Artificial Heart Valves
as Treatment for Valvular Heart Disease

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Valvular Heart Disease can affect any one of the four valves in the heart: Tricuspid -between the right atrium and right ventricle; Pulmonary - between the right ventricle and the pulmonary artery; Mitral - between the left atrium and left ventricle; and the Aortic - between the left ventricle and the aorta. Valvular Heart Disease has many common causes. It can stem from birth defects, Infective Endocarditis, Rheumatic Fever, heart attack, and calcification of the valves. Infective Endocarditis is an inflammation of the inner layer of the heart (endocardium), and it can also be caused by valvular heart disease. Rheumatic fever develops from strep throat or scarlet fever, and also can cause inflammation of the heart. In elderly patients changes in the structure of the valves can cause them to function improperly.

A defective valve fails to open or close completely. Defective valves result in two possible problems: Stenosis where heart valve can't open completely, so blood is pumped through a smaller-than-normal opening; or Insufficiency (Regurgitation) in which the heart valve can't close completely causing blood to leak back through the valve. These problem cause excess work that can weaken the heart causing it to enlarge and produce various symptoms: chest pain; shortness of breath; dizziness; fainting; chronic tiredness; and swelling of the feet and legs.

Prosthetic (artificial) Heart Valves are available as a replacement for a dysfunctional or diseased valve. There are mechanical or biological (animal) options for replacement. The implantation of valves requires open heart surgery, 1-2 days of ICU (Intensive Care Unit) monitoring, 5-7 days of hospital stay (more if complications occur), and several weeks to a few months recovery depending on health prior to surgery.

The mechanical valves are designed to allow one way flow of blood in the heart
In the case of the Mitral valve for example the Left atrium contracts and the valve will be forced open by blood flow. The left ventricle then contracts as the left atrium relaxes, this contraction closes the leaflets and the blood is forced into the aorta through the aortic valve. Biological valves work in a similar fashion to the mechanical valves, allowing for the one way flow of blood more efficiently than the diseased or damaged existing valve. The one major difference is the materials with which the valves are made of
–The FDA has recently approved a few new designs for valves to be used in the USA. The ATS Open Pivot® Bileaflet Heart Valve which is a mechanical heart valve with two half circle leaflets (flap like structures) made of carbon. The leaflets are surrounded by a ring made of polyester fabric. It is used to replace aortic or mitral valves. The Contegra® Pulmonary Valved Conduit is a bioprosthetic (prosthesis made from biological material) made from a segment of cow jugular vein that is treated with preservatives to keep it durable, flexible, and sterilized for human implantation. The patient's defective pulmonary valve and artery are replaced with the valved conduit. The Edwards Prima™ Plus Stentless Bioprosthesis Model 2500P is a segment of pig aortic artery that contains the pig's aortic valve. The diseased aortic valve is removed and the pig valve is sewn in its place. This surgery is called subcoronary aortic valve implantation. Another is Extremely similar to Edwards Prima™ Plus Stentless Bioprosthesis Model 2500P, it is called the Mosaic Porcine Bioprosthesis. In addition to the valve there is also a stent to support a vessel for regular blood flow. Another mechanical valve is the On-X® Prosthetic Heart Valve, Model ONXA it has two movable half-discs or bileaflets made of graphite and tungsten, with a carbon coating. The Leaflets are held in a housing surrounded by a man-made fabric-covered ring. The fabric is poly-tetra-fluor-ethylene. This particular valve is used to replace the aortic valve. The SJM Biocor™ consists of a small round device with three cusps (pieces of pig tissue that act like one-way doors) mounted in a covered plastic stent that helps keep the round shape.

As more research is done ranges of diameters increase and now range from 15 to 40mm. There is also availability of larger sewing cuffs of fabric around some mechanical devices. There are other advances also such as MRI compatible valves, designed to avoid magnetic interference with valve. Radiopaque valves to provide enhanced visualization on flat chest x-ray. Radiopaque prevents x-rays from passing through device. Extra suture markers for surgeons, adjustable leaflets, torque rotational control that allows for adjustment during surgery, all make the implantation of such devices much easier and more effective for the patient.

The advantage of mechanical valves is that they can usually last a lifetime, however they can increase the risk of blood clots and patients must take blood thinners for the rest of their lives which can result in bleeding inside the body. Biological heart valves may wear out over time and may need to be replaced every 10 to 15 years. As with any surgery there are risks such as: bleeding, development of blood clots, respiratory failure, infection, and device failure.

References

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