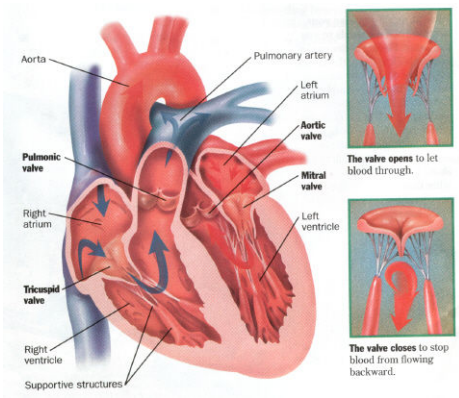
Heart Valve Replacement Surgery



The heart has a right side and a left side. The right chambers are responsible for pumping the de-oxygenated (used and returned) blood from the body to the lungs where the blood will pick up oxygen from the air that we breathe. The left chambers then pump the oxygenated blood from the lungs into the aorta, which is the main artery that delivers the blood to the vital organs through its branches. The human heart has four valves to ensure one way flow of the blood through its four chambers.

In a heart beat, the heart chambers go through a cycle of pumping and filling phases. During the pumping phase, the mitral valve shuts and prevents the backing up of blood into the lungs, and the aortic valve opens to allow the blood to be ejected into the aorta. During the filling phase, the opposite happens; the mitral valve opens to allow the oxygenated blood from the lungs to flow into the heart and the aortic valve closes to prevent the blood in the aorta to back up into the heart.

The diseases of the human valves can render them stenotic (not opening well) or regurgitant (leaky, or not closing well). Most commonly, the mitral valve or the aortic valve or both can be affected with either one of the two patho-physiology.

In the early stages of alve disease, the appropriate regimen of medications may improve symptoms, halt or slow down the progression of the disease. In the advance stages, surgery is often life saving.

Types of valve diseases and the surgical options:

Aortic Stenosis:

This disease occurrs when a heavy build-up of calcium on the valves prevent them from opening adequately. Most commonly, it occurs as part of aging. In younger patients, it is often developed in underlying abnormal valves that the patients are born with (bicuspid), or among immigrants who are more likely to be exposed to rheumatic fever in childhood. The latter is called rheumatic valvular disease. Regardless of the cause, surgery is recommended in the advanced stage when the valve opening area is less than $1cm^2$ for an average size person,. The surgery requires the excision of the diseased valve and a replacement with an artificial or man-made valve.

Aortic Regurgitation:

A leaky aortic valve is typically caused by degeneration due to old age, underlying aneurysm, infection, or acute dissection of the aorta. In certain situations, the defect can be repaired (such as in aortic dissection, endocarditis) and in others, it needs to replaced with a new valve (such as in degenerative disease, and underlying aneurysm).

Mitral Stenosis:

The stenosis of the mitral can be caused only by rheumatic valvular disease, and, therefore, it is mostly seen among the immigrant population. In the very early stage a repair can be performed. If there is no associated regurgitation or leaks, a balloon can be inserted to stretch open the valve without open surgery. This procedure is called "balloon valvuloplasty," which is very successful in experienced hands and may delay the need for surgery for another ten years. Ultimately, all patients with this disease will require surgery in which the valve will be excised and replaced with an artificial one.

Mitral Regurgitation:

The leaky mitral valve can be caused by a variety of associated heart disorders. The more common causes include degenerative diseases, leaflet prolapse, ischemic heart disease, cardiomyopathy, and rheumatic disease. The different disease entities affect the mitral valve differently, although the end result is the incompetence of the valve closure leading to a leakage of blood back into the lungs during the pumping phase of the heart. Surgeons have an armamentarium of surgical techniques and devices that allow consistent and reproducible repair of the incompetent mitral valve. Unlike the other valves of the heart, the mitral valve is most amenable to be repaired. The success of a complex mitral valve program reflects the maturity of the heart surgery center.

In the most advanced anatomical defects, the mitral valve may need to be replaced with an artificial valve.

Artificial Valves used for replacement:

The man made artificial valves can be placed into two categories: (1) **tissue** or bioprosthetic valves, and (2) **mechanical** valves.

Tissue valves are made from treated animal tissues—pigs, cows and horses (porcine, bovine and equine respectively). The advantage of the tissue valves is that they do not require the long-term use of an anticoagulant (blood thinner or Coumadin) which is associated with a small life time risk of hemorrhage. The disadvantage of the tissue valve is that it does not last forever. Depending on the type used and its location, tissue valves are expected to last about ten years. The new generation tissue valves may last another 6-8 years longer. In sum, the tissue valve does not require any long-term medication; however, is has a limited life span. Below is an example of a valve made of bovine pericardium hand sewn to a metal frame, which is covered in cloth material. The outer rim is composed of a sewing cuff for suturing to the patient's heart.

Mechanical Valves

Mechanical valves are not made of any biologic tissue, but are made of all artificial materials. Currently, all the available mechanical valves are made of a very smooth, least thrombogenic material called "pyrolytic carbon." This material has the texture of porcelain. Below is an example of a mechanical valve. The black colored material is pyrolytic carbon, and the white rim is composed of a fabricated sewing cuff for the purpose of suturing to the heart.

In terms of maintenance and life span, the situation is opposite for the mechanical valves to that of tissue valves. They may last a lifetime when proper care is taken. However, the disadvantage of mechanical valves is that they require life long use of an anticoagulant, Coumadin. In addition to the potential bleeding complication of Coumadin, it cannot be taken during pregnancy because of toxicity to the fetus. Because of its longevity, it is usually the valve of choice for the younger patients. Because of its need for Coumadin and its associated risks of bleeding and thromboembolism, it is usually contraindicated for elderly patients and those with a life expectancy of less than 10 years.