Surgical treatment of valve disease is becoming an increasingly important segment of activity in cardiac surgical centres around the world, mainly due to the ageing of the population, with its increased incidence of degenerative valve disease, and to the decrease in coronary surgery because of the growing activity of interventional cardiology in coronary pathology. Prosthetic valve replacement is the most frequent technique, being used almost exclusively in the aortic valve. In the mitral valve, replacement is still done in the majority of the cases but repair is increasingly used and in specialised centers, where it is the preferred technique.

Modern valve prostheses

The first artificial heart valves to be used clinically were mechanical devices and the continuous research and development over the last 25 years led to the modern prostheses which offer simplicity and safety of implantation, haemodynamic efficiency, lower rates of thromboembolism and excellent durability. After the old Starr-Edwards ball-and-cage valve and the Björk-Shiley tilting-disk valve, both off the market now, the first prosthesis to show haemodynamic efficiency and low embolic rate was a single tilting-disc model, the Medtonic Hall valve, introduced in 1977. This prosthesis has proven efficient, reliable and durable and remains our preferred valve substitute. The St. Jude Medical (SJM) prosthesis, a bileaflet design was introduced at about the same time and gained the preference of most surgeons in the world. This valve demonstrated low gradients, minimal insufficiency, and low rates of thromboembolism (TE) [1]. Anticoagulation continued to be necessary but to a lesser extent than with previous designs [2]. Because of its low-profile and lesser need for special annular orientation, surgical implant was further simplified.

Several other models of bileaflet prostheses were introduced, including the CarboMedics, the ATS Medical and the On-X prostheses. Over two million implants have been performed and the results reported in extensive literature.

Because of the improved results, Surgeons have become more confident about earlier aortic valve replacement (AVR) and guidelines for anticoagulation necessary for all mechanical valves have been developed for each generation of prosthesis at progressively decreasing target levels [2].

Furthermore, over the past 25 years, design changes have been made. The sewing rings have been improved to allow for larger valve size implantation and/or for implantation in a supravalvular position, as exemplified by the SJM latest Regent model which became the first mechanical prosthesis to demonstrate left ventricular mass regression across all valve sizes [3,4].

The bioprostheses were introduced in the early seventies in response to the haemodynamic insufficiencies and high thromboembolic rates of the first-generation mechanical valves. The porcine aortic valve, developed by Hancock in the United States (1970) and Carpentier in Paris (1976), revolutionized valve surgery, especially in the mitral position, by providing a biologic alternative without the need for lifelong anticoagulation. In the early 1980s, however, structural valve dysfunction became more apparent, 15 to 20% of the prostheses failing within 10 years of implantation. The rate of deterioration seemed to be accelerated in younger patients, with the valve gradually wearing down as a result of different biologically-mediated dysfunctional processes [5,6].
To improve durability, the third-generation biological valves were introduced, which still include porcine valves in addition to bio-mechanically engineered bovine pericardial valves. New technologies were incorporated aimed at improving valve longevity and hemodynamic function, and at decreasing calcification, including low-pressure or no-pressure fixation, anti-mineralization processing of the tissues, and low-profile, semiflexible stents that better preserve the biomechanical properties of the leaflets, which resulted in better midterm and long-term results [7-9].

With these developments, last generation prosthetic valves are expected to last longer and have fewer long-term complications. Eichinger and colleagues [10] published their 20-year experience with the St Jude Biocor porcine bioprosthesis in the aortic position and found a 70% freedom of structural valve deterioration and 86% freedom from re-operation.

Emery et al [11] reported 20-year absence of structural failure and freedom from valve related re-operation and mortality of 97% and 76%, respectively, with the St. Jude valve. Thrombo-embolism occurred at a rate of 1.9%/patient-year in the aortic and 2.8% in mitral valves. In long-term studies with the Medtronic Hall valve, Svennenig et al [12] also reported absence of structural failure and a 1.5%/patient-year aortic thromboembolic rate, and Butchart et al [13] reported a 15-year absence of valve related re-operation of 96% and 1.7%/patient-year thromboembolic rate.

Hence, the ideal prosthetic valve still does not exist. The longer durability of mechanical valves is still offset by the continuous risks of trombo-embolism and of bleeding from long-term anticoagulation, while bioprostheses do not require anticoagulation but carry the risk of structural failure and re-operation. However, Khan and associates [14] reported in a large series of patients that the incidence of tromboembolic events is the same with bioprostheses and mechanical prostheses on warfarin, and a large meta-analysis of 32 articles made by Lund et al [15] found no difference in risk-corrected mortality between mechanical and bioprosthetic aortic valves, regardless of patient age. Structural valve deterioration is age-dependent and has been demonstrated for all biological prostheses. Patients below 65 years of age should be advised that, even with the most durable biologic valve today, they have a chance of around 50% of having a re-operation for replacement within 20 years [10].

Mitrail annuloplasty is particularly amenable for use with minimally invasive techniques, including video-assisted and robotic surgery, which were developed in the last decade, albeit still with limited acceptance by the surgical fraternity. These methods have a significant learning curve and require expensive technology which is beyond the reach of most surgical groups.

The results of mitral valve repair for most types of pathology, perhaps with the exception of rheumatic, have compared favourably with replacement. One important advance was the extension of use to patients with dilated and ischemic cardiomyopathies. The results depend on the experience of the surgical groups and individual surgeons. Currently, most surgeons believe that it is of utmost importance to preserve the mitral valve, although the STS database shows that this valve is replaced in more than half of the cases.

Changing patterns of valve surgery

In the last decade, we have witnessed a modification in the patterns of valve surgery in that the number of annually operated patients has increased together with an increased frequency of risk factors and older age, yet without a significant increase in surgical mortality and morbidity. Brown and colleagues [16] studied the patients from the Society of Thoracic Surgeons National Database submitted to AVR from 1997 to 2006 and found that in 2006 AVR recipients were older and with higher predicted operative risk. However, observed mortality and permanent stroke rate fell by 24% and 27%, respectively, during the study period. There was also a 39% reduction in mortality in patients with preoperative renal failure. In 2006, mortality by age groups was less than 1% for patients younger than 60 years and less than 5% for those within the 80-90 years range. The use of bioprostheses increased from 43.6% in 1997 to 78.4% in 2006 and the number of patients older than 80 years increased from 13.4% to 19.7%.

Valve repair

The limitations and complications associated with valve prostheses have motivated surgeons to procure other options. Valve repair has, thus, emerged as an alternative to replacement. Although the aortic valve is apparently simpler than the mitral, it has eluded surgeons’ efforts to repair, only a few persistently using this technique today. By contrast, mitral valve repair has become an increasingly preferred alternative in most important cardiac surgical centres in the world. Initiated by Carpentier and Duran in the 70s, the techniques were modified and developed by these and many other surgeons.

Artificial chordae made of GoreTex and new models of annuloplasty rings, some tailored for specific situations, especially in the field of ischemic mitral regurgitation, constitute the most important developments in this field.
The number of elderly patients will increase regularly in the future as it is expected that only in the USA the number of people aged 80 and older will exceed 20 millions by the year 2020. In this population, the most common structural cardiac disease is calcific aortic stenosis, with an estimated prevalence of 20% [17]. This population is probably undertreated, as suggested by data from the EuroHeart Survey which showed that 33% of patients with severe valve disease and severe symptoms are not considered for surgery [18]. This can be the result of the belief that advanced age, with its comorbidities, is an important factor for increased surgical mortality, of scepticism among physicians about the expected gain in quality of life after surgery, of a risk-adverse attitude on the part of surgeons, and of the difficult decision for the patient if there is not enough emotional support from the family.

However, medical management alone is associated with poorer outcomes, the large majority of symptomatic patients dying within three years if not surgically treated. Conversely, in the last few years there has been increasing evidence showing that conventional AVR can be performed in octogenarians with acceptable mortality and morbidity [19, 20]. Thourani and colleagues [21] showed that in patients 80 years and older who had primary AVR, hospital mortality was 5.7%, not significantly different from that of the 70 to 79-year group, although there was a trend toward prolonged ventilator dependence, and intensive care unit and postoperative hospital length of stay. In the older age group, the 5-year survival was 61% and the median survival was 7.4 years. Also, Zingone and colleagues [22] reported that in a group of 355 octogenarians hospital mortality was 9% and 5-year survival was 64.6%.

In these authors’ experience, the observed death rates were significantly lower than those predicted by the Euro-Score, in accordance to the findings of Stoica [23] and colleagues that the EuroScore can significantly overestimate operative risk in octogenarians. This was also reported by Mihaljevic and colleagues [24] in a group of 731 patients identified as high risk, with a mean EuroScore of 9.7%, 50% of whom had a score of 10 or higher. Grossi and colleagues [25] counted 43% septuagenarians and 44% octogenarians, 32% with previous cardiac surgery and 17.4% with cerebrovascular disease. They had a hospital mortality of 7.8% and a 5-year survival of 72.4%. Even in reoperations, the elderly can be treated with good results, as shown by Maganti and colleagues [26] who reported on a group of 112 patients aged 75 years or older who underwent redo-valve surgery, including 30% who had double valve surgery and 30% who required concomitant coronary grafting. Operative mortality was 10% and 5-year survival and event-free survival were 67% and 66%, respectively.

Another important issue is that older age usually means heavily calcified valves with small annuli and, consequently, the use of small sized prostheses with the risk of patient-prosthesis mismatch (PPM), meaning a prosthesis too small for the patient’s size.

In their study of 3,049 patients, Mihaljevic et al [24] found that the deleterious effect of small prosthesis-patient size, was absent in the elderly and that complex operations to insert a larger prosthesis should be avoided. Moon and co-workers [27] reported that PPM affects survival after prosthetic AVR in patients younger than 70 years of age, but not in patients above that age. Vicchio and colleagues [28] also found that in a population of septuagenarians, PPM did not influence long-term outcome and quality of life, compared to the general Italian population matched for age and sex.

CONCLUSION

Currently used prosthetic heart valves have reached a good clinical record of safety, reliability and long-term durability. Aortic valve surgery in the senior population, especially in those older than 80 years, has a reasonably low mortality and results in a good and durable quality of life, which is also cost-effective [29]. Consequently, there is a need for evaluation of the causes for non-referral to surgery, allegedly for high risk. van Geldorp et al identified inadequate classification of the severity of the symptoms and of the disease, and of the surgical indications and results as the main reasons for non-referral [30].

Naturally, thus, the new techniques of transcatheter aortic valve implantation for treatment of severe aortic stenosis should be compared with the results discussed above for the classical surgical approach, since there are pending questions concerning their safety and long-term durability [31, 32].
REFERENCES


