**Evolution of bioprosthetic valves, where we are heading!**

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Bioprosthetic heart valves are used to replace or repair diseased or damaged heart valves. They are made from animal tissue, such as bovine pericardium or porcine valves, and are designed to mimic the function of a natural heart valve. Bioprosthetic valves remained a valve of choice among elderly patients above 60yrs since long time. Though there are different valves of different generations (According to Manufacturer’s Companies) available for implant in patient’s needing valve replacement. These valves are divided into different generation (1-4th) depending upon durability and development in tissue, their parts over the years1. Now days rapid deployment, polymeric and tissue engineered heart valves are also evolving. Further development is happening to decrease chance of prosthesis- patient mismatch (PPM)2 more durability3,4 and lower valve gradient even at long term.

**Early Development:**

The first bioprosthetic heart valves were implanted in the 1960s1. These early valves were made from porcine valves and were sewn into place during open-heart surgery. However, they were prone to calcification and other complications, and their lifespan was limited.

**The Introduction of Bovine Pericardium:**

In the 1970s, bovine pericardium was introduced as a material for bioprosthetic valves1. This material is less likely to calcify than porcine valves, and it has a longer lifespan. Bovine pericardial valves are now the most common type of bioprosthetic heart valve. Tissue treatment changed over time latest tissue treatment include Resilia4 by Edwards and AOA (alpha amino oleic acid) tissue treatment by Medtronic.

**Other key developments:**

1. Better anti-calcification treatment
2. Future ready for valve in valve and MIS
3. Better sewing ring/stent material/dual stent/Improved design to avoid distortion/stress
4. More chances of upsize in TAVI (Transcatheter aortic valve replacement)5,6
5. Ease of implant/surgeon friendly/One cut release
6. High profile to low profile design
7. Intra-annular to supra-annular design
8. Hart stent to soft stent
9. Larger cuff size to smaller cuff size
10. Wet storage to dry storage
11. Decrease in rinsing time or no rinsing
12. Better anticalcification treatment
13. Future readiness for valve in valve transcatheter procedures
14. Single stent to dual alloy stent
15. Improved design (externally mounted leaflet design to internally mounted leaflet design) to avoid distortion, stress and early leaflet damage7
16. Better effective orifice area and more chances of upsizing during transcatheter procedure (TAVI/TMVR/TPVR/TTVR)
17. Better swing ring and stent material to avoid distortion9

**The Development of Transcatheter Bioprosthetic Valves:**

In recent years, there has been a trend towards the development of transcatheter bioprosthetic heart valves. These valves are delivered to the heart through a catheter, which is a minimally invasive procedure. Transcatheter bioprosthetic valves are still under development, but they have the potential to offer a number of advantages over traditional surgical valves, including shorter recovery times and lower risks of complications.

**The Future of Bioprosthetic Heart Valves:**

The evolution of bioprosthetic heart valves has led to a number of improvements in the treatment of heart valve disease. These valves are now more durable and less likely to cause complications, and they can be implanted using less invasive procedures. As a result, bioprosthetic heart valves have become a valuable option for patients with heart valve disease. Though ongoing research and development is occurring in polymeric, tissue engineered heart valves.

**Current Challenges and Opportunities:**

Despite the progress that has been made, there are still some challenges and opportunities facing the future of bioprosthetic heart valves.

Challenges: -

* Calcification: Calcification is a major problem for bioprosthetic heart valves. It can cause the valve to stiffen and narrow, which can lead to redevelopment of disease.
* Thrombosis: Thrombosis, or the formation of blood clots, is another challenge for bioprosthetic heart valves. Blood clots can block blood flow and cause serious complications (stroke, organ ischemia etc).
* Durability: Bioprosthetic heart valves have a limited lifespan (8-15years). The valves can degenerate over time, which can lead to valve failure.

Opportunities: -

* Tissue engineering: Tissue engineering is a promising field that could lead to the development of new and improved bioprosthetic heart valves. Tissue-engineered valves would be made from the patient's own cells, which would reduce the risk of rejection.
* Polymeric heart valves: Development is happening in polymeric tissue for biological valves. Still more development and in development of ideal tissue is lacking. Singh et al8 had given a review of current technologies and future direction in their review article.
* Transcatheter valves: Transcatheter valves10 are less invasive than traditional surgical valves. This could make them a more attractive option for patients, especially those who are at high risk of complications from surgery.
* Personalized medicine: Personalized medicine is a field that is developing rapidly. This could lead to the development of bioprosthetic heart valves that are specifically designed for each patient. This would improve the chances of a successful outcome.

**Conclusion:**

The future of bioprosthetic heart valves is bright. As research continues, new and improved bioprosthetic valves are being developed. These valves are likely to be more durable, less likely to cause complications, and easier to implant. As a result, bioprosthetic heart valves will continue to be a valuable option for patients with heart valve disease. In future valve in valve11 procedure after few years of implantation of tissue valve can be done safely. More development is needed in search of ideal material, valve design and higher durability. Though initial results of newer generation Edwards and Medtronic tissue valves are promising.

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