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SHORT REPORT

A Completely Endovascular Solution for Transcatheter Aortic Valve Implantation Embolisation and Inversion into the Aortic Arch

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WHAT THIS PAPER ADDS

Snaring using a through-and-through wire technique, combined with through-valve thoracic endovascular aortic repair, provides a new bailout strategy for transcatheter aortic valve embolisation and inversion into the ascending aorta.

Introduction: Transcatheter aortic valve implantation (TAVI) has evolved into the preferred alternative to surgical valve replacement for severe aortic valve stenosis with high surgical risk. With expanding indications, life threatening complications including transcatheter aortic valve embolisation and inversion (TAVEI), in which the valve dislodges, inverts, and migrates caudally, may increase concomitantly.

Report: An 80 year old male with severe aortic valve stenosis underwent balloon expandable transcatheter aortic valve implantation (TAVI). Valve embolisation into the aortic arch inverted the bioprothesis, excluding the option of fixation in the descending aorta. Through-valve thoracic endovascular aortic repair (TEVAR) was performed after bifemoral snaring using a through-and-through wire technique and pulling the valve into the descending aorta.

Discussion: TAVI is emerging as the preferred treatment for severe aortic valve stenosis and comes with unique procedural complications, such as life threatening transcatheter aortic valve embolisation and inversion (TAVEI). Although some authors prefer treating embolisation of a non-inverted balloon expandable valve into the aorta by using the valvuloplasty balloon to pull the valve distally and fixing it in the descending aorta, this risks further expansion of the valve and consequently fixing it in an undesirable position and is not possible if the valve inverts. Downstream placement of the valve by snaring with a guiding catheter covering/protecting a through-and-through wire technique, combined with through-valve TEVAR, provides a new bail out strategy for this serious complication and may reduce TAVEI associated mortality and morbidity.

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INTRODUCTION

Since its introduction in 2002, transcatheter aortic valve implantation (TAVI) has evolved into the preferred alternative to surgical aortic valve replacement (SAVR) for the treatment of symptomatic aortic valve stenosis.[1,2] In patients with intermediate to high surgical risk, TAVI has shown favourable short and intermediate term results compared with SAVR in terms of mortality, stroke, and valve regurgitation.[2,3] Recently, the PARTNER 3 study showed benefit over SAVR in patients with low surgical risk as well.[1] Nonetheless, TAVI is subject to unique peri-procedural complications, including transcatheter aortic valve embolisation and inversion (TAVEI), in which the valve dislodges, inverts, and migrates caudally. Although embolisation of a non-inverted balloon expandable valve into the aorta is preferably treated by balloon dilatation over the guidewire with valve fixation in the descending aorta, this is not possible if the valve inverts. A completely endovascular solution is presented for an inverted aortic valve bioprosthesis embolised into the aortic arch.

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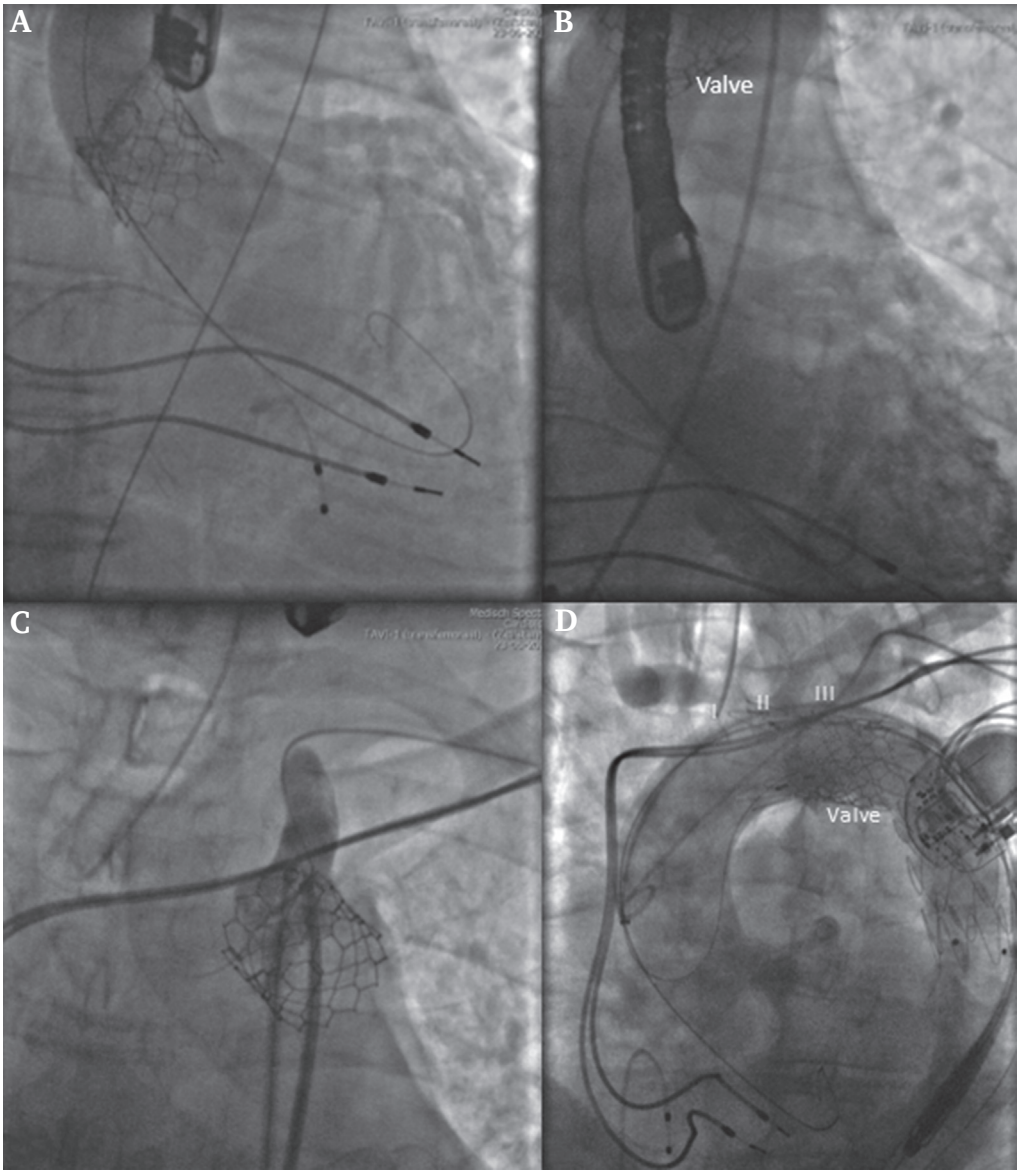

Figure 1. Intra-operative fluoroscopy. (A) Following failed capture of the temporary pacemaker and lost guidewire position through the valve, the 26 mm Edwards SAPIEN 3 Ultra aortic bioprosthesis migrates to the ascending aorta. (B) The embolised valve inverts and migrates further into the aortic arch at the left common carotid artery origin. (C) Compromised, but flow present past the embolised valve. A femoro-femoral through-and-through wire set up was established using two 7 F Check-Flo® introducer sheaths guided over two 260 cm 0.035″ Radiofocus® guidewires and pushing a dilatator into the other. Manual traction pulled the bioprosthesis 3 cm caudally into the descending aorta, distal of the left LSA origin. (D) Fluoroscopy via the left brachial artery, showing successful in-valve thoracic endovascular aortic repair (Valiant™ Captiva™), fixing the embolised and inverted bioprosthesis distal to the left subclavian artery (LSA) origin with sufficient flow to the brachiocephalic artery (I), left common carotid artery (II), and LSA (III) (further filling of the LSA was shown on subsequent fluoroscopy frames).

REPORT

An 80 year old male with severe symptomatic aortic valve stenosis (AVA 0.8 cm^2) was accepted for TAVI. His medical history included hypertension, insulin dependent diabetes mellitus, ischaemic stroke, myocardial infarction, atrial fibrillation, and tachycardia bradycardia syndrome, for which a VVI-R pacemaker (Medtronic, Azure™ XT SR) was implanted.

Under general anaesthesia and full heparinisation (activated partial thromboplastin time $>$ 300 seconds), a 26 mm Edwards SAPIEN 3 Ultra aortic bioprosthesis (Edwards Lifesciences, Irvine, CA, USA) was guided on a stiff wire into the aortic annulus via a transfemoral approach. Under rapid pacing, the bioprosthesis was partially expanded, after which fluoroscopy confirmed adequate positioning in the aortic annulus and the

bioprosthesis was expanded completely. During final dilatation, a ventricular contraction occurred due to failed capture of the temporary pacemaker, which was presumably the result of myocardial fibrosis following previous infarction of the right ventricle and inferior wall. This caused the completely expanded bioprosthesis to be expelled into the ascending aorta, with the stiff wire still in place (Fig. 1A). Unfortunately, the valvuloplasty balloon was removed, which prevented the use of the balloon to pull the bioprosthesis into the descending aorta. Instead, a snare kit (Amplatz GooseNeck™; eV3 Inc., Plymouth, MN, USA) was advanced over the stiff wire and through the bioprosthesis. Before valve inversion, the snare captured a stent element on the upstream side of the bioprosthesis, however, pulling on the snare pulled the stiff wire out of the bioprosthesis unintentionally. With the stiff wire no longer in place, blood flow caused the bioprosthesis to invert and migrate further downstream, where it became lodged in the distal aortic arch (left common carotid artery origin; Fig. 1A and B). The patient remained haemodynamically stable with sufficient peripheral circulation and fluoroscopy showed compromised, but present flow past the valve.

After prompt intra-operative multidisciplinary consultation, open surgical conversion, requiring sternotomy with cardiopulmonary bypass, was considered but was deemed very high risk given his age and comorbidities. A completely endovascular approach to resolve the TAVEI was proposed. Passing a guidewire through the bioprosthesis and using the balloon to pull the dislodged bioprosthesis distally was considered, but this option was abandoned due to the risk of further dilatating the valve, fixating it in the aortic arch, and consequently increasing the risk of intimal damage. Instead, a through-and-through wire technique was used to advance a 260 cm 0.035″ Radiofocus® guidewire (Terumo, Inchinnan, UK) through the valve via a left sided transfemoral approach, while inserting a second 260 cm 0.035″ Radiofocus® guidewire between the bioprosthesis and the aortic wall via a right sided transfemoral approach. Two 260 cm 7 French guiding sheaths (Check-Flo® Introducer; Cook Medical, Bloomington, IN, USA) were passed over both wires. To further reduce the cutting effect of the sheaths, a dilatator was advanced over one of the guiding sheaths and pushed into the other, which resulted in a through-and-through set up around the bioprosthesis, with a softer and wider surface than the guidewires or sheaths alone. Gentle pulling of both guiding sheaths under fluoroscopy, allowed controlled pulling of the bioprosthesis 3 cm caudally into the proximal descending aorta, just distal to the left subclavian artery (LSA) origin, maintaining cerebral and subclavian perfusion (Fig. 1C). The through-and-through wire was exchanged for a stiff wire (Lunderquist® 260 cm; Cook Medical), over which a Valiant™ Captiva™ stent graft (VAMF2828C100TE; Medtronic, Minneapolis, MN, USA) was guided through the bioprosthesis and was successfully deployed and expanded, opening and anchoring the bioprosthesis in the proximal descending aorta. Fluoroscopy and trans-oesophageal ultrasonography visualised the stent graft and aortic branch vessels without signs of stenosis, dissection, or occlusion (Fig. 1D). A second 26 mm Edwards SAPIEN 3 Ultra bioprosthesis was successfully implanted in the aortic annulus via a transfemoral approach. Post-operatively, as is standard in the centre, the patient was set on phenprocoumon, in addition to clopidogrel for three months. Follow up computed tomography confirmed adequate positioning of the functional bioprosthesis in the aortic annulus and thoracic endovascular aortic repair excluding the embolised and inverted bioprosthesis in the descending aorta without signs of stenosis, dissection, or occlusion (Fig. 2). Clinical recovery was uneventful and the patient was discharged home on the fourth post-operative day.

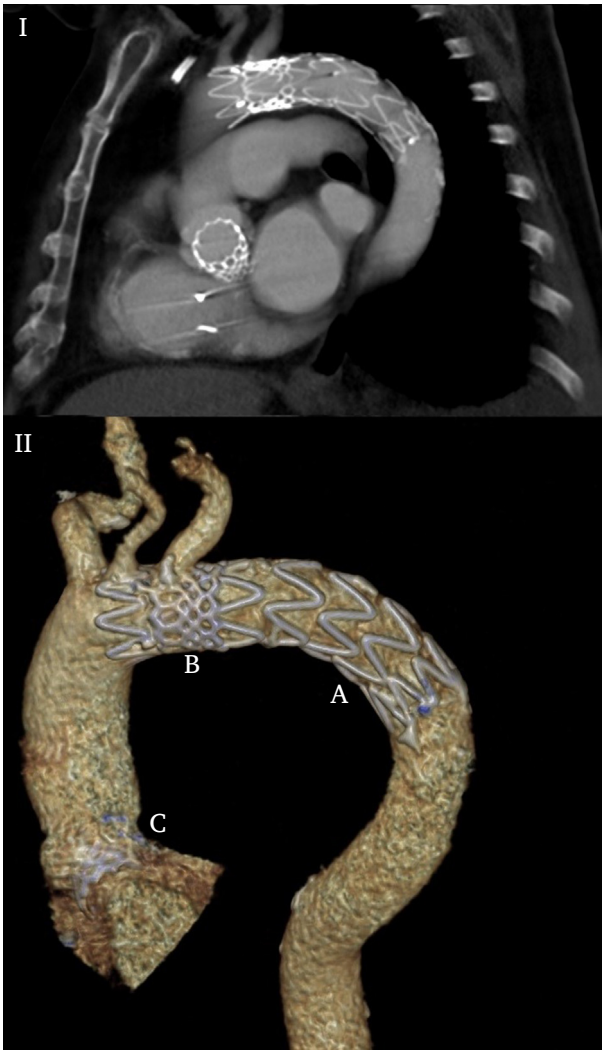

Figure 2. Post-operative computed tomography scan (I) and volume rendered reconstruction (II). Successful in valve thoracic endovascular aortic repair (Valiant™ Captiva™) (A), fixing the dislodged and inverted bioprosthesis distal of the left subclavian artery (LSA) origin (B). Although part of the LSA was overstented, intra-operative fluoroscopy showed sufficient flow to it. A second, functional 26 mm Edwards SAPIEN 3 Ultra aortic bioprosthesis is positioned in the aortic annulus (C).

DISCUSSION

This case demonstrates a completely endovascular solution for TAVEI of a balloon expandable valve into the aortic arch. Valve embolisation is a rare, but life threatening complication of TAVI especially if guidewire position is lost, as aortic flow tends to invert the embolised valve with risk of haemodynamic obstruction.[4] TAVEI recovery can be challenging. Ibebuogu et al. reported conversion to open heart surgery in 28.2% of patients with TAVEI with high 30 day mortality and stroke risks (17.0% and 11.3% respectively).[3] If embolised distally and still on the guidewire, using the valvuloplasty balloon the valve can be pulled into the descending aorta where balloon dilatation ensures valve fixation against the aortic wall.[4] In the present case, the valvuloplasty balloon and stiff wire were removed unintentionally, which resulted in inversion of the embolised valve and this excluded the option of fixation in the descending aorta. A guidewire with a balloon may be used to pull the bioprosthesis distally, but risks further valve expansion with fixation of the valve in a undesirable position. Snaring through a femoro-femoral through-and-through wire technique covered/protected by a guiding catheter and dilatator — a technique similar to "cheese wire" fenestration in chronic aortic dissection[5] — offers an alternative approach by pulling the valve distal of the LSA in a controlled manner with an acceptable risk of damage to the aortic wall. The inverted and therefore closed valve can then opened and fixed by deployment of a thoracic stent graft. Gentle pulling should be applied, as pulling too forcefully may induce intimal damage, ultimately risking laceration or dissection of the aortic wall.

CONCLUSION

TAVEI into the aortic arch is a serious complication following TAVI. This case emphasises the importance of careful pre-operative planning with bailout strategies. A completely endovascular solution to resolve this life threatening complication is presented.

CONFLICT OF INTEREST

None.

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AUTHOR CONTRIBUTIONS

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