Transcatheter treatment for valvular heart disease

Newer, less invasive techniques provide a wider option for the treatment of severe valvular heart disease in high risk patients. Older patients are likely to benefit from these techniques, as surgical risk increases with age.

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Valvular heart disease poses a rising public health concern.1 Evidence suggests that the incidence of valvular heart disease increases significantly with age.2 A recent study3 showed that the prevalence of valve disease in the US, corrected for age and sex is 2-5%. Prevalence increased with age, from 0-7% in 18–44 year olds to 13-3% in the 75 years and older group. As the population in the Western world becomes older, the problem of valvular heart disease will widen, with significant implications to public health.

Aortic stenosis is the most common valvular disease in countries where rheumatic fever has a low incidence.4 The treatment options for severe aortic stenosis, have until recently been limited to aortic valve replacement (AVR), with a few new emerging medical therapy options.5 Aortic stenosis has a very poor prognosis.6 Medical therapy on its own offers limited results. Aortic valve replacement, when deemed possible, offers the optimal result.7 Unfortunately, not all patients are suitable for AVR, mainly due to the rising risk of surgery with worsening comorbidities, and the reluctance by some patients to undertake the risk of major surgery.

With the increasing risk of surgery with age, as well as the other factors, such as poor left ventricular function, up to one third of patients treated for valvular heart disease are not referred for surgery.8 This has created a desperate need for less invasive procedures that offer a reduced operative mortality in the patient populations where the risk of traditional surgery, outweighs the benefits.

Transcatheter Aortic Valve Implantation (TAVI)

The most important part of undertaking an innovative treatment is risk stratification.9 In order to reach a conclusion that a patient has either low, moderate or high risk for undergoing major cardiac surgery, a risk stratification model needs to be used. The most commonly used risk stratification model is the EuroScore.9,10 This is used to predict risk for coronary artery bypass grafting (CABG) patients, and is also in valve surgery,11,12 Another risk scoring system is the Society of Thoracic Surgery (STS) scoring system, which has recently been compared to the Euroscore in predicting risk in isolated aortic valve surgery,13 and found to be more representative of real risk. More importantly, clinical acuity remains a valid way to predict risk. This is where the importance of a multidisciplinary team in patient selection becomes apparent.

The British Cardiovascular Intervention Society (BCIS) and the Society for Cardiothoracic Surgery (SCTS) have issued a position statement on TAVI.14 Centres undertaking the TAVI procedure are obliged to set up a multidisciplinary team of at least two interventional cardiologists and two cardiothoracic surgeons that undertake patient selection. There has to be adequate facilities on site, such as cardiopulmonary bypass facilities, anaesthetic support, vascular surgery support, an intensive care unit that is accustomed to caring for patients...
after valve operations, interventional radiology and renal support. The selection of patients is a rigorous procedure, where disease severity, anatomy, vascular access, and comorbidities are all carefully considered prior to offering the procedure to the patient. All TAVI procedures are entered into a central database for audit purposes, and monitored centrally. All operators have to be well experienced, with adequate training and proctored procedures undertaken. A crucial part of the BCIS/SCTS recommendations is that TAVI should currently be reserved for patients who have been considered for traditional AVR surgery, but risk to benefit ratio of open heart surgery and TAVI, to favour TAVI. The usual “high risk” patient will have a logistic Euroscore of >20 or an STS score of >10. They have also recommended that in ideal circumstances the involvement in the multidisciplinary team of a general physician with experience in the care of the elderly would be appropriate.

NICE has also published guidelines in 2008 assessing the safety and efficacy of the procedure, but not the cost-effectiveness. The guidelines stress the need for good clinical governance, informed consent, patient selection by the multidisciplinary team, and procedure data entry into the national UK Central Cardiac Audit Database.

There are currently two main transcatheter valve systems, with some others in development, for the treatment of severe aortic stenosis. The basic principle of the percutaneous aortic valve systems is to provide significant relief from aortic stenosis, providing a valve area of 1.5 cm² or more. Furthermore, the valve system should not interfere with the workings of the mitral valve, or the patency of the coronary arteries, whilst maintaining a profile that allows for little, if any, aortic regurgitation.

The Edwards SAPIEN Transcatheter Heart Valve is a bovine pericardium prosthesis mounted on a balloon-expandable stent that is placed in the sub-coronary position. The valve can be placed either antegradely (ie. via the venous system, transeptally, across the mitral valve, and into the aortic root), retrogradely (ie. via the femoral artery, into the aortic valve), or trans-apically (ie. via a small incision in the apex of the heart).

The CoreValve ReValving system is a self-expanding porcine pericardium valve placed percutaneously. The valve is mounted on a self-expanding nitinol frame. The first balloon expandable valves were deployed via the antegrade approach, this allowed more flexibility in terms of sheath size, as venous distensibility allowed for bigger sheaths to be used. Unfortunately, the complexity of having to effectively cross from the right heart to the left heart in order to deploy the valve made this approach difficult, and less favourable. Following the progress of the prostheses, and the delivery platforms, the retrograde approach via the femoral artery became more popular. A 22F or 24F sheath is inserted in the femoral artery. The insertion of the femoral sheath can be undertaken by a vascular surgeon with a cut-down procedure, in order to minimise vascular complications. The valve is advanced and then positioned under fluoroscopic guidance, and with the aid of transoesophageal echocardiography. Following balloon dilatation, it is then deployed whilst the right ventricle is paced rapidly in order to reduce cardiac output. This results in a reduction of the blood pressure, in order to minimise valve migration. Vascular closure is then undertaken by the vascular surgeon and the patient cared for on the intensive care unit or high dependency unit.

If peripheral vessels are not large enough, tortuous or diseased, the transapical approach provides a good alternative. Developing this approach has expanded the options available to those patients with a calcified aorta, or peripheral vascular disease. Both transfemoral and transapical
Interventions are performed in the Cardiology Catheter Laboratory under fluoroscopic and TOE guidance. The other European-licensed TAVI system, CoreValve, offers a self expanding valve with the advantage of a smaller delivery sheath sizes of 18F.17 The advantage of not needing a surgical cut-down is somehow counterbalanced by the increased need for permanent pacemaker implantation, which may possibly be due to the prostheses positioning.9

Case study

We present a case of an 82 year old gentleman who underwent coronary artery bypass grafting and permanent pacemaker insertion in 2007. He presented with shortness of breath on exertion with New York Heart Association Class 3 grade, and was found on transthoracic echocardiography (TOE) to have severe aortic stenosis, with a peak gradient across the valve of 92 mmHg and a valve area of 0.57cm2. He had bilateral carotid artery disease, and renal impairment. Following cardiac catheterisation, transoesophageal echocardiography, CT aortogram, lung function tests and carotid dopplers, he was discussed in the TAVI multidisciplinary team meeting, and deemed suitable for the transfemoral TAVI approach.

He underwent TAVI retrogradely, with the EDWARDS SAPIEN valve (Figures 1 and 2), and was discharged without complications 10 days later. On follow up at 6 months, he reported going back to playing golf, and enjoying being able to climb stairs with little shortness of breath.

The evidence for the use of TAVI in high risk patients is now building. The early registries from 2003 and 2004 ( I-REVIVE, and RECAST)23 showed high mortality (23% at 30 days) major adverse cardiovascular and cerebrovascular event rate at 26%. The antegrade technique used at the time was complicated by the need of transeptal puncture, the guidewires used in the procedure interfered with the workings of the mitral valve and lead to detrimental
mitral regurgitation. This made the antegrade approach unattractive.

The retrograde approach was found to be promising, with some pioneers of the technique reporting a steep learning curve, but an eventual success rate of 96% after the first 25 cases. The 30-day mortality was 12%, in comparison to an expected mortality rate of 28%.

The PARTNER study (Placement of aortic transcatheter valves trial) is recruiting patients with severe symptomatic aortic stenosis who are poor surgical candidates in the US and Canada. The primary end point is 1-year mortality, comparing TAVI with optimal medical therapy and balloon aortic valve balloon valvuloplasty (BAV), with a second arm comparing TAVI to AVR, using a noninferiority analysis.

The transapical approach is also undergoing analysis in large series. Initial 12 month follow up data on 26 patients from Vancouver recently reported an 85%, 12-month survival with no late valve related complications. Data from
the European SOURCE Registry demonstrated a procedural success of 92.9%. The 30-day mortality was nearly 10%, with those having a Euroscore >20 fairing the worst.

There are many ongoing registry data being collected, most recently BCIS have launched their online TAVI database, which is collecting data from all UK centres.

Mitral regurgitation

Mitral regurgitation has been found in population studies to be the most common valvular abnormality. The surgical treatment of mitral regurgitation depends on the aetiology, as well as the anatomy of the valve.

In the early 1990’s Alfieri developed an edge to edge leaflet repair operation, with the suturing of the edge of mid anterior valve leaflet to the edge of the posterior mitral valve leaflet. This technique offered durable results in only a carefully selected group of patients. In functional regurgitation, the annular dilation provides an important substrate in propagating further regurgitation, and this procedure does not include annuloplasty.

The new transcatheter technique (MitraClip, by Evalve, San Francisco, CA), provides a similar procedure, percutaneously. Access is gained via the femoral vein, a transeptal puncture is undertaken, and the clip is guided into the left ventricle via the left atrium. The clip is deployed, grasping the anterior and posterior mitral valve leaflets, creating a double orifice valve. TOE guidance is used, and optimisation of the position can be undertaken by unclipping, and re-clipping. More than one clip can be used to obtain an optimal result as confirmed by TOE.

The Endovascular Valve Edge-to-Edge REpair Study (EVEREST I) study investigated the echocardiographic outcomes of 96 patients who underwent the MitraClip procedure for mitral regurgitation found that at 24 month follow up the procedure decreased the mitral valve area without significant obstruction. No patients required surgery within this time period. The results were independent of the aetiology of the mitral regurgitation.

There are ongoing registry data being collected, and the EVEREST II study has finished recruiting, having randomised patients either to percutaneous MitraClip repair versus standard surgical approach.

Long term results are awaited.

The MitraClip approach is likely to provide a solution for a cohort of patients where the anatomy is favourable and surgical repair less attractive. The EVEREST II study however, unlike the PARTNER trial for aortic stenosis did recruit patients with normal surgical risk, which would directly challenge the standard surgical approach across the risk groups.

Midterm results from both the Everest I and Everest II studies were published in August this year with 3 year follow up. 107 patients underwent the procedure, with a 74% acute success rate. Kaplan-Meier freedom from death was 95.9%, 94.0%, and 90.1%, and Kaplan-Meier freedom from surgery was 88.5%, 83.2%, and 76.3% at 1, 2, and 3 years. A total of 50 of 76 (66%) successfully treated patients met the primary efficacy endpoint of freedom from death, mitral valve surgery, or mitral regurgitation grade 2 or above at 12 months.

Conclusion

Newer, less invasive techniques provide a wider option for the treatment of severe valvular disease in the high risk patients. Older patients are likely to benefit from these techniques, as surgical risk increases with age. Newer and more sophisticated systems are being tirelessly developed and tried, with anticipation of better procedural and clinical outcomes.

The most important aspect of undertaking the new percutaneous valve treatment techniques is patient selection within a multidisciplinary team, involving physicians with experience in the care of elderly patients, as well as experienced interventional cardiologists and cardiothoracic surgeons.

Conflict of interest: none declared

References

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