

Aortic stenosis

Update on transcatheter aortic valve implantation

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Aortic stenosis (AS) is the third most common cardiovascular disease in the West and primarily occurs from the narrowing of the aortic valve. There are several treatment options available for patients with AS including balloon aortic valvuloplasty and surgical aortic valve replacement. However, there is growing clinical evidence that transcatheter aortic valve implantation (TAVI) may be the superior alternative to open heart surgery in intermediate and high-risk patients.

Aortic stenosis (AS) is the third most common cardiovascular disease in the West after hypertension and coronary artery disease.¹ Although degenerative disease accounts for most AS presentations, rheumatic heart disease is an important cause in Aboriginal and Torres Strait Islander people.² Patients can remain asymptomatic for many years; however, once symptoms develop, prognosis is limited without surgical intervention. Innovations in percutaneous techniques mean that patients previously deemed inoperable are now eligible for transcatheter aortic valve implantation (TAVI) and there is new evidence that TAVI is an excellent alternative to surgery in those at intermediate and even low surgical risk.³⁻⁵

Aetiology and pathophysiology

AS occurs from either narrowing of the aortic valve (valvular AS) or, rarely, from narrowing below or above the valve (sub- or supra- valvular, respectively). Valvular AS is most commonly caused by degeneration, with calcified nodules developing on the aortic side of the cusps. Rheumatic heart disease results in inflammation and fusion of the commissures and is typically accompanied by stenosis of the mitral valve. Bicuspid aortic valve is the most frequent congenital cause of AS and typically presents at a younger age. Subvalvular AS can result from hypertrophic cardiomyopathy or sub-aortic membrane formation. Supra- valvular stenosis is due to a congenital narrowing of the ascending aorta.⁶

Clinical features

AS presents insidiously with a long latent period before valve stenosis becomes symptomatic.⁷ The three cardinal symptoms of AS: breathlessness, syncope and chest pain, which can occur independently, herald important prognostic markers. Breathlessness, the most common symptom, usually begins on exertion before other heart failure symptoms

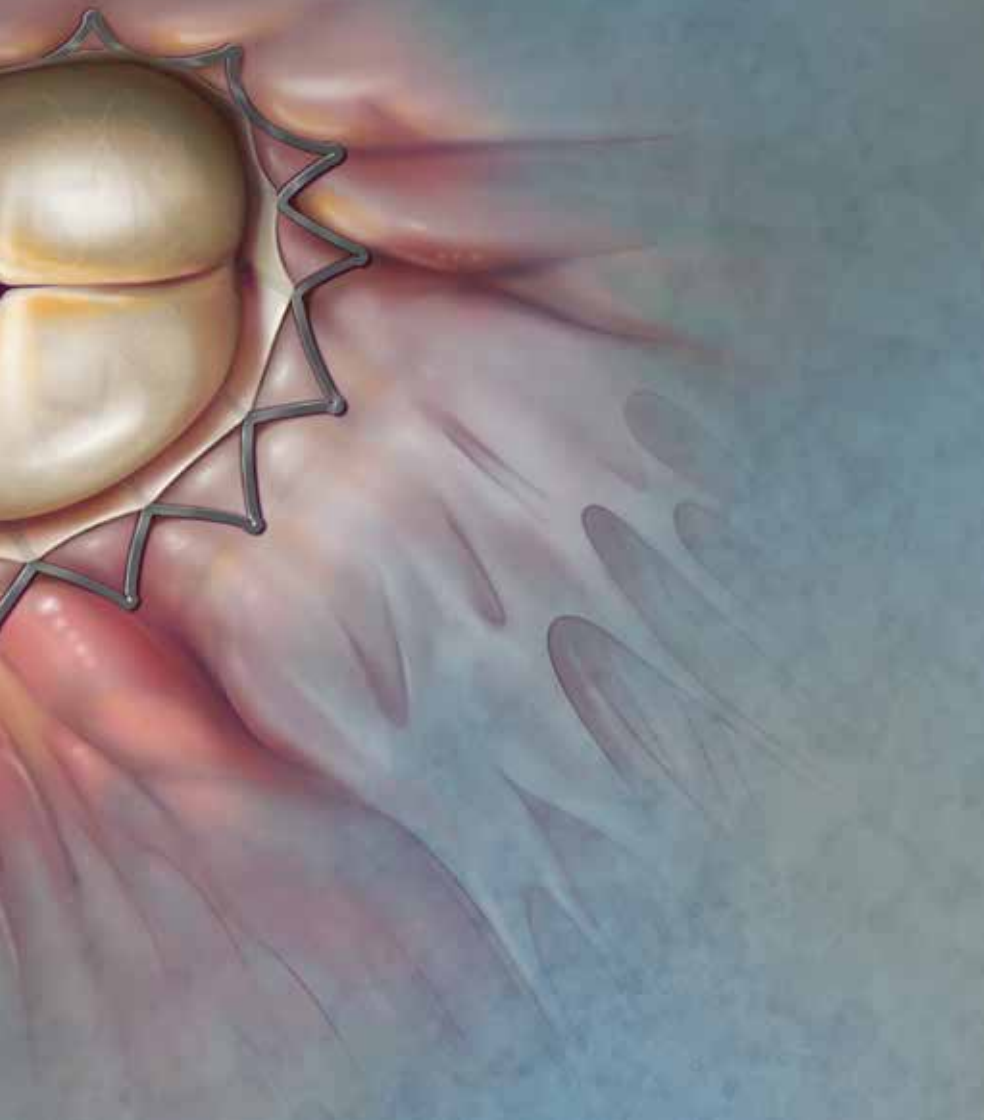
develop, such as orthopnoea, paroxysmal dyspnoea and peripheral oedema. These symptoms can develop because of systolic or diastolic left ventricular dysfunction. Exertional syncope occurs due to a fixed left ventricular stroke volume that is unable to compensate for peripheral vasodilatation. Syncope can also result from atrial and ventricular tachycardia. Glyceryl trinitrate should be used cautiously as it can induce loss of consciousness through profound hypotension. Demand ischaemia and left ventricular hypertrophy cause angina pectoris.⁸

Examination reveals a low volume, slow up-rising plateau carotid pulse unless the arteries are heavily calcified. A pressure loaded apex beat and a systolic thrill over the aortic area can often be palpated in severe disease.

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Auscultation of the heart helps determine severity. S1 is typically soft or normal; however, a normal or loud A2 rules against severe AS. S4 can develop later on, as a forceful left atrium contracts into a hypertrophied left ventricle. An ejection systolic, crescendo-decrescendo murmur in the right second intercostal space that radiates to the carotids and loudens with expiration is a hallmark of AS. A longer and later peaking murmur suggests increasing severity. Signs of heart failure might also be present.⁹

In severe aortic stenosis, transthoracic echocardiography reveals a valve area of under 1 cm², and increased pressure gradients (mean greater than 40mmHg) and peak velocity (greater than 400cm/sec) across the valve.⁶

Treatment options for symptomatic aortic stenosis

A ‘heart team’, typically comprised of an interventional cardiologist, a cardiothoracic surgeon, an imaging specialist, a geriatrician and an anaesthetist, discuss the best treatment for each patient based on surgical risk, valve anatomy and functional status.

Balloon aortic valvuloplasty

This percutaneous procedure entails expanding the stenosed valve with a pressurised balloon. It is a bridging measure that is useful in patients who are initially too unwell for surgery because of cardiogenic shock. However, restenosis recurs within a few months to two years of the

Key points

- **Aortic stenosis is a common cardiovascular disease that accounts for significant morbidity and mortality if left untreated**
- **Transcatheter aortic valve implantation (TAVI) provides an excellent alternative to open heart surgery in intermediate- and high-risk patients**
- **Patients with surgical prosthetic valve failure are usually eligible for transcatheter valve-in-valve replacement**
- **Balloon aortic valvuloplasty provides patients with a bridge to definitive treatment**

procedure for all patients. Previously associated with high complication rates of up to 20%, including free myocardial wall rupture, myocardial infarction and severe aortic regurgitation, and with a periprocedural mortality of 3%, newer balloon aortic valve devices are considered safer.^{10,11} The procedure can be repeated when symptoms recur.

Surgical aortic valve replacement

This procedure involves a median sternotomy or mini thoracotomy with replacement of the aortic valve, with either a bioprosthetic (porcine or bovine) or metallic valve. The choice of device is primarily determined by the patient’s age and anticoagulation preference. Bioprosthetic valves have a particularly short lifespan in younger patients; after 15 years, most bioprosthetic valves will have deteriorated in 30-year-old patients compared with 10% degrading after 15 years in 70-year-old patients.¹² However, bioprosthetic valves require the patient to take aspirin for three months only, while metallic valves require lifelong warfarin therapy. Until recently, surgical aortic valve replacement (SAVR) was the treatment of choice for all eligible patients, and although it is still preferred for patients with either aortic regurgitation or bicuspid aortic valves, TAVI has emerged as a safe alternative.¹³

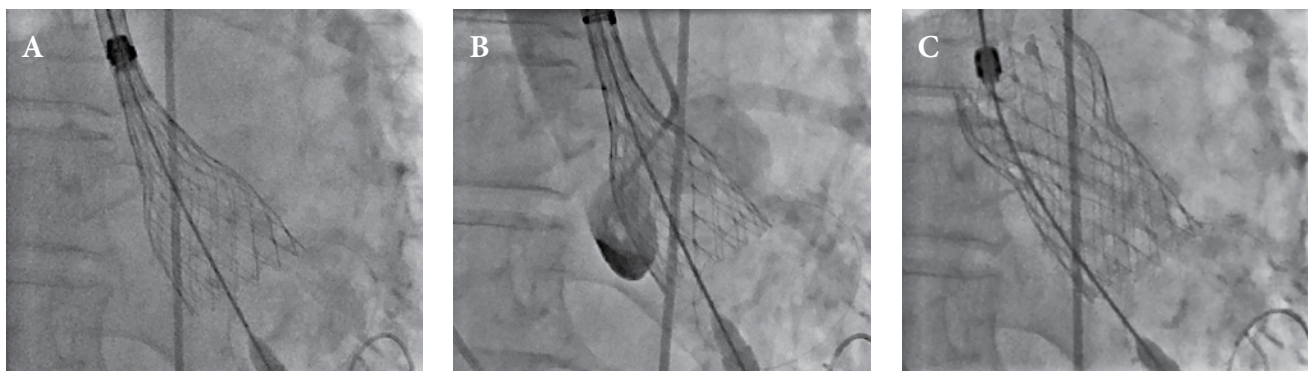


Figure 1. Positioning and deployment of a self-expanding bioprosthetic valve. **A.** The transcatheter heart valve is advanced across the aortic valve. **B.** The valve is positioned such that the inferior edge of the valve frame is 2 to 6 mm inferior to the non-coronary cusp (on the left of the picture). **C.** After slow and gradual deployment, the valve appears fully expanded.

Images courtesy of Dr Isaac George, Columbia University Medical Center, NYC, USA.

Transcatheter aortic valve implantation

The first TAVI was performed in 2002 via a transvenous, transeptal, antegrade approach and was followed a few years later by a transfemoral arterial approach (Figure 1).¹⁴ Technology has since evolved, with a variety of balloon-expanding and self-expanding valves available in Australia.¹⁵ With advances in

multiple detector CT (MDCT) and transoesophageal echocardiography, valves are more accurately sized and placed, leading to improved outcomes for patients.¹⁶ MDCT is the gold standard in accurate sizing of the aortic annulus. Transoesophageal echocardiography may complement MDCT in assessing annulus size and prove invaluable intraprocedurally, when the presence of

high-risk features such as left ventricular outflow tract calcification mandates real-time assessment of the interaction between the transcatheter valve and the annulus.

The Placement of Aortic Transcatheter Valves (PARTNER) trials have been pivotal in showing that TAVI is superior to medical management in patients with severe, symptomatic AS deemed inoperable, and more recently noninferior in patients deemed at low, moderate and high surgical risk.^{3,17-19} Compared with patients treated medically, inoperable patients undergoing TAVI had 20.0% absolute risk reduction in death at one year.

The PARTNER A trial also showed similar mortality rates between high-risk surgical candidates undergoing SAVR or TAVI, but significantly lower rates of bleeding with TAVI.¹⁸ After the publication of the PARTNER A trial, the American Heart Association (AHA)/American College of Cardiology (ACC) updated their guidelines, stating that TAVI was indicated over SAVR for high surgical-risk patients.²⁰ Since then, trials (including PARTNER 2 and SURTAVI trials) have found TAVI to be noninferior to SAVR in intermediate-risk patients, with much less bleeding and atrial fibrillation post-procedure.^{19,21} These findings have been reflected in the AHA/ACC guidelines, which state that it is reasonable to perform TAVI (Class IIa) instead of SAVR in this setting.²⁰ As with the high-risk cohort, TAVI has comparable mortality to SAVR in intermediate-risk patients. Furthermore, rehabilitation

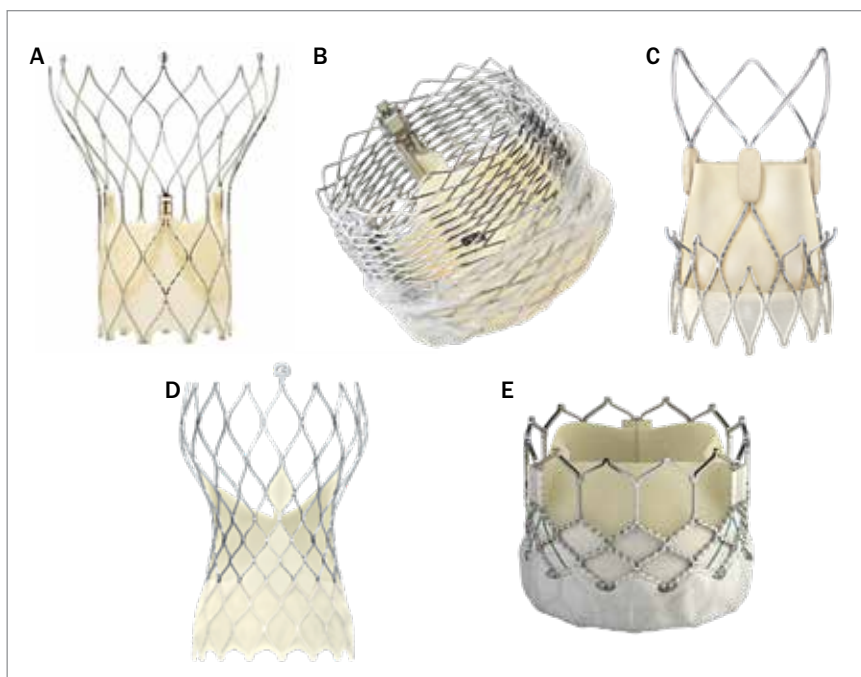


Figure 2. New and emerging TAVI devices approved by the TGA. **A.** Portico™ valve*, **B.** Lotus Edge™ valve†, **C.** Accurate neo™ valve‡, **D.** Evolut Pro™ valve§, **E.** Sapien 3™ valve¶.

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is quicker, with reduced length of hospital stay post-TAVI. This year, two further trials have been published, comparing TAVI and SAVR in low-risk patients (PARTNER 3 and Evolut Low Risk).^{3,4} Again, noninferiority has been demonstrated and we envisage that the guidelines will be further amended to reflect these results.

Medium-term outcomes following TAVI are satisfactory and comparable to SAVR. Five-year results published from the PARTNER A trial showed no significant difference in mortality between TAVI and SAVR, but an increased prevalence of severe aortic regurgitation with TAVI. Data beyond two years is not available in the lower risk cohorts.

Overall, compared with surgery, transcatheter aortic valve replacement results in less stroke, less bleeding and less atrial fibrillation, but increased risk of vascular complications, significant paravalvular leak and need for permanent pacing.²² Recovery time is much faster with TAVI than with surgery.²³ On economic analyses, the overall societal

cost of TAVI is largely similar to SAVR.²⁴ Bicuspid valves were excluded from the largest trials, but in a smaller cohort TAVI was found to be an acceptable treatment, albeit with higher rates of aortic regurgitation and lower device success rates.²⁵

The long-term durability of TAVI valves is currently unknown. On machine testing, TAVI valves are expected to last 15 to 20 years, but we do not have clinical follow-up that extends to that time frame yet. As with surgical bioprosthetic valves, TAVI valves are likely to be less durable than metallic valves; therefore, valve deterioration and subsequent re-intervention is more likely.²⁶ Valve deterioration would previously have meant surgical replacement; however, in 2007, a transcatheter valve-in-valve procedure was developed that implants a bioprosthetic valve over the previous bioprosthetic replacement, sparing the patient from repeat open heart surgery when the bioprosthetic valve fails.¹³ This procedure is suitable for both balloon-expandable and self-expanding bioprosthetic valves and has similar

long-term outcomes to surgically replaced valves in high-risk patients. However, no randomised controlled trials on the procedure exist.²⁷

There are several valves for TAVI currently available on the Australian market. The balloon-expandable bioprosthetic and self-expanding bioprosthetic valves were the first to be marketed. Since then TGA approval has been granted to several self-expanding valves (Figure 2).¹⁵

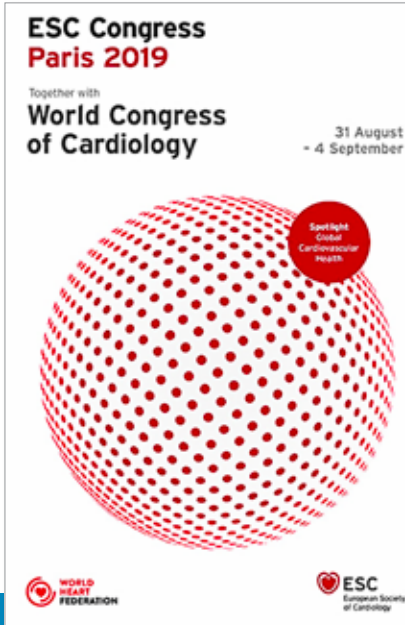
Conclusion

TAVI has been shown to be a safe, minimally invasive treatment option for aortic stenosis in Australia. We predict that it will soon be the preferred approach for all patients with symptomatic disease. **CT**

References

A list of references is included in the online version of this article (www.cardiologytoday.com.au).

COMPETING INTERESTS: None.



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