Chapter 17
The Use of Biomaterials in the Field of Cardiology on the Perspectives and Possibilities of Creating a Permanent Total Artificial Heart:
Artificial Organs

D. Kamalakkannan
Gnanamani College of Technology, India

A. Peter Soosai Anandaraj
Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, India

T. R. Vijayaram
Bharath Institute of Higher Education and Research, India

J. Samson Isaac
https://orcid.org/0000-0001-9860-2816
Karunya Institute of Technology and Sciences, India

K. Uma
Sree Venkateswara College of Engineering, India

R. Vijaya Kumar Reddy
Koneru Lakshmaiah Education Foundation, India

ABSTRACT

Loss of organ function, either partially or completely, can cause numerous social and psychological problems. Therefore, the importance of the artificial heart in medicine is evident, since it can help reduce symptoms and prolong the life of patients for a time, offering a better quality of life and later serving as a bridge for heart transplantation. So, would it be possible in real life to safely and reliably develop a permanent total artificial heart that performs all the functions of a biological one? In addition, the growth of nanotechnology and tissue engineering is contributing exponentially to the development of biospecific and mechanically more appropriate materials. It will be possible to create not only a device made of metal alloys, bioceramics, or polymers but also an organ that has the same composition and compatibility as a natural organ. This work aims to present the applications of biomaterials in cardiology, bringing a discussion about the perspectives and possibilities in the creation of a total permanent artificial heart.

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1. INTRODUCTION

The heart has always intrigued man and Aristotle already considered it as the main organ of the human body responsible for the seat of intelligence and the place of formation of animal heat. Soon after came Galen, proposing that veins connected from the liver to the heart allowed the circulation of "natural spirits", vital and psychic, which represented, respectively, nutrition, refrigeration, bodily vivification and sensitivity and thought (Cooper et al., 2004).

These ideas about the functions of the cardiovascular system served as the basis for the English physician William Harvey (1578-1657) to expose, in 1628, a modern view in which the heart is considered a "pump" and is responsible for propelling the blood to all the extremities (Ratner, 2004). With this new vision, improvements on cardiac anatomy began and, in clinical practice, numerous pathological causes that affected the cardiovascular system were discovered (Gonzalez-Lavin & Ross, 1970).

The functional loss of the heart, whether partial or total, can cause the patient numerous psychosocial problems or even death. In major Hollywood productions such as, for example, King Kong in 1986, the primate's biological heart was replaced by a mechanical device that performed the same functions. At that time, it was believed that it was an impossible feat to accomplish. Over the years, with the aging of the population and the search for a better quality of life, a growing increase in investments in research and technology in the area of biomaterials can be seen, which, gradually, is facilitating access to treatments for diseases/ clinical conditions that until then were seen as untreatable.

Currently, it is estimated that around 300 thousand products in the health area are of biomaterial origin and the sectors that most understand the use of these products are the areas of orthopedics, with the development of orthopedic implants, and cardiology (approximately 34.5% of the market) with large investment in equipment and tools such as heart valves, pacemakers, stents, defibrillators, endovascular prostheses and the artificial heart itself; followed by the injury treatment market and ophthalmology (Gonzalez-Lavin & Ross, 1970).

2. BIOMATERIALS

2.1 History

The use of materials to repair the human body is an old idea dating back to ancient civilizations.

4000 years ago, ancient Egyptians used linen threads to close wounds, and in the Middle Ages, Europeans used sutures made from cat intestines. The Incas repaired skull fractures with gold plates and the ancient Mayans created artificial teeth from shells. The first iron teeth created by Europeans dating back to 200 AD were also identified. In the past, fabrics from life forms, manufactured materials (iron, gold, zinc or glass) and all kinds of natural materials (wood, glue and rubber) were used as biomaterials. However, the first attempts to use materials in the body were quite disappointing (Patel & Gohil, 2012).

In the late 19th and early 20th centuries, a number of physicians began to explore how the body reacted to implanted materials through observation in animals, and they reached the general consensus that the body did not adequately tolerate foreign materials. However, these ideas began to change after World War II, where some studies and observations of ex-combatants injured with some projected materials began to demonstrate that certain materials were well tolerated (Patel & Gohil, 2012).