Perspective Article

Quo vadis, Heart valve therapy? (Where are you heading?)

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It was over a hundred years ago that Sir Lauder Brunton, a visionary cardiologist first envisioned surgical intervention for valvular heart disease. The first procedure performed for the relief of heart valve disease was Closed Mitral Valvotomy, which was developed by bold mavericks like Souttar, Bailey and Brock. After several failures, success ensued. The indomitable pioneering spirit of these surgeons is best exemplified by Charles Bailey. His operating authority was revoked in all the hospitals but two, due to multiple failures. To overcome this minor obstacle, he posted simultaneous cases in the remaining two hospitals so that he could operate the patient in the second hospital if things went wrong in the first case. Before the hospital got the news that his first patient died, Bailey rushed to the second hospital and did a successful case, that later became the cornerstone for development of Mitral valve surgery.[1]

The next big development in the surgical management of valvular heart disease was artificial valves. The development of cardiopulmonary bypass gave a fillip to artificial valve replacement in the latter half of the last century. Myriad valves were developed and refined. However, the requirement for oral anti-coagulation with its associated morbidities proved to be an insurmountable problem.[2]

The great French surgeon Alain Carpentier was responsible for developing tissue valves and valve repair techniques that would avoid the complications related to oral anti coagulation. He devised a reproducible model based on pathophysiology of the mitral disease, which is being used by every surgeon till date. Other pioneering surgeons such as Yacoub, David and El Khoury developed techniques of aortic valve repair, that were both durable and reproducible. By the turn of the century, surgical therapy and interventional therapy in the form of balloon valvotomy had been perfected with excellent results.[3]

From closed valvotomies to valve replacements with mechanical as well as bioprosthetic valves and then to valve repairs, minimal access approaches were the subsequent development in the treatment of valve diseases. Conventional sternal splitting approaches to valve surgery offer excellent exposure for valve replacement techniques with good patient recovery. However, sternotomies have their own set of complications. Rare cases of sternal wound infections could be extremely morbid with mutiple surgical procedures and a resultant unseemly scar. Return to normal activities was also slow and cosmesis was not great, particularly important for younger patients. Sternal sparing minimally invasive approaches through minithoracotomies and partial sternotomies have slowly developed to be the choice in many centers, these minimal access approaches have been shown to be safe and can be used in the vast majority of patients.[4]

The trans arterial aortic valve replacement has taken the world by storm and is poised to replace surgical aortic valve replacement as the gold standard. TAVI (trans catheter aortic valve implantation) was developed as a palliative alternative to surgical aortic valve replacement in patients with prohibitive risk. With refinement of technique and catheters and improved collective experience, these procedures can be undertaken in nearly all patients requiring aortic valve replacement. The only prohibitive factor for these procedures is the cost, which can run up to five times the cost of traditional aortic valve replacements.[3]

In the foreseeable future bio-prosthetic tissue valve implanted either surgically or in the cath labs are going to remain the gold standard. The Achilles heel of bio-prosthetic tissue valves is Structural Valve Degeneration and it is being studied and addressed. Improvement in valve design, storage and implantation has improved the durability of these valves. Results from the last 20 years have been extremely satisfying, especially in the aortic position. These tissue valves will continue to be used in the older age group. However, patients below the age of 60 will also be increasingly considered for tissue valves as the feasibility of the valve in valve implantation by TAVI has been shown to be safe and feasible in degenerated valves.[5]

Finally, development of novel therapeutic targets to prevent or regress valve disease are being worked on. Defining the gene expression and various cellular and extracellular factors responsible for initiation and progress of valve disease will lead to developing gene based and drug-based therapy of at-risk patients. This will either halt or prevent disease in these high-risk groups. There have been a growing number of researchers involved in studying the actual disease process at the tissue and cellular level. Improved understanding of the genetic expression and response to hemodynamic stress is possible now with the advent of laboratory bioreactors. New insights have provided greater understanding of the complex cell-matrix interactions responsible for initiation and progression of valve disease. [6]

Recognition of the micro structure of the native valves and their ability to repair and regenerate over a 3 billion cycle lifestyle will allow critical modification in the design of degeneration-resistant tissue valves in the future. Tissue engineering has also progressed to the animal experimentation stage, this maybe the answer to the 'Holy grail', the perfect valve. The perfect valve has been described to be non-obstructive, non-thrombogenic, which will grow with the patient and last a lifetime .[4] Better understanding of the mechanobiology of the valves, cell-cell and cell-extra cellular matrix interaction, as well as their role in initiation and progression of valve calcification will result in development of novel therapeutic targets to prevent or even

regress valve disease. This new understanding will also improve existing tissue valves and provide insights on methods to prevent structural valve degeneration. In the foreseeable future we will have the 'perfect' tissue engineered heart valve.[5,6]

References

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