

Long-term outcomes of valve-in-valve transcatheter aortic valve implantation for degenerate homograft aortic valve replacement



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Introduction

“Valve-in-valve” transcatheter aortic valve implantation (ViV-TAVI) is an alternative to conventional redo surgery for bioprosthetic aortic valve replacement (AVR) dysfunction¹ but ViV-TAVI for degenerate stentless bioprostheses is challenging². We report the five-year follow-up of a single-centre consecutive series of patients undergoing ViV-TAVI for degenerate homograft AVR.

Methods

All patients receiving ViV-TAVI for degenerate homograft AVR between October 2009 and April 2019 were retrospectively analysed. Clinical, echo, and brain natriuretic peptide (BNP) levels were measured preprocedurally and after 1, 3, and 5 years. The Royal Brompton and Harefield Clinical Practice Committee approved the study protocol, the study was performed in compliance with UK Data Protection and Information Governance legislation, and all subjects gave written, informed consent to ViV-TAVI and study participation.

ViV-TAVI PROCEDURE

Our ViV-TAVI procedural methods for degenerate homografts lacking calcified leaflets (**Figure 1**) have been reported previously³.

Results

PATIENT CHARACTERISTICS

Twenty-seven patients with degenerate homograft AVR (aged 68±16 years, range 25-88 years, 19 male) underwent ViV-TAVI. Five were <50 years old (4 had each undergone 2 previous homograft AVRs, 1 was a 25-year-old on cardiac mechanical support). Median time from homograft AVR to ViV-TAVI was 15 years (range 5-22 years). All presented with severe symptomatic transvalvular aortic regurgitation (AR), 63% in New York Heart Association (NYHA) Class III and 37% in NYHA Class IV. Patients had multiple comorbidities (**Table 1**), EuroSCORE II 21±16% and STS-PROM score 15±10%. The left ventricular (LV) cavity was dilated and impaired, patients had raised LV filling pressure (E/E' 19±8), mitral and tricuspid regurgitation, and pulmonary

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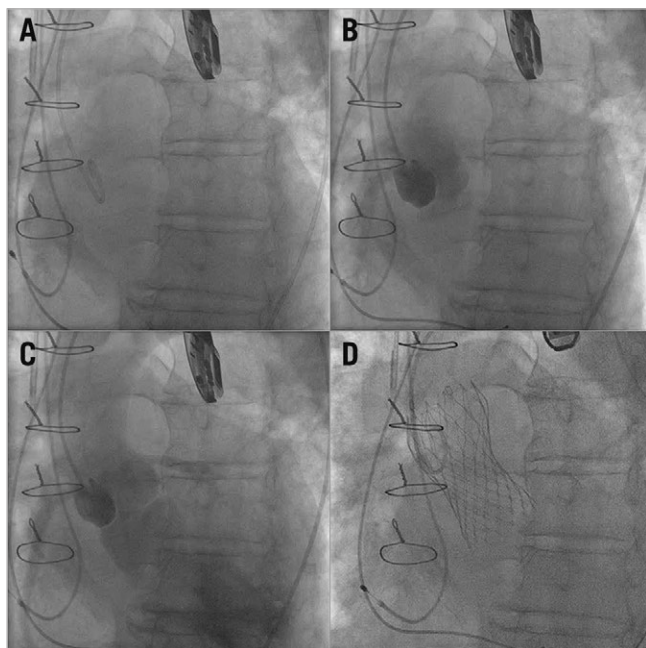


Figure 1. Homograft AVR. A) & B) No calcific landmarks. C) Severe transvalvular regurgitation. D) Final ViV-TAVI deployment.

hypertension (42 ± 5 mmHg) (Table 2). Mean (IQR) homograft label size was 22 mm (20-26 mm) and aortic annular perimeter on multi-detector computerised tomography was 73 mm (63-82 mm).

HOMOGRAFT ViV-TAVI PROCEDURE

The access route was transfemoral in 25 patients, left subclavian in 1, and direct aortic in 1. Before June 2014, a CoreValve® (Medtronic, Minneapolis, MN, USA) THV was implanted in 18 patients; after June 2014, 6 received an Evolut™ R THV (Medtronic) and 3 received a Direct Flow Medical® THV (Direct Flow Medical, Santa Rosa, CA, USA). Unconstrained THV

Table 1. Patient demographics.

Variable	Homograft ViV-TAVI (n=27)
Age, years	68±16 (range 25-88)
Male, n (%)	19 (70%)
New York Heart Association Class III/IV, n (%)	27 (100%)
Pulmonary systolic arterial pressure ≥40 mmHg, n (%)	20 (74%)
Aortic calcification, n (%)	18 (67%)
Previous coronary artery bypass graft, n (%)	15 (56%)
Atrial fibrillation, n (%)	13 (48%)
Estimated glomerular filtration rate <60 ml/kg/m ² , n (%)	7 (26%)
Previous percutaneous coronary intervention, n (%)	7 (26%)
Lung carbon monoxide transfer factor <50%, n (%)	4 (15%)
Previous stroke, n (%)	3 (11%)
Peripheral vascular disease, n (%)	3 (11%)
Diabetes, n (%)	2 (7%)

perimeter (IQR) was 82 mm (72-97 mm), and mean THV device oversizing was 11.8% (range 2.7-23.4%).

SHORT-TERM OUTCOMES

There were no intraprocedural deaths, myocardial infarction, tamponade, stroke, or major vascular complications. One patient died within 30 days from a subarachnoid haemorrhage (30-day mortality 3.7%). Periprocedural device migration occurred in two patients requiring a second THV implantation during the same procedure: in both cases, the initial THV devices were oversized by 2-3%. There were no cases of device embolisation or coronary

Table 2. Echocardiographic data.

Variable	Pre-procedure n=27	1 year n=25	3 years n=19	5 years n=14
LV end-diastolic volume/BSA, mL/m ²	95±40	64±28**	53±32**	60±17**
LV end-systolic volume/BSA, mL/m ²	49±34	31±22*	25±27**	32±18*
LV ejection fraction, %	48±15	51±13	53±9	57±11*
Transvalvular severe regurgitation	27	0	0	0
Peak AoV gradient, mmHg	41±20	19±13***	18±9***	17±8***
Mean AoV gradient, mmHg	24±13	12±7***	10±6***	9±5***
Paravalvular leak, n	None/trivial/mild	–	18	19
	Mild-moderate	–	3	0
Moderate/severe mitral regurgitation, n	4	0	0	0
E/E'	19±8	16±10	14±8	13±7**
Moderate/severe tricuspid regurgitation, n	7	0	0	None
Pulmonary systolic arterial pressure, mmHg	43±5	36±13*	35±16	32±10**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ compared to baseline; # $p < 0.05$: 5 years compared to 1 year. AoV: aortic valve; BSA: body surface area; LV: left ventricular

obstruction, and paravalvular leak (PVL) was absent/trivial/mild in 24. Thirteen patients were discharged on warfarin (pre-existing atrial fibrillation), the remainder on a single antiplatelet agent.

5-YEAR OUTCOME

Median follow-up was 2,046 days (range 9-3,684 days); one patient was lost to follow-up. Actuarial mortality at 1, 3, and 5 years was 11.4% (CI: 3.8-31.5%), 15.5% (CI: 6.1-36.2%), and 25.2% (CI: 12.0-48.1%), respectively (numbers at risk 22, 21, and 15) (**Figure 2**). Two patients died between 30 days and 1 year: the first (the salvage case on mechanical support [also the youngest patient]) died at 35 days from multi-organ failure; the second died after 238 days of bronchopneumonia. A further 3 patients died between 1 and 3 years (1 stroke, 2 respiratory); 2 had mild-moderate PVL at one-year follow-up, while the third patient with mild-moderate PVL at 1 year was lost to follow-up. No patients died between 3- and 5-year follow-up.

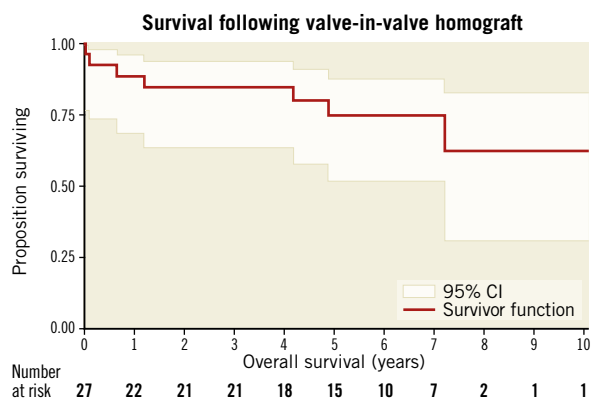


Figure 2. Kaplan-Meier curve for ViV-TAVI for failing homograft AVR.

After five years, the patients' NYHA class decreased from 63% NYHA Class III, 37% NYHA Class IV to 7% NYHA Class II, 93% Class I; BNP levels also decreased (500 ± 570 ng/L to 188 ± 131 ng/L, $p=0.01$). There was no echo evidence of late THV migration, increase in severity of PVL, device thrombosis, endocarditis, or structural valve dysfunction. No patient required re-intervention. Left ventricular ejection fraction (LVEF) increased, LV cavity size and aortic pressure gradients decreased, aortic valve area did not change ($p=0.81$), no patient had more than mild mitral or tricuspid regurgitation, and E/E' and pulmonary pressures decreased (**Table 2**).

Discussion

Actuarial mortality after ViV-TAVI for high-risk patients with degenerate homograft AVR at 1, 3, and 5 years was comparable to five-year mortality for stented and stentless ViV-TAVI⁴ and redo surgical AVR⁵. At five years, transcatheter devices were durable, and LV function and haemodynamics improved, highlighting that

ViV-TAVI in a degenerated homograft can be performed safely with favourable midterm to long-term outcomes.

Limitations

This was a single-centre study, performed by select operators, using predominantly self-expanding THV, and hence is subject to the limitations of one unique centre's pattern of practice. THV malpositioning and paravalvular leak severity were not analysed by a central core lab. Although it would have been of interest to investigate possible predictors for mortality at 1, 3, and 5 years in a Cox regression analysis that might guide patient selection, our sample size was too small and underpowered to detect any differences.

Conclusion

Despite technical challenges, five-year mortality of 25.2% following ViV-TAVI for failing homograft AVR in a high-risk population is comparable with redo surgical AVR. Long-term valve durability appears favourable and was associated with recovery of LV function and haemodynamics in this single-centre series.

Impact on daily practice

At five years, ViV-TAVI in high-risk patients with degenerated homograft AVR has a mortality rate comparable with redo surgical AVR. The THV devices appear durable with no cases of late structural valve dysfunction.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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