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Transcatheter valve-in-valve aortic valve implantation for failed aortic homografts: A single-center experience

Short title: TAVI for failed aortic homografts

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INTRODUCTION

In recent years, the use of bioprosthetic valves, including aortic homografts, has increased. These grafts offer superior hemodynamics, low thrombogenicity, and better resistance to recurrent endocarditis compared to conventional bioprosthetic valves.

Surgical reintervention for aortic homograft failure is technically challenging and carries increased perioperative risks, such as potential aortic or heart injury during chest re-

entry, the need for extensive aortic resection due to conduit calcification, and difficulty manipulating coronary ostia [1–4]. The average 30-day mortality rate for reoperation in aortic homograft failure ranges from 3% to 12% and is higher compared to standard aortic bioprosthesis reoperation [5]. Additionally, unique challenges in failed aortic homografts complicate transcatheter aortic valve implantation (TAVI), including the predominance of aortic regurgitation, limited leaflet calcification, and the absence of a well-defined landing zone [1, 4, 5].

Percutaneous treatment of aortic homograft failure (valve-in-homograft [ViH]) is rarely reported, with most studies focusing on individual cases. Larger studies are uncommon and often combine analyses of homograft failure with bioprosthetic valve deterioration [1, 3, 5, 6]. This study presents a single-center experience with TAVI for failed aortic homografts.

METHODS

We retrospectively analyzed data from all consecutive patients who underwent ViH between August 2018 and September 2024 at a single heart valve center. The study was conducted in accordance with the principles of the Declaration of Helsinki and received approval from the local ethics committee.

The transthoracic echocardiographic recordings, stored in DICOM format, were reviewed following current guidelines. Image evaluation was performed using ComPACS (Medimatic S.R.L., Genova, Italy).

All procedures were preceded by computed tomography angiography to assess the vascular access site, angiographic projections, and the landing zone. Based on the scan results, the TAVI platform was selected to optimize anchoring, ensure proper coronary access, and minimize the risk of paravalvular leak. All procedures were conducted in the presence of the anesthesiologist, with analgosedation administered using propofol and fentanyl. Temporary pacing was provided using either a right ventricular lead or a left ventricular guidewire, at the operator’s discretion. An antegrade pigtail catheter, introduced via the right radial or contralateral femoral artery, was positioned at the base of the non-coronary sinus for angiographic guidance and final aortography. The TAVI valve was positioned at the level of the homograft suture line, with the prosthesis routinely oversized to improve anchoring and minimize the risk of paravalvular leak. Oversizing was achieved by selecting larger valves in cases of borderline anatomy and by increasing the volume of saline-contrast dye in the system for balloon-expandable valves. To facilitate future coronary artery engagement, commissural alignment was systematically attempted. Femoral access hemostasis was achieved with the

Angio-Seal (Terumo Interventional Systems, US) and 2 Perclose ProGlide (Abbott Vascular, US) vascular closure devices or via surgical closure.

Statistical analysis

Normality was evaluated with the Shapiro–Wilk test, with a *P*-value <0.05 indicating deviation from a normal distribution. Descriptive statistics were applied, with continuous variables following a non-normal distribution presented as median and interquartile range, and categorical variables as counts (percentages). All statistical analyses were performed using Statistica 13.3 (Tibco Software, Inc., Palo Alto, CA, US).

RESULTS AND DISCUSSION

Reoperation for failed aortic homografts presents significant technical challenges and increased operative risk, often underestimated by conventional risk scores [1, 3]. Given the elevated mortality and morbidity associated with reoperation, the ViH strategy has emerged as a viable alternative [1, 4–6]. However, data on its safety and efficacy remain scarce.

We implanted TAVI valves in eight patients, evenly split between genders. Half of the patients had New York Heart Association class III/IV heart failure. The median age was 66 years, and most were overweight. Hypertension (87.5%) and hyperlipidemia (62.5%) were the most common comorbidities.

The predominant reason for initial aortic homograft implantation was an ascending aortic aneurysm with aortic regurgitation (62.5%), followed by infective endocarditis (25%) and aortic stenosis (12.5%). TAVI valves were implanted approximately 26.5 years after the initial homograft procedure, aligning with prior reports [2]. All cases involved prosthetic insufficiency as the primary failure mode, with moderate stenosis in 62.5%. Patients exhibited eccentric left ventricular hypertrophy with an average end-diastolic volume of 250 ml, indexed mass of 140.04 g/m^2, and a preserved ejection fraction of 50%. Cardiac reoperation risk, assessed by STS score (7.41%) and EuroSCORE II (9.02%), was moderate but underestimated the technical challenges posed by homograft calcification and the substernal position of the ascending aorta [5].

Femoral access was used in all patients, with surgical exposure and femoral artery puncture required in one patient (12.5%). Direct left ventricular pacing was used in half of the patients. None of the homografts underwent predilatation. Both self-expanding (6 subjects, 75%) and balloon-expanding TAVI valves were implanted, with a mean prosthesis size of 29 mm.

The absence of extensive valvular calcification in patients undergoing TAVI complicated the identification of the landing zone. Positioning the transcatheter bioprosthesis at the level of the homograft suture line was a key factor contributing to procedural success. The first attempt at device implantation was successful in all patients, with no perioperative device migration or embolization. Procedural time, radiation dose, and contrast volume were within standard ranges (Table 1). None of the patients had perivalvular regurgitation greater than mild. Each patient spent typically one day in the intensive cardiac care unit. One subject (12.5%) required a pacemaker implantation following the TAVI, and another experienced a temporary worsening of chronic kidney disease. There was no in-hospital, 30-day, or 1-year mortality observed in the study group.

Surgical reinterventions yield acceptable results but are accompanied by significant and often unpredictable perioperative risk. During the reported period, two patients required surgical intervention. One underwent reoperation to prevent coronary ostia occlusion by the TAVI prosthesis, while the other, a 45-year-old, opted for a mechanical valve due to anticipated bioprosthesis degeneration. No patients requiring treatment were disqualified. There are a few reports based on similarly small patient groups undergoing the ViH procedure. Kislitsina described a series of 8 TAVI patients, while Peterss and Sedeek independently compared the outcomes of surgical (n = 53 and 40, respectively) versus transcatheter (n = 28 and 11, respectively) re-interventions [1, 3, 5]. Patients who underwent ViH implantation experienced fewer complications and shorter hospital stays compared to those who had surgical re-intervention. Their findings align with our observations, suggesting that ViH approach is a feasible and safe alternative to high-risk surgical reoperation, offering favorable short- and mid-term outcomes. Additionally, the authors reported using a similar implantation technique [5].

In the Polish context, the only mention of ViH comes from a publication by Huczek et al. [7], who references it in the national valve-in-valve registry, discussing homografts broadly alongside degenerated stentless valves. The presence of only a single report is surprising given the existence of the internationally recognized allogenic heart valve bank at the Department of Cardiovascular Surgery of Jagiellonian University Medical College and the relative popularity of the method from 1980 to the early 2010s [2]. At that time, both fresh and cryopreserved allografts were used, and the surgical techniques employed included intra-aortic inclusion, subcoronary graft implantation, and aortic root replacement. Approximately 700 patients received these implants, with an estimated graft lifespan of 23 years.

This is a single-center, retrospective observational study involving a small group of patients. Due to the limited sample size, we were unable to conduct statistical analyses that

went beyond the group characteristics. Moreover, the study did not compare percutaneous treatment with surgical management of aortic homograft failure.

In conclusion, TAVI implantation in failed aortic homografts appears to be an effective and safe treatment option for patients whose elevated reoperation risk is not adequately reflected by contemporary cardiac surgical risk scores. We believe our findings will contribute to selecting the optimal treatment approach for this challenging patient population.

Article information

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Table 1. Selected clinical, echocardiographic, and procedural parameters

	Total (n = 8)
Demographic and group characteristics	
Age, years	66 (50.75–76.5)
Female, n (%)	4 (50)
Body mass index, kg/m^2	25.35 (24.15–28.15)
Body surface area, m^2	1.83 (1.76–1.97)
NYHA functional class III or IV, n (%)	4 (50)
Time since homograft, years	26.5 (22.75–28)
Hypertension, n (%)	7 (87.5)
Hyperlipidemia, n (%)	5 (62.5)
Permanent pacemaker, n (%)	2 (25)
Atrial fibrillation, n (%)	1 (12.5)
Marfan syndrome, n (%)	1 (12.5)
Stroke, n (%)	1 (12.5)
PCI, n (%)	1 (12.5)
GFR, ml/min/1.73 m^2	69 (54.75–77.75)
STS score	7.41 (5.67–13.43)
EuroSCORE II	9.02 (5–16.86)
Baseline echocardiography	
LVEDD, cm	6.3 (6.28–6.43)
EDV, ml	250 (240.25–266)
LVMI, g/m^2	140.04 (125.96–181.63)

LVEF, %	50 (42.5–56.25)
EOA, cm^2	1.5 (1.18–2.55)
EOAI, cm^2/m^2	0.85 (0.58–1.49)
AVPG, mm Hg	35.5 (20–51.5)
AVMG, mm Hg	24.5 (10.75–28.25)
Severe aortic regurgitation, n (%)	8 (100)
Moderate or severe mitral regurgitation, n (%)	4 (50)
Moderate or severe tricuspid regurgitation, n (%)	1 (12.5)
RVSP, mm Hg	50 (38.5–66)
Procedure	
Urgent, n (%)	1 (12.5)
Local anesthesia, n (%)	8 (100)
Transfemoral access, n (%)	8 (100)
Surgical access, n (%)	1 (12.5)
Right ventricular pacing, n (%)	4 (50)
Predilatation, n (%)	0 (0)
TAVI valves	
Evolut R 34 mm (Medtronic, Minneapolis, MN, US), n (%)	3 (37.5)
Evolut R 29 mm (Medtronic, Minneapolis, MN, US), n (%)	3 (37.5)
Edwards Sapien S 23 mm (Edwards Lifesciences, Irvine, CA, US)	1 (12.5)
Octacor 26 mm (Meril Life Sciences, Gujarat, India)	1 (12.5)
Procedural time, min	65 (54–66.25)
Radiation dose, mGy	481.5 (329–662.25)
Fluoroscopy time, min	14.3 (11.25–17.65)
Contrast volume, ml	200 (100–250)
Postprocedural echocardiography	
LVEF, %	50 (40–52.75)
AVPG, mm Hg	18 (16.75–20)
AVMG, mm Hg	10 (9.75–10.5)
Trace or mild perivalvular regurgitation, n (%)	8 (100)

Moderate or severe mitral regurgitation, n (%)	2 (25)
Moderate or severe tricuspid regurgitation, n (%)	1 (12.5)
RVSP, mm Hg	47.5 (37.25–55)
Outcomes	
Intensive care unit length of stay, days	1 (1-1)
Pacemaker implantation, n (%)	1 (12.5)
Renal failure	1 (12.5)
Length of stay, days	5 (4–7)
In-hospital mortality	0 (0)
30-day mortality	0 (0)
1-year mortality	0 (0)
12-month follow-up echocardiography	
LVEF, %	50 (46–53.5)
AVPG, mm Hg	19 (13.5–22.5)
AVMG, mm Hg	10 (7.5–14)
Trace or mild perivalvular regurgitation, n (%)	8 (100)
Moderate or severe mitral regurgitation, n (%)	1 (12.5)
Moderate or severe tricuspid regurgitation, n (%)	2 (25)
RVSP, mm Hg	46 (33–55)

Abbreviations: AVMG, aortic valve mean gradient; AVPG, aortic valve peak gradient; EDV, end-diastolic volume; EOA, effective orifice area; EOAI, effective orifice area index; EuroSCORE, European System for Cardiac Operative Risk Evaluation; GFR, glomerular filtration rate; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVMI, left ventricular mass index; NYHA, New York Heart Association; PCI, percutaneous coronary intervention; RVSP, right ventricular systolic pressure; STS, Society of Thoracic Surgeons; TAVI, transcatheter aortic valve implantation