

Heart Valves for Congenital Heart Disease Patients

Vathana Ngeth, Biomedical Engineering, University of Rhode Island
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Congenital heart disease refers to any structural or functional defects of the heart present at birth due to problems or abnormalities during development of the heart before birth. It is the most common birth defect affecting 8 out of every 1000 infants every year and the issues cover improper formation of heart walls, main veins and arteries, and valves.

Valves control the flow blood throughout the heart and the most severe is aortic valve stenosis, which is the stiffening, thickening, or a fusion of the valve. This causes narrowing of the valve which can lead to chest pains, poor circulation, and fatigue. The most severe cases requiring valve replacement surgery.

These valves can be biological which are harvested from donors or artificial. Biological valves are more difficult to acquire and have more complications in compatibility so artificial valves are more commonly used. Since the 1950's, over 80 different kinds of valves have been developed using these three basic concepts: the caged ball valve, the tilting disc valve, and the bi-leaflet valve.

The caged ball valve is comprised of a metal cage on a ring base with a silicone elastomer ball inside. The ball moves to the top of the cage allowing blood flow or sits at the bottom of the cage to seal the valve depending on the pressures inside and outside of the heart. This design was first invented by Charles A Hufnagel in 1952 and remade to produce the most famous Starr-Edwards Silastic Ball Valve. This has been discontinued in 2007 due its high rate of thrombi.

Tilting disc valves have disc which opens and closes like a door due to the placement of metal rods across the ring base. The disc moves accordingly to the pumps of the heart.

Bi-leaflet valves have two semi-circular leaflets that rotate about metal struts. These leaflets open and close with each heart pump. This double opening feature allows for more area for the blood to flow.

The base rings of the artificial valves are lined with Teflon material for easier attachment to the heart. This surgery takes 3 to 6 hours on average to complete. Patients that undergo this type of procedure also have a higher risk of infection and must take antibiotics accordingly throughout their life.

Risks that are concerned with mechanical heart valves include a thrombus attaching and impairing the heart valve. Because of this, patients must also take blood thinners for the rest of their lives. The bileaflet has the lowest rate of clots and therefore most preferable. Engineers are testing with different materials like pyrolytic carbon for discs for less degradation over time. This will also help reduce the number of operations in the future. Other techniques for less invasive procedures are also being explored.

References

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