Artificial and Biologic Materials for Heart Valve Replacements

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Abstract

Advanced cardiovascular disease may necessitate replacement of one or more of the valves of the heart. Current options for patients include mechanical and bioprosthetic heart valves; the most recent research focuses on tissue engineered heart valve replacements. Factors such as the patient's age and activity determine the optimal valve for the situation. Mechanical heart valves are constructed of a variety of materials including silicone rubber, Teflon, pyrolytic carbon and polyurethane. Bioprosthetic heart valves originate from transplants of xenogenic or cadaveric origin. Tissue engineered heart valves consist of natural or artificial scaffolds seeded with cells; scaffold materials include decellularized tissue, biological polyesters, or collagen. The advantages and disadvantages of each material with respect to essential properties such as biocompatibility and mechanical strength are discussed.

1. Introduction

1.1 Heart Valve Physiology

At the most fundamental level, the heart can be described as a pump whose function is to deliver oxygenated blood from the lungs to the rest of the body. The human heart consists of four chambers: the left atrium, right atrium, left ventricle, and right ventricle. These chambers are connected by four valves: the tricuspid valve, the pulmonary valve, the mitral valve, and the aortic valve (Fig. 1). These valves open and close in sequence to maintain the directional flow of blood. Oxygen-depleted blood returns from the body through the vena cava and enters the right atrium. This blood then passes through the tricuspid valve into the right atrium, from where it is pumped into the lungs through the pulmonary valve. The freshly oxygenated blood reenters the left atrium of the heart and is then pumped through the mitral valve into the left ventricle. From there, the blood exits the heart via the aortic valve and is pumped back into the body [1].