Successful mitral valve-in-ring repair of mitral annuloplasty ring dehiscence causing severe mitral regurgitation – a case report

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Abstract

Background: Annuloplasty failure caused by ring dehiscence can lead to trans-ring and para-ring mitral regurgitation. Transcatheter treatments are available for patients at prohibitive risk of surgery. In patients unsuitable for edge-to-edge repair, valve-in-ring transcatheter mitral valve implantation has been described to treat trans-ring or para-ring jets but not both concurrently.

Case summary: A 78-year-old male presented with severe mitral regurgitation due to dehiscence of a 34 mm Edwards Physio II mitral annuloplasty ring. Transesophageal echocardiography showed two jets of regurgitation; trans-ring and para-ring. Repair was successfully undertaken with a valve-in-ring procedure (29mm S3 Edwards Lifesciences).

Discussion: Patients with failure of mitral valve annuloplasty with trans-ring and para-ring regurgitation can be safely and effectively treated by valve-in-ring transcatheter mitral valve implantation.
Learning points

- Valve-in-ring transcatheter mitral valve implantation can be used to treat patients with concurrent trans-ring and para-ring regurgitation.

- Resolution of MR may be linked to distortion of the D-shaped annulus and improved contact between the dehisced annuloplasty ring and the mitral annulus.
2016
- Surgical mitral valve repair (34mm Edwards Physio II annuloplasty ring) and tricuspid valve repair, complicated by post-operative bleeding requiring re-do sternotomy

Sep 2019
- NYHA class III heart failure

Oct 2019
- Transthoracic echocardiography revealed severe MR

Jan 2020
- Transesophageal echocardiography revealed annuloplasty ring dehiscence
- Clinic appointment with cardiac surgeon: patient declined surgery, preferred transcatheter option. Patient was also deemed to be high-risk by cardiac surgeon.

Oct 2020
- Valve-in-ring transcatheter mitral valve implantation performed

Jan 2021
- 3-month follow-up echo: No trans-ring MR, mild para-ring MR

Apr 2021
- 6-month clinic follow-up: Significant improvement in symptoms
Introduction

Surgical mitral valve repair using a ring annuloplasty has emerged as the gold standard treatment for mitral regurgitation (MR) in patients with severe degenerative mitral valve (MV) disease (1). While mitral annuloplasty provides a durable treatment, recurrence of severe MR is expected in up to 10% of patients within 20 years (2). Failure of repair may be attributed to a number of complications including incorrect annuloplasty size or position, incorrect artificial chord length, systolic anterior motion, rupture of previously shortened chordae, or even new valvular lesions (3).

One notable complication is ring dehiscence, which occurs when the sutures anchoring the annuloplasty ring detach from the mitral annulus. Several large registries indicate that ring dehiscence is responsible for annuloplasty failure in 13-42% of cases (4,5). Such patients pose a treatment dilemma as they may have trans-ring and para-ring leak. Furthermore, the risk of surgical re-operation may be prohibitive, thus transcatheter repair may be the only viable option. Transcatheter edge-to-edge repair is the technique of choice in patients ineligible for surgical correction with de novo mitral valve disease. However, the same constraints which limit patient selection for primary repair exist for re-repair. A full list of unfavorable characteristics are described in table 1.

In select cases, a transcatheter heart valve (THV) can be implanted in the mitral position via a transseptal approach (6). Although not widely performed, valve-in-ring (ViR) transcatheter mitral valve implantation (TMVI) for annuloplasty failure has been shown to have relatively low early and midterm mortality, albeit with higher rates of procedural complications and mid-term mortality compared with valve-in-valve (ViV) TMVI (7). Previous literature has documented correction of individual trans-ring and para-ring leaks (8) using ViR TMVI but not both concurrently. When both entities co-exist, use of a vascular occlusion device has been described to treat the para-ring leak (9,10).
This case report uniquely describes simultaneous correction of a trans-ring and para-ring leak using ViR TMVI, obviating the need for further intervention.

**Case**

A 78-year-old male presented with progressive exertional breathlessness (New York Heart Association Functional Classification 3). He had previously undergone surgical mitral valve repair with a 34 mm Edwards Physio II annuloplasty ring (Edwards Lifesciences, California, USA) for severe mitral regurgitation (MR) in 2016 together with tricuspid valve repair. The operation was complicated by bleeding at 48 hours and required redo sternotomy. Trans-esophageal echocardiography (TEE) now revealed localized, postero-medial dehiscence of the annuloplasty ring (Figure 1). There was severe MR with 2 large jets; one para-ring jet passing through the dehiscence (vena contracta area of 0.23cm²) and one trans-ring jet passing through the centre of the ring (vena contracta area 0.53cm²) (Figure 2; Video S1 and S2). Right heart catheterization showed a pulmonary artery pressure of 50/22 mm Hg, mean of 32 mm Hg and pulmonary capillary wedge pressure of 20 mm Hg. The patient was considered at prohibitive risk for redo open heart surgery and the patient also firmly declined this option. Edge-to-edge repair was considered, however, anatomy of the mitral valve leaflets was deemed unfavorable due to inadequate length of the posterior leaflet.

After discussion with the Heart Team, a transseptal mitral ViR repair was planned with a subsequent percutaneous intervention to correct mitral regurgitation through the dehiscence with a vascular occlusion device. On computed tomography the annuloplasty ring had internal dimensions of 33 x 22mm and the neo left ventricular outflow tract (LVOT) area was 350mm² with a 29mm prosthesis thus considered low risk for LVOT obstruction. Under general anaesthesia, the patient underwent
ViR TMVI via transseptal approach with a balloon-expandable 29 mm Edwards Sapien 3 THV (Edwards Lifesciences, California, USA). The transcatheter heart valve (THV) was successfully implanted with 5 mL over filling of the deployment balloon (Figure 3; Video S3). Transesophageal echocardiography showed elimination of the trans-ring regurgitation (as expected) and surprisingly showed reduction of para-ring regurgitation to a minor, haemodynamically insignificant jet (Figure 4A and 4B; Video S4, S5 and S6). The procedure was uncomplicated with no evidence of LVOT obstruction and the patient was discharged the following day. At 3-month follow-up, repeat transthoracic echocardiography (Video S7) revealed no trans-ring MR and only mild para-ring MR that required no further intervention. At 6-month follow-up the patient reported significant symptomatic improvement.

**Discussion**

The prevalence of degenerative mitral regurgitation is increasing as life expectancy improves. Elderly patients previously treated by mitral annuloplasty, who experience ring dehiscence, pose a treatment dilemma due to high risk of further surgical intervention. In the case described, annuloplasty ring dehiscence occurred posteriorly, which is the site most prone to dehiscence due to lower collagen density and tensile strength of the posterior relative to the anterior mitral annulus (11). Edge-to-edge repair, if feasible, is an attractive proposition as this may eliminate mitral regurgitation both trans and para-ring (12,13). However, ViR TMVI has several potential benefits over edge-to-edge repair including reproducibility and less restrictive inclusion criteria (14). In the case described, ViR TMVI successfully treated trans-ring and para-ring regurgitation simultaneously.

The Edwards Physio II is a semirigid, complete, annuloplasty ring. We propose that the mechanism by which improvement of the para-ring MR occurred is by the expanded circular THV pushing the D-shaped semirigid ring at the posterior site, thus improving contact between the ring and the posterior annular tissue (figure 5) (15). The observed improvement in para-ring regurgitation may not be
extended to rigid complete rings (e.g. Edwards IMR ETlogix or St Jude Saddle annuloplasty rings) as contact between the ring and annular tissue may not be altered. Furthermore, ViR TMVI may also be less effective in reducing trans-ring regurgitation in such cases as good contact between the THV and the inner angles of the rigid ring may not be achieved. Lastly, caution must be maintained due to the risk of ViR procedures deforming the ring and causing dehiscence, para-valvular leak (16) or even complete ring detachment. This case report adds to the growing body of evidence indicating that patients with failure of mitral valve repair can be safely and effectively treated by ViR TMVI and para-ring. Further work is required to evaluate the longevity of this treatment.

Consent

This manuscript has been submitted with the patient’s informed written consent.

Funding and Conflicts of Interest

None declared.

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**Figure legends**

**Figure 1:** 3-Dimensional transesophageal echocardiography (atrial aspect) showing localized posteromedial dehiscence of the annuloplasty ring.

**Figure 2:** (A) 3-Dimensional transesophageal echocardiography with colour Doppler showing severe mitral regurgitation through the dehiscence and centrally through the annuloplasty ring. (B) 2-Dimensional transesophageal echocardiography (long axis) with colour Doppler showing severe mitral regurgitation through the dehiscence and centrally through the annuloplasty ring. (C) 3-Dimensional transesophageal echocardiography with colour Doppler demonstrating the trans-annuloplasty ring MR jet with a vena contracta area (VCA) of 0.23cm². (D) 3-Dimensional transesophageal echocardiography with colour Doppler demonstrating the para-annuloplasty ring MR jet with a vena contracta area (VCA) of 0.53cm².

**Figure 3:** post deployment position of 29 mm S3 within the Edwards Physio II (complete) annuloplasty ring.

**Figure 4:** (A) 3-Dimensional transesophageal echocardiography (atrial aspect) showing the S3 THV with no trans-ring or para-ring regurgitation. (B) 2-Dimensional transesophageal echocardiography (long axis) with colour Doppler showing absence of trans-ring and only trivial para-ring regurgitation following S3 deployment.

**Figure 5:** Proposed mechanism of improvement of trans- and para-ring mitral regurgitation caused by annuloplasty dehiscence and treated by transcatheter mitral valve replacement. Force exerted by the expanded circular valve on the semi-rigid ring re-establishes contact between annuloplasty ring and mitral annular tissue.
Video legends

**Video S1** - 2D TEE showing severe mitral regurgitation with 2 jets; one through the posteromedial dehiscence of the annuloplasty ring and the other central through the annuloplasty ring.

**Video S2** - 3D TEE with colour Doppler of annuloplasty ring from atrial aspect showing severe regurgitation through the centre of the annuloplasty ring and through the area of dehiscence.

**Video S3** - a 29 mm S3 THV was deployed with pacing through the LV wire. The deployment balloon was overfilled by 5 mL.

**Video S4** - 2D TEE with colour Doppler showed absence of trans-ring and para-ring regurgitation.

**Video S5** - 3D TEE with colour Doppler post THV deployment showed absence of mitral regurgitation through the dehiscence and through the centre of the annuloplasty ring.

**Video S6** – Transesophageal echocardiography demonstrating the improvement in MR from severe MR pre-procedure to trivial MR post-procedure.

**Video S7** – Follow-up transthoracic echocardiography demonstrating only mild residual mitral regurgitation in the parasternal long axis and apical 4-chamber, 3-chamber and 2-chamber views.
### Unfavourable characteristics for transcatheter edge-to-edge repair

| Characteristic                                                                 |
|-------------------------------------------------------------------------------|
| Prolapse width > 15mm                                                          |
| Flail gap > 10mm                                                               |
| Orifice area < 3.5cm²                                                          |
| Severe calcification of grasping zone                                          |
| Commissural lesions                                                           |
| Clefts                                                                         |
| Leaflet perforations                                                           |
| Mitral stenosis with baseline mean gradient > 5mmHg                           |
| Endocarditis or rheumatic heart disease                                       |

**Table 1:** Unfavourable characteristics for transcatheter edge-to-edge repair
Annuloplasty ring

Dehiscence
Surgical annuloplasty

Annuloplasty dehiscence

Implantation of transcatheter valve

Anterior mitral leaflet

Annuloplasty ring

Mitr al annulus

Posterior mitral leaflet

Para-ring regurgitation at site of ring dehiscence

Trans-ring regurgitation due to malcoaptation with distortion of mitral leaflet geometry

Annuloplasty ring pushed against mitral annulus

Transcatheter valve