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Introductory Chapter: Heart Valve Surgery – Current Status and Future Directions

Sameh M. Said

1. Introduction

This year marks the 70th anniversary of the first artificial heart valve [1] that was implanted in 1952 by Charles Hufnagel to treat a 30-year-old woman with severe aortic regurgitation [2] in an era where the concept of direct valve repair or replacement did not exist. It is remarkable, how far we have come since then in terms of managing heart valve disease. This is not only in terms of advances in surgical techniques or choice of prostheses for different valve pathology but also in terms of transcatheter therapy and minimally invasive surgical approaches. In the current chapter, we will review briefly, the major milestones in management of different valve pathology in regard to approaches, techniques, and future directions.

2. Aortic valve

2.1 Aortic valve repair

If the aortic valve can be repaired, there is no doubt, this is the number one option for patients. This achieves the best quality of life and freedom from anticoagulation. However, the process of reconstructing the aortic valve is relatively new and is more complex in comparison to the mitral valve, which has much more robust and longer-term data in terms of durability and survival.

Aortic valve repair remains challenging and requires higher level of experience and judgment [3]. Surgeons started to pay attention in the current era to the importance of repairing the native aortic valve, and with the current trend of expansion for the valve-sparing surgery and aortic valve repair, the future of aortic valve surgery is promising.

2.2 Aortic valve replacement

2.2.1 *Transcatheter valve therapy*

Since the introduction of transcatheter aortic valve replacement (TAVR), and the emergence of early favorable results from the TAVR trials showing equivalent mortality and short-term survival to surgical aortic valve replacement (SAVR) [4], this form of therapy has spread widely across the globe. The procedure is no longer limited to transfemoral or transapical access as initially started, but it expanded to include other alternate accesses such as trans-carotid [5], trans-caval [6], and trans-subclavian [7]. This allows providing transcatheter therapy to the highest-risk

population and further participated in its widespread with currently patient rarely get turned down for the procedure because of access limitations or procedural risks.

The procedure was associated with several morbidities in the beginning, particularly access-related, periprosthetic regurgitation and had higher risk of stroke and other neurological events. Many of these early problems have been resolved with improvements in the delivery system, valve design, and the use of cerebral protection devices [8]. One other major advance is the ability to perform these procedures without general anesthesia and in a totally percutaneous fashion with no incisions. This contributed markedly to rapid recovery, shorter length of hospital stay, and quicker return to activity.

TAVR did not stop at the high-risk patients and further expanded to the medium and low-risk populations. Whether this is a good strategy or not, remains to be determined.

2.2.2 Choice of the surgical prosthesis

With the expansion of transcatheter valve therapy, it-without doubt-changed the choice of the prosthesis, even in younger patients with more and more tendency to using bioprostheses, despite knowing the need for repeat operation or repeat interventions.

While the data remains in favor of implanting mechanical prostheses in young patients in terms of survival [9], this did not result in its expansion, and bioprosthesis continues to be number one prosthetic implant in the current era. The On-X® prosthesis (Cryolife Inc., Kennesaw, GA, USA) was utilized on a widescale recently with the goal to use a lower anticoagulation target and may be avoiding standard anticoagulation to provide both a better quality of life and the best durability. The result of the PROACT trial was quite disappointing when the data showed higher risk of adverse events in patients receiving apixaban, and the trial was stopped [10].

Developing a new prosthetic design that is durable and requires low or no anticoagulation will be a key that may change the paradigm in the future in regard to the choice of the valve prosthesis.

2.2.3 Aortic annular enlargement

Recent data showed that there was a trend of placing small aortic prostheses in the previous era, which resulted in higher number of patients experiencing patient-prosthesis mismatch, and need for repeat operations.

With the expansion of transcatheter therapy, data shows that implanting transcatheter valves inside degenerated smaller-size prostheses will result in creating gradient across that left ventricular outflow tract [11]. More emerging data supportive of the negative impact of patient-prosthesis mismatch on survival [12] drew the attention of the surgical community and currently, there are more trends to enlarge the aortic annulus with a variety of surgical techniques to accommodate a large enough prosthesis that will facilitate future transcatheter therapy.

2.2.4 Advances in minimally invasive approaches

With the advent of transcatheter therapy and the obvious advantage of minimal to no incisions needed and the quick return to activities, this stimulated the surgical community to think of alternative accesses to aortic valve repair or replacement. A variety has been pioneered by several centers and expands from robotic [13], to totally endoscopic [14], to minimally invasive right axillary thoracotomy or anterior thoracotomy [15] and upper mini-sternotomy.

While most data do not show major differences between upper sternotomy and right anterior mini-thoracotomy in terms of 30-day mortality [16], it is to be determined, the longer-term data of other minimally invasive approaches in comparison to standard sternotomy.

2.2.5 Ross renaissance

Ross procedure continues to cause debate over the years, however, with more recent and robust data coming out of several institutions across the globe, there has been an upward trend in utilization of the Ross procedure, especially in young adults. Data shows better long-term survival and excellent quality of life in young adults after the Ross procedure [17]. This makes the procedure currently the number one of choice as a replacement option in young adults and those who have an active lifestyle and do not want anticoagulation.

It remains to be determined if this trend will continue especially in the continuing expansion of transcatheter therapy and the technical challenges that are needed for the Ross operation or its repeat interventions.

3. Mitral valve

The progress in mitral valve surgery has been in parallel with aortic valve surgery in terms of the expansion of the minimally invasive approaches and the importance of repairing the valve whenever possible. The choice of the surgical prosthesis has been shifted in a similar manner to the aortic valve with more tendency for bioprosthesis and lower trend for the mechanical ones.

Recently, transcatheter therapy has progressed from being an initial option for degenerated mitral prostheses (valve-in-valve) and recurrent valvular regurgitation (valve-in-ring) to primary interventions in native mitral valve disease. This role of transcatheter therapy has been growing to involve edge-to-edge repair and mitral valve replacement in calcified mitral annulus. Long-term data are needed to determine the appropriate application of these transcatheter therapies.

4. Tricuspid valve

Tricuspid valve has been known for a long-time as the “forgotten valve” as there was a tendency not to address tricuspid valve regurgitation, especially in the settings of left-sided pathology. A misconception that tricuspid regurgitation will improve once the left-sided lesions are addressed, however, time has proven that this is inaccurate and tricuspid regurgitation should be treated at the time of the initial heart surgery. An upward trend that we started to see in the current era due to the negative long-term effects of significant tricuspid regurgitation on survival.

This even expanded to offer tricuspid valve annuloplasty in absence of tricuspid regurgitation but in the presence of the annular dilation to prevent adverse remodeling of the right ventricle and the development of future significant regurgitation [18].

Recently, transcatheter therapy started to play a role in tricuspid valve disease, especially in high-risk patients *via* application of edge-to-edge repair in a similar fashion to the mitral valve or bicaval valve implantation [19] or standard transcatheter valve implantation [20]. Long-term data will be needed to prove the efficacy of these techniques.

5. Future directions

No doubt the current era has witnessed major milestones in both the transcatheter and surgical aspects of valve therapy. This, while provides several options to patients with every valve disease, it also creates confusion on which is the better option. This demonstrates the importance of having a heart valve team with all the expertise available for surgical, both open and minimally invasive, and transcatheter therapy. This should provide the patients and their families with unbiased opinions that suites each individual patient and give them the best option that is good for their expected survival, and desired quality of life and matches their future expectations.

Disclosures

The author S.M.S. is a consultant to Artivion, Abbott, and Stryker.

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