

## Development of Minimally Invasive Surgical Treatment for Aortic Stenosis in Older Patients

Deepika Manoharan (4<sup>th</sup> year MBChB, BSc (Hons)) & Divya Manoharan (4<sup>th</sup> year MBChB, BSc (Hons))

Correspondence to: Deepika Manoharan : [m\\_deepika2001@yahoo.com](mailto:m_deepika2001@yahoo.com)

### ABSTRACT

Aortic stenosis (AS) is the term used to describe the narrowing of the valve within the aorta (aortic valve). The restricted opening of the valve results in the obstruction of the left ventricular outflow leading to a reduced volume of blood entering the systemic circulation. Once patients develop symptoms, particularly of chest pain, breathlessness, syncope and heart failure, the prognosis becomes poor with drug treatments providing only symptomatic relief. Increasingly older patients with multi-morbidities are developing AS and as such the traditional open-heart surgical methods of treatment are less well tolerated or contraindicated. This article discusses some recent developments in less invasive surgical techniques for older patients with comorbid health problems which is hoped to improve outcomes for older patients with AS.

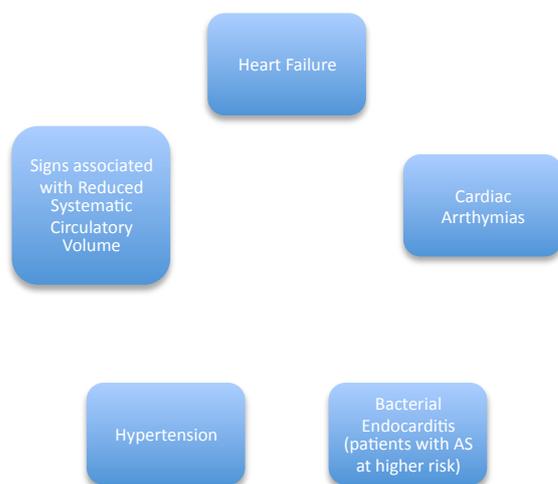
**Key Words:** Cardiology; Aortic Stenosis; Geriatrics; Interventional Cardiology

### Aortic Stenosis

Aortic stenosis (AS) is the term used to describe the narrowing of the valve within the aorta (aortic valve).<sup>1</sup> This is typically noted on examination by a mid-systolic ejection murmur. The restricted opening of the valve results to the obstruction of the left ventricular outflow leading to a limited volume of blood entering the systemic circulation.<sup>1-2</sup> Following the onset of symptoms especially chest pain, breathlessness, syncope and heart failure, the prognosis becomes poor with medical treatments providing only symptomatic relief (Figure 1).<sup>3-4</sup> Mortality rates rise rapidly to 3% within a few months and progresses to 50% in 2 years, with three quarters of patients dying within 3 years from the onset of symptoms.<sup>4-6</sup>

In industrialised countries, AS is the most prevalent valvular heart disease due to the rise in life expectancy and the resultant effect of an expanding ageing population.<sup>3-4,7</sup> Degenerative/senile calcific AS is the commonest type and the disease process, recently thought to be analogous to atherosclerosis, mainly happens in the sixth, seventh and eighth decades of life.<sup>4,8</sup> Treatment is vital and a medication-only regime proves to be ineffective and eventually fatal in patients with significant AS. Indeed, medication regimes only treat the symptoms and complications of AS including heart failure, hypertension, increased risk of bacterial endocarditis and arrhythmias. Commonly used medications include digoxin, angiotensin converting enzyme inhibitors, and loop diuretics .

The most valued and recommended treatment involves the mechanical correction of the valve in selected patients as this alleviates the debilitating and life-threatening symptoms previously mentioned.<sup>4</sup>



**Figure 1 – Summary of some Key Clinical Associations with Aortic Stenosis (AS)**

### **Aortic Stenosis & Surgery**

Surgical aortic valve replacement (SAVR) is the gold standard method of treatment for those with AS and is the most widely performed valve treatment.<sup>3,9</sup> SAVR is commonly advised in symptomatic patients and in asymptomatic patients with <50% ejection fraction in order to improve survival rates.<sup>6,9</sup> However, the procedure is invasive and involves sternotomy, aortotomy and cardiopulmonary bypass.<sup>10-11</sup> Therefore, SAVR is not recommended in high-risk patients, particularly in the elderly, due to the invasive and complicated nature of the surgery.<sup>3</sup> Even though old age plays an influential role in contraindicating SAVR, it is also necessary to formulate a risk/benefit ratio and use multivariate scores such as the logistic EuroSCORE score or the Society of Thoracic Surgeons risk calculator.<sup>7,9,12</sup> Studies show that over 30%-40% of elderly patients with severe aortic stenosis are excluded from surgical treatment owing to their advanced age, general frailty and the presence of co-morbidities such as COPD, cerebrovascular disease, chronic kidney disease and wide-spread atherosclerosis. In addition, some older patients do not wish to undergo cardiothoracic surgery. Hence, the unsuitability and subsequent denial of SAVR in a large proportion of elderly patients has a definite impact upon their quality of life and longevity.<sup>7</sup>

However, advancements in the last decade have led to the development of an alternative minimally invasive aortic valve replacement (AVR) method ideal for use in high-risk elderly patients. A transcatheter aortic valve implantation (TAVI) procedure can be done either by a percutaneous or a transapical approach.<sup>13</sup> A **percutaneous method** is performed by inserting the prosthesis in a delivery catheter through the femoral artery (the most common route), axillary artery or subclavian artery (all retrograde techniques). The **transapical method** is carried out by gaining access to the left ventricular apex through an anterolateral minithoractomy. In both methods, fluoroscopy (continuous X-Ray monitoring showing moving structures) and echocardiography are used throughout the procedure to aid the clinician position and direct the delivery catheter with the compressed prosthetic valve to the aortic annulus where it is later expanded.<sup>12,14</sup> Figure 2 shows the difference in size when the valve replacement is expanded.

The first successful **percutaneous AVR** was performed by Cribier et al in 2002 and since 2008 the methodology has been quickly adapted for use throughout the globe.<sup>8</sup> In contrast, the transapical AVR is a fairly new cardiology intervention and has been developed as an alternative method for elderly patients whom both the SAVR and the percutaneous AVR approach is contraindicated because of the presence of small, torturous or severe peripheral

vascular disease affecting the femoral, iliac or aortic vessels.<sup>9,12,14</sup> Transapical AVR also proves to be less technically challenging than the percutaneous AVR and is performed by cardiac surgeons instead of interventional cardiologists. However, limitations to the transapical approach also exist and the procedure is not suitable in patients with left ventricular apical thrombus, aneurysm or scarring. Despite these limitations, both approaches of TAVI are still being constantly revised and developed as they are very useful procedures in high-risk elderly candidates.<sup>9</sup>

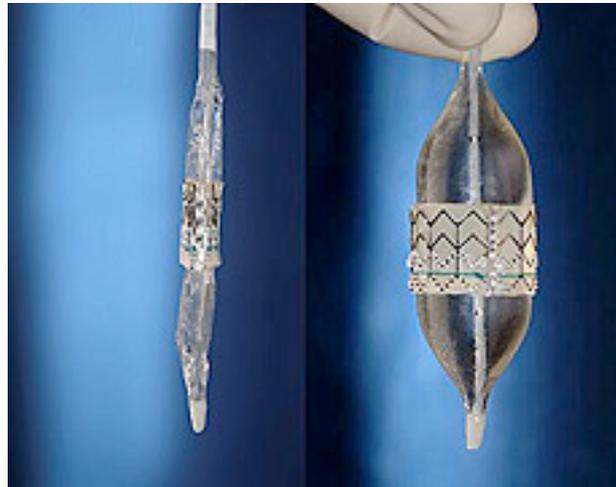


Figure 2 – TAVI being inflated<sup>16</sup> (Image used with permission from Papworth Foundation Trust)

Recent reviews have indicated TAVI success with 30-day survival rates being 93% and 90%, respectively, for the percutaneous transfemoral approach and 94% and 88%, respectively, for the transapical approach.<sup>11-15</sup> The main complications related to TAVI include arrhythmias, vascular site problems, cerebrovascular events (less common in transapical AVR), myocardial infarction and hemodynamic collapse. The higher 30-day mortality rate of 11% in TAVI compared to the 3-4% in SAVR is also slightly discouraging, although patients' undergoing TAVI are typically older with more comorbidities. Indeed, one study showed that TAVI mortality proved to be lower than the operative mortality rate predicted by the EuroSCORE for high-risk elderly patients.<sup>15</sup> Most importantly, 1-year mortality rate, including death from any cause, is 20% lower with TAVI than with standard medical therapy.<sup>6</sup>

## Discussion

The availability of less invasive treatments to AS and the opportunity of lengthening lifespan is the perfect option for elderly patients deemed unsuitable for SAVR. The invention of TAVI increases the number of elderly patients who can benefit from treatment for AS when compared to the rapid rise in morbidity and mortality that occurs with medical treatment alone.<sup>6-7</sup> TAVI holds the key to future change in the treatment of AS, but since the development of this technique is fairly new, it is necessary to conduct long-term studies in patients who have undergone the procedure. Further follow-up of large numbers of patients is necessary to draw clearer conclusions and to determine the surgical risk, complications, long-term outcomes and cost-effectiveness of TAVI in comparison with SAVR.<sup>9</sup> Whether TAVI has the potential to become a therapeutic option in normal risk patients and perhaps be the next gold-standard procedure for the treatment of AS still remains unclear. Further modifications and rigorous evaluations of the outcome of patients undergoing TAVI is necessary to answer this question and hence, younger patients who are more likely to benefit with the conventional open heart SAVR (first-line of treatment), should not yet be considered for TAVI.<sup>12</sup>

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- Image
- (16) Image of TAVI being expanded in clinical practice. Image used with permission from NHS Papworth Hospital Foundation Trust. [Accessed 21/06/2012] Available from: [http://www.papworthhospital.nhs.uk/content.php?our\\_services/cardiac\\_services\\_heart/transcatheter\\_aortic\\_valve\\_implantation](http://www.papworthhospital.nhs.uk/content.php?our_services/cardiac_services_heart/transcatheter_aortic_valve_implantation)