterior mitral annulus after debridement of calcium. *Ann Thorac Surg*. 1999;68(1):261-262. doi:10.1016/s0003-4975(99)00337-9
8. Yoon SH, Whisenant BK, Bleiziffer S, et al. Transcatheter mitral valve replacement for degenerated bioprosthetic valves and failed annuloplasty rings. *J Am Coll Cardiol*. 2017;70(9):1121-1131. doi:10.1016/j.jacc.2017.07.714
9. Guerrero M, Dvir D, Himbert D, et al. Transcatheter mitral valve replacement in native mitral valve disease with severe mitral annular calcification: results from the first multicenter global registry. *JACC Cardiovasc Interv*. 2016;9(13):1361-1371. doi:10.1016/j.jcin.2016.04.022