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Use of A Suture-Less Aortic Valve In High-Risk Mitral Valve Surgery

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Abstract: Elderly patients with frailty and multiple comorbidities increasingly require mitral valve surgery. This includes patients who have previously undergone surgery with a tissue valve, which may deteriorate over time and require replacement. These cases are considered high-risk. There is growing interest in performing valve replacements using minimally invasive techniques, including access via the groin. However, such approaches are not always feasible. Here, we report the first case where innovative, "outside-the-box" thinking was employed to replace the valve using a non-conventional approach.

Keywords: Mitral Valve, Sutureless Valve, Rapid Deployment Valve In Mitral Surgery, Transcatheter Mitral Valve

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1. Introduction

In adult cardiac surgical practice, concomitant and primary mitral valve pathologies are commonly encountered, often necessitating surgical intervention. The frequency of bio-prosthetic mitral valve use during valve replacement surgery has more than doubled over the past decade [1]. The increasing prevalence of mitral valvopathy, including Mitral Annular Calcification (MAC), coupled with the higher incidence of early structural bio-prosthesis failure in the mitral position, and the frequent occurrence of high surgical risk and/or elderly patients, has led to growing interest in utilizing percutaneous interventions to treat these conditions [2].

MAC, as part of a systemic atherosclerosis process, is associated with an increased risk of perioperative complications, including bleeding, atrioventricular dehiscence, stroke, myocardial infarction, arrhythmias, and heart failure. This condition carries up to a sixfold increase in perioperative mortality during isolated mitral valve surgery [3].

Transcatheter aortic valve replacement (TAVR) technology has rapidly evolved and is now well established. However, adapting TAVR valves for the treatment of native mitral valve disease (TMVR) presents significant challenges. These include the complex and unique D-shaped anatomy of the mitral valve annulus, often with calcification predominantly involving the posterior part; high risk of both fixed and dynamic left ventricular outflow tract (LVOT) obstruction due to the retention of the native anterior mitral valve leaflet (AMVL) in percutaneous techniques; a higher risk of prosthesis migration caused by the significant pressure gradient between the left ventricle (LV) and left atrium (LA); and an increased risk of injury to surrounding structures, such as the LVOT, the circumflex artery, and, less commonly, the coronary sinus [4, 5].

Several reports have described trans-apical, trans-septal, or trans-atrial approaches for deploying TAVR valves in the mitral position within calcified annuli (MAC), prior mitral valve repair annuloplasty rings (valve-in-ring, ViR), or failed bio-prostheses (valve-in-valve, ViV). These procedures are predominantly performed via percutaneous approaches and, less frequently, through open surgical techniques. When an open surgical approach is employed, the Edwards Sapien 3 valve is often preferred and deployed following excision of the AMVL.

As an alternative open surgical technique, we present the first reported case of trans-left atrial deployment of an Edwards Intuity Elite rapid deployment (sutureless) aortic valve (Edwards Lifesciences, Irvine, California) as a valve-in-valve (ViV) procedure for a failing mitral bio-prosthesis.

2. Case Synopsis

The patient was a 76-year-old woman who had undergone a successful mitral valve repair 20 years earlier. Eight years later, she developed symptomatic severe mitral regurgitation and underwent a redo-sternotomy with re-repair of the valve. Unfortunately, the repair failed early, necessitating a third sternotomy and bio-prosthetic mitral valve replacement with an Edwards Perimount Magna Mitral Ease valve (27 mm) and a tricuspid valve annuloplasty (Edwards MC3, 36 mm).

She remained asymptomatic for 10 years but subsequently developed symptoms secondary to severe bio-prosthetic mitral valve stenosis, with a mean gradient of 18 mmHg. Additionally, she experienced paroxysmal atrial fibrillation, requiring cardioversion and, eventually, dual-chamber pacemaker insertion.

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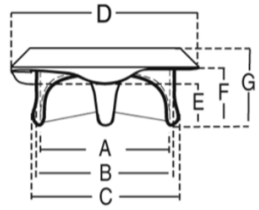
Her pre-operative evaluation included computed tomography (CT), which revealed the proximity of the right ventricle to the sternum. She was moderately frail, and it was assessed that a fourth conventional mitral valve intervention carried a high risk of atrioventricular discontinuity due to extensive scarring and limited annular tissue. Her estimated Society of Thoracic Surgeons (STS) score for perioperative risk prediction was 5.5.

Transcatheter valve replacement options were limited due to technical availability, cost constraints, and the high likelihood of left ventricular outflow tract (LVOT) obstruction.

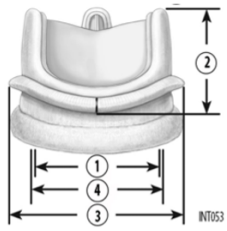
As a result, we planned to deploy either a TAVR valve or a rapid deployment valve via an open approach, avoiding explantation of the existing bio-prosthetic scaffold. Considering cost and funding issues, along with the risk of LVOT obstruction associated with the Edwards Sapien valve, we explored the use of the Edwards Intuity rapid deployment valve. We conducted an in vitro test, deploying a 25 mm Intuity valve inside a 27 mm Perimount Magna valve. The test demonstrated a good fit, and we decided to proceed with surgery.

Table 1: Nominal specification of Edwards Magna Mitral valves with the dimensions of the explanted 27mm valve highlighted.

Carpentier-Edwards PERIMOUNT Magna Mitral Ease Bioprosthesis, Model 7300TFX						
	Size	**25 mm**	**27 mm**	**29 mm**	**31 mm**	**33 mm**
	A. Stent Diameter (Wireform)	25	27	29	31	33
	B. Tissue Annulus Diameter*	28	29.5	31.5	33.5	33.5
	External Stent Post Diameter (Tip)	29	31	34	35	35
	D. External Sewing Ring Diameter	36	38	40	42	44
	E. Effective Profile Anterior	7	7.5	8	8.5	8.5
	F. Effective Profile Posterior	10	10.5	11	11.5	11.5
	G. Total Profile Height	15	16	17	18	18

*External Stent Post Diameter (Base). Source: [9].

Table 2: Nominal Specification of Edwards Intuity rapid deployment valve with the chosen 25mm valve highlighted.



Legend
Internal Diameter
Profile Height
External Sewing Ring Diameter
Stent Diameter (wire form)*
*TAD (Tissue Annulus Diameter)

Size	**19 mm**	**21 mm**	**23 mm**	**25 mm**	**27 mm**
1. Internal Diameter	18	20	22	24	26
2. Profile Height	13	14	15	16	17
3. External Sewing Ring Diameter	24	26	28	30	32
4. Stent Diameter (wireform)	19	21	23	25	27

Source: [9]

The above size specification clearly shows that the 25mm Intuity rapid deployment valve would have fitted inside the 27mm Magna Mitral valve wireframe with excellent overlap on the atrial side of the expandable stent apparatus.

3. Surgical Technique

The right groin was exposed, and the femoral vessels were mobilized for peripheral cannulation. The redo-median sternotomy was uneventful. Following the mobilization of the heart, cardiopulmonary bypass was initiated via the femoral vessels and superior vena cava (SVC) cannulation for bi-caval drainage. After applying the aortic cross-clamp, the heart was arrested with antegrade cardioplegia. The mitral valve was approached through a trans-septal route.

Dense scar formation was observed around the valve. Two out of the three leaflets of the previous bio-prosthesis were calcified and immobile, while the third leaflet remained mobile. It was determined that explanting the valve might not leave sufficient annular tissue to secure a new valve and could increase the risk of atrioventricular discontinuity. Consequently, valve-in-valve (ViV) deployment was chosen as the preferred option.

The leaflets of the previous valve were excised entirely, and the remaining valve scaffold was left in situ but meticulously debrided using a rongeur (Figure 1). A 25 mm sizer demonstrated a perfect fit within the rim of the previous bio-prosthesis, leading to the decision to implant a 25 mm Intuity aortic valve in reverse orientation. The valve was positioned with three guiding sutures, with the sewing ring placed on the ventricular side and the expandable stent on the atrial side of the annulus. The valve was securely seated within the annulus. Additional sutures were deemed unnecessary (Figure 2).

The valve was serially balloon-inflated following the recommended pressure settings. Passive testing with saline injection confirmed the absence of a paravalvular leak. The septum and atriotomy were closed, and the patient was weaned off bypass without any complications. Post-bypass valve function was excellent, with a mean mitral valve gradient of 2 mmHg (Figure 3).

The patient had a slow but uneventful recovery and was discharged home on Day 10. Echocardiography performed on postoperative Day 9 demonstrated a normally functioning bio-prosthetic mitral valve with no left ventricular outflow tract (LVOT) obstruction.

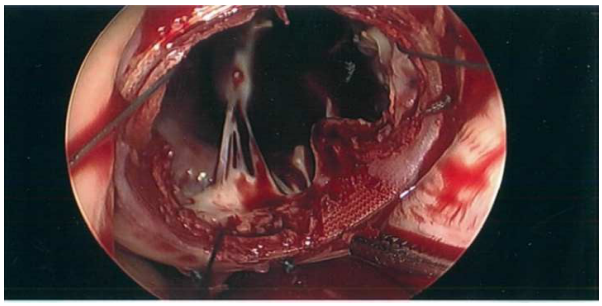


Figure 1: Intraoperative picture following leaflets excision, the cage of the previous bioprosthetic valve was left in place.

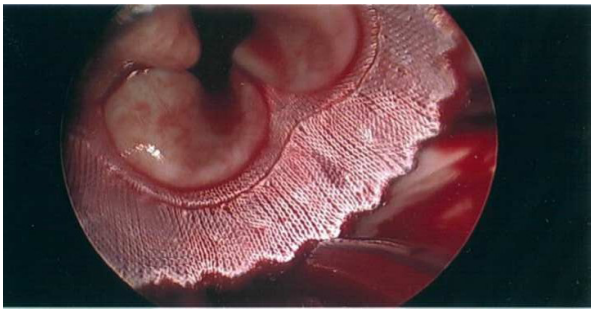


Figure 2: Intraoperative picture post-deployment of the inverted Intuity valve in the mitral position.

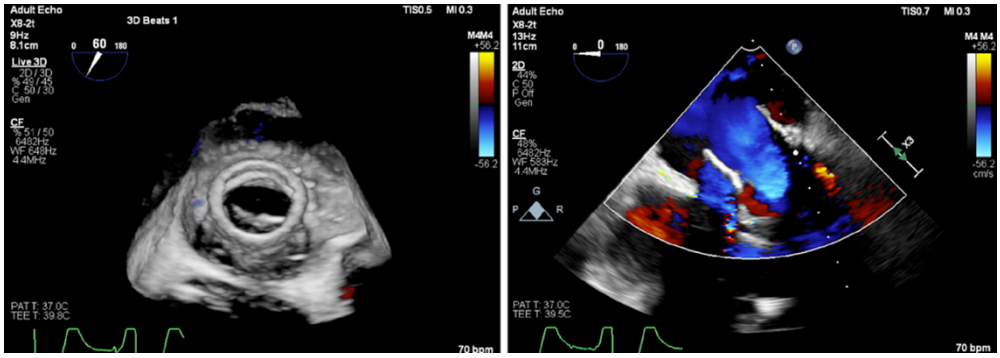


Figure 3: Transoesophageal echocardiography picture of the newly deployed valve.

4. Outcome and Follow-Up

At 12 months follow-up, transthoracic echocardiography (TTE) confirmed normal valve function with no measurable gradient. Functionally, the patient is unrestricted in her activities, living independently and requiring no assistance with daily living. She remains anticoagulated with a direct oral anticoagulant due to paroxysmal atrial fibrillation.

The newly implanted mitral valve is expected to exhibit standard longevity without being adversely affected by the valve-in-valve (ViV) technique used. Similarly, there is no anticipated increased risk of infective complications such as endocarditis. However, thromboembolic complications could theoretically be higher, given the increased prosthetic surface area and patient factors, including atrial fibrillation and compliance with the anticoagulation regimen.

5. Discussion

Severely calcified mitral annuli, prior surgical bio-prostheses, and annuloplasty rings can serve as effective anchors for the ViV technique. In 2009, the first technically successful ViV procedure was performed by Cheung et al. using the transapical approach [5, 6]. Since then, significant advancements in the field have been made, including the adoption of multiple techniques such as ViV, valve-in-ring (ViR), and valve-in-mitral annular calcification (ViMAC) transcatheter mitral valve replacement (TMVR) using TAVR valves. These concepts have been further refined to enable mitral valve replacement using TAVR valves via trans-atrial exposure [7].

Recently, Henrick et al. reported the first use of a rapid deployment valve for surgical mitral valve replacement in a patient with severe MAC [8].

In this case, we selected the inverted Edwards Intuity Elite rapid deployment valve as a novel ViV technique to address a failed bio-prosthesis. To our knowledge, this is the first reported use of this valve for open deployment as a ViV in the mitral position. This valve was chosen due to its favourable low profile, potentially reduced risk of LVOT obstruction and lower cost compared to TAVR valves. Based on this experience, we are confident in adopting this technique for future clinically challenging patients.

6. Conclusion

We propose that a sutureless rapid deployment valve can be safely and effectively used in complex, high-risk redo mitral valve surgeries.

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Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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