Valvular heart disease: percutaneous alternatives

Rafal Dworakowski
Bernard Prendergast
Olaf Wendler
Philip MacCarthy

Abstract

Percutaneous and minimally invasive treatment of valvular heart disease is becoming rapidly established as an attractive, less invasive option to conventional valve surgery. Severe aortic stenosis can be treated with balloon aortic valvuloplasty (BAV) and more definitively with transcatheter aortic valve implantation (TAVI). However, TAVI as a definitive treatment should currently be performed only in patients with severe symptomatic aortic stenosis who are deemed unfit or high risk for conventional, surgical aortic valve replacement. Rheumatic mitral stenosis is effectively treated with balloon mitral valvuloplasty (BMV), which is the procedure of choice in symptomatic patients with favourable valve anatomy. Interventions for mitral regurgitation are emerging and include percutaneous annuloplasty (via the coronary sinus) and edge-to-edge valve leaflet repair. Congenital pulmonary stenosis can also be treated percutaneously with balloon pulmonary valvuloplasty. Transcatheter pulmonary valve implantation is used for the treatment of pulmonary valve stenosis and/or regurgitation in a right ventricle-to-pulmonary artery conduit. The key to successful outcome in all of these techniques is appropriate case selection — sophisticated cardiac imaging and a multidisciplinary approach are fundamental.

Keywords aortic balloon valvuloplasty; balloon mitral valvuloplasty; transcatheter aortic valve implantation; transcatheter mitral valve repair; valvular heart disease

Rafal Dworakowski *PhD MD is an Interventional Fellow at the Department of Cardiology, King's College Hospital, London, UK. Competing interests: none declared.*

Bernard Prendergast *MD FRCP is Consultant Cardiologist at the John Radcliffe Hospital, Oxford, UK. Competing interests: none declared.*

Olaf Wendler *PhD MD is Consultant Cardiothoracic Surgeon at the Department of Cardiothoracic Surgery, King's College Hospital, London, UK. Competing interests: Dr Wendler is procedural proctor and consultant for Edwards LifeScience Inc.*

Philip MacCarthy *BSc PhD FRCP is Consultant Cardiologist at the Department of Cardiology, King's College Hospital, London, UK. Competing interests: Dr MacCarthy is procedural proctor for Edwards LifeScience Inc.*

What's new?

- Increasing role of balloon aortic valvuloplasty in the treatment of adult patients with critical aortic stenosis
- Transcatheter aortic valve implantation (TAVI) for patients with severe symptomatic aortic stenosis who are deemed unfit or high risk for conventional, surgical aortic valve replacement
- Transcatheter mitral valve repair for symptomatic, high-risk surgical patients with functional or degenerative mitral regurgitation
- Transcatheter pulmonary valve implantation for patients with pulmonary valve stenosis and/or regurgitation in a right ventricle-to-pulmonary artery conduit

Introduction

The changing clinical characteristics of patients with valvular heart disease have brought challenges for cardiologists and cardiac surgeons alike. This is because older patients are very often high-risk candidates for surgical valve replacement or repair, which is still widely regarded as the 'gold standard therapy' for the treatment of most valve defects. These patients are consequently under-treated, and are often not even exposed to rigorous assessment by the appropriate specialist teams.[1] It is the combination of an unmet need with a desire to find lower-risk, less invasive approaches that has driven the development of percutaneous valve therapy, which is now an extremely fast-growing area of cardiology. Percutaneous and minimally invasive treatment of valvular heart disease presents a very attractive option for this high-risk group.

The aortic valve

Aortic stenosis (AS) is the most common form of valvular heart disease, predominantly affecting the elderly. It is usually caused by a degenerative, age-related process of valve calcification/destruction.[1,2] Once AS becomes symptomatic, life expectancy decreases dramatically[3] (Figure 1). Until recently, the only definitive treatment of aortic valve disease was surgical aortic valve replacement (AVR). However, the concept of percutaneous treatment of AS has been evolving since the late 1980s, initially using balloon aortic valvuloplasty (BAV) and, more recently, transcatheter aortic valve implantation (TAVI).[4]

Balloon aortic valvuloplasty

In adults, the immediate results of BAV in calcific degenerative AS are surprisingly good in terms of symptom relief. However, restenosis of the valve is unacceptably frequent and occurs in about 50% of patients within the first few months. Moreover, BAV does not appear to confer a mortality benefit.[5]

Despite this, in recent years BAV has experienced something of a renaissance, largely because of the growth and development of transcatheter aortic valve therapy. The BAV technique has been refined by the use of modern balloons, guidewires and vascular closure devices, and improved imaging techniques have decreased procedural mortality.

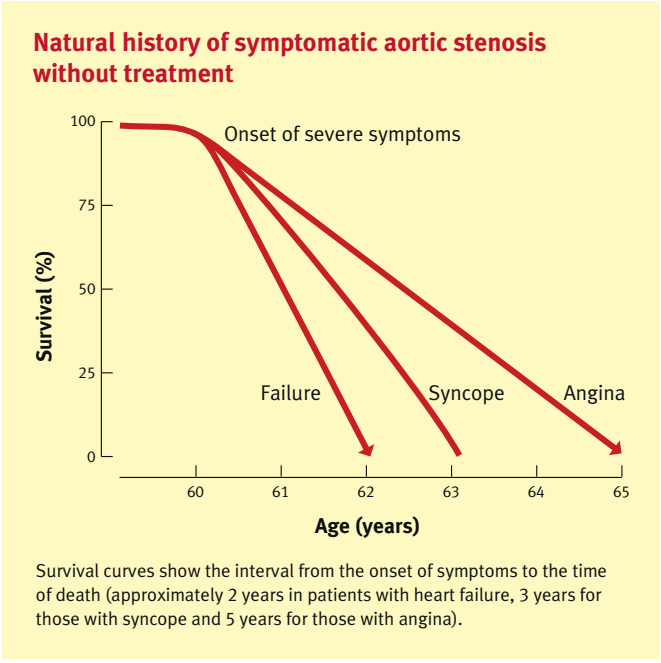

Figure 1

BAV now has a well-defined role in the treatment of patients with critical AS. Generally accepted indications are:

- Bridge to definitive treatment (either open AVR or TAVI).
- Bridge to new technology (e.g. those patients whose aortic annulus is too large for the currently available TAVI devices).
- Prior to pre-TAVI percutaneous coronary intervention (PCI), which can often be complex and high risk in the setting of severe AS.
- Therapeutic trial, particularly in breathless patients with a combination of severe AS, significant coronary artery disease and severe airways disease.
- Palliative — whilst this is more controversial, some feel that offering 3–6 months of symptomatic benefit to very elderly patients (even when recurrence of symptoms is likely) is worth while in some clinical scenarios.

Transcatheter aortic valve implantation

Until recently, the only definitive treatment for AS was conventional (open) surgical AVR, which remains the gold standard. However, the novel technique of TAVI has become feasible in recent years in patients unsuitable or high risk for open-heart surgery. The two devices currently available are the Edwards Sapien bioprosthesis (Edwards Lifescience, Inc., CA, USA) and the CoreValve ReValving system (Medtronic CV Luxembourg Sarl.) (Figure 2). The Edwards Sapien valve consists of three bovine pericardial leaflets mounted within a balloon-expandable, stainless steel stent and is deployed transfemorally or transapically (via a left lateral mini-thoracotomy). The CoreValve device has three porcine pericardial leaflets within a larger, self-expanding nitinol frame and can be delivered via the femoral or subclavian artery.

TAVI is currently indicated in patients with severe symptomatic AS who are deemed unfit or high risk for conventional, surgical aortic valve replacement. This diagnosis should be delineated by standard transthoracic echocardiography

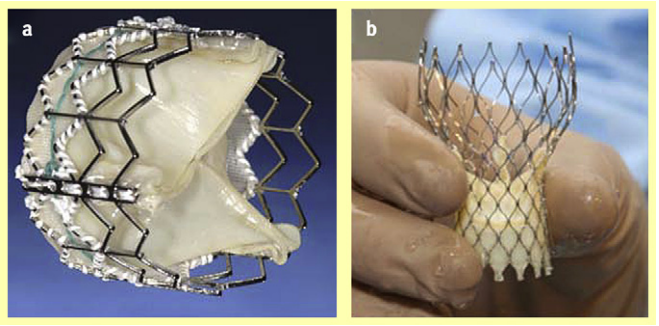

Figure 2 Devices used for percutaneous treatment of aortic valve disease. **a** Edwards Sapien Valve; **b** CoreValve prosthesis. (Reproduced from Grube et al., *JACC* 2007; **50:** 69–76, with permission from the American College of Cardiology.)

(Figure 3) and, occasionally, dobutamine stress echocardiography (in cases of low-gradient, low-output AS) or/and transoesophageal echocardiography. TAVI is approved for use in patients in whom conventional surgery carries a high estimated mortality risk (logistic EuroSCORE >20%, Society of Thoracic Surgeons score >10%) or those turned down for conventional surgery by two or more cardiothoracic surgeons.[6]

Detailed work-up investigations are required (Table 1). One of the most important components is assessment of valve morphology and sizing of the aortic annulus, which is vital for appropriate choice of device and prediction of paraprosthetic aortic regurgitation or ostial obstruction of the coronary arteries.

As the most common and serious complications of the transfemoral route are vascular, special attention should be paid to the size, tortuosity and calcification of peripheral vessels to assess the suitability of this approach. Angiography of the femoral and iliac arteries is important to measure vessel diameter but CT angiography (particularly with additional 3D reconstruction) is also helpful for estimation of calcification and tortuosity. Contraindications for transfemoral access include small-calibre vessels, severe tortuosity/calcification of the iliac arteries and severe intraluminal aortic atheroma.

More than 10,000 TAVI procedures had been performed world-wide by the end of 2009 with early literature suggesting good procedural success and encouraging short-/medium-term survival.

The mitral valve

Mitral stenosis (MS) is much less common than AS and its prevalence has now dramatically decreased in the developed world following the decline of rheumatic heart disease. Balloon mitral valvuloplasty (BMV) is a particularly attractive alternative to open-heart surgery in young patients or elderly patients with significant co-morbidities.

Mitral regurgitation (MR) is the most common defect of the mitral valve and mitral valve repair has been shown to result in improved outcomes compared to valve replacement. Over the last 30 years, various surgical techniques have been established to repair valve defects in these patients. However, there remains a group with severely impaired ventricular function or other serious co-morbidity, in whom conventional cardiac surgery presents considerable risk. A variety of percutaneous techniques