

Artificial Heart Mechanism

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ABSTRACT

The artificial auxiliary heart is a method produced to be used in humans who present with severe heart disease and need to replace the native organ. Its main purpose is to provide patients with waiting for a healthy and compatible heart transplant. In this way the objective was to describe the mechanism of operation of the artificial heart. As a specific goal to address the inherent aspects of the native heart. It used as a research methodology of a bibliographical nature, carried out through the analysis of publications of periodicals made available by electronic means, which contemplated the scientific production on the artificial heart. The results demonstrated that the frequency conditions of the artificial heart take into consideration the adequate pressure and flow, without leaks and good response in the sensors with variation of the pressure. It was concluded that the Brazilian artificial heart, which beats together with the natural heart, can save life of many heart patients who are unable to perform transplantation.

Keywords

Artificial heart, Transplant, Cardiopaths.

Introduction

The Auxiliary Artificial Heart - AAH is an electromechanical device that obtains the heartbeat by alternating the pumping chambers ejections, left and right. It is composed of three subsystems, AAH subsystem, complacency chamber subsystem, and AAH electrical subsystem.

AAH was designed with reduced dimensions to be implanted next to the patient's natural heart, inside the thoracic cavity in a heterotopic form. It is important to emphasize that the functioning of the AAH is synchronized to the natural heart until the latter has its contractility reduced until its full stop [1].

The artificial heart implantation is really complex, it occurs more frequently in countries such as France, Portugal, and Brazil. After the procedure, measures should be taken to avoid tissue trauma, implanted material contamination, and secondary infections.

The artificial auxiliary heart is a method produced to be used in humans who present severe heart disease and need to replace the native organ. Its main purpose is to provide survival time to the patients who are in the waiting queues for a healthy and compatible heart transplant [2].

Heartmate II stands out, this is an implant equipment that assists the blood pumping of patients with severe heart failure - HF. This device is also known as the Mechanical Circulatory Care Device (MCCD) and it also serves as a bridge for transplantation.

Thus, the objective of this article is to describe the mechanism of operation of the artificial heart. The specific goal is to address the native heart inherent aspects.

Methodology**Type of Survey**

Is consists on a bibliographical nature research, carried out through the analysis of journal publications available on the internet, which contemplated the scientific production on the artificial heart.

To analyse the articles, the literature review technique was used, based on the concepts of Mendes; Silveira; Galvão (2008), through six stages of analysis construction: (I) elaboration of a guiding question; (II) search or sampling in the literature; (III) data collection; (IV) critical analysis of the included studies; (V) discussion of results; (VI) and presentation of the integrative review, in order to obtain a better understanding of the theme based on previous studies.

This way, it is possible to say that the literature review searches for evidence that are able to prove a fact in the numerous available

studies. It is emphasized that experimental and non-experimental studies are both accepted, thus presenting a broad methodological approach, which allows a complete view of the phenomenon analyzed.

Problem Formulation

In the first stage of the Literature Review, the delimitation of the objectives and the question that guides this study were established, that question is the same one responsible for facilitating the data collection. Considering the problem reported in the contextualization of the object herein presented, the question raised to guide the research was: What are the scientific evidences about the artificial heart mechanism?

Data Collection

The research was carried out by the published periodicals survey in the electronic bases of data: Latin American Literature in Health Sciences (LILACS), Medline and Scientific Electronic Library Online (SCIELO). To choose the proper articles, the availability of it in full Portuguese language was used as a criterion. This criterion was justified on the theme and its national relevance.

To search the articles, the following descriptors were used: Artificial heart; transplant; cardiopathy.

It should be emphasized that the exclusion criterions used were: the fact that it did not respond to the research and objectives, problems outlined in it or that it was not published in its entirety. 19 articles were selected to compose this study because they were in Portuguese language and in their entirety. Considering all the researches carried out, it was verified that a number of 7 articles were selected to compose this study.

Data Assessment

The fourth step of the Literature Review is a critical analysis of the selected articles. To do so, the data collection instrument used in this study contained data such as: origin country, title of the text, periodical and year of publication, authorship, study objective, methodological approach, type of study, data collection, data analysis, results regarding the elderly life quality, contributions of the walk to the improvement of the elderly life quality, as well as the limitations and study suggestions.

The articles were listed from 1 to 7, randomly, as they were analyzed. During the analysis, data from the data collection instrument were filled carefully article by article, aiming to establish relations between the data and the guiding question of the study herein presented.

Analysis and Data Interpretation

To analyze and interpret the results, the data collection instrument used in the research was observed, as well as the main approaches of the articles, which were grouped into general categories for later analysis.

Results

The articles that were part of this study had their research and

publication carried out in Brazilian territory, therefore, the mechanisms of the artificial heart were studied. When the subject turns to mechanisms of the artificial heart, the Brazilian literature is restricted, as shown in Table 1:

Publication in journal	
IX Latin American Meeting of Scientific Initiation and V Meeting Latin American Graduate Program - University of Vale do Paraiba [7]	1
Brazilian Journal of Cardiovascular Surgery	1
Magnus Domini	1
Arq Bras Cardiol	1
USP-SP	1
Brazilian Society of Cardiology	1
ABRASCO	1

Table 1: Distribution of article by journal. Source: primary research data.

Each study goals that compose this research were also verified and are exposed in Frame 1, also considering title and authorship:

N	Title	Authorship	Goal
1	Preparation of "in vitro" tests in the auxiliary artificial heart (AAH), Configured as a ventricular assistance device (VAD)	Ingrid Solange Sepúlveda Muñoz, Juliana Leme, Jeison Fonseca, Eduardo Bock, Edivânia Wada, Jarbas Dinkhuysen, Paulo Paulista, Paulo Valente, Denys Nicolosi, José Francisco Biscegli, Christiane Davi, Paulo Henrique Paulista, Aron Andrade.	"In Vitro" tests were carried out following the "In Vitro" Research Protocol, in which the following items were observed: the existence of leaks in the bonding; mechanical and electrical operation (noises or failures) and the response capacity of sensors to changes in the fluid pressure.
2	In vitro and in vivo tests with the Auxiliary Artificial Heart (AAH): a new fully implantable and heterotopic artificial heart model	Aron J. P Andrade; Yukio Ohashi; Júlio Lucchi; Denys E Nicolosi; Jarbas J Dinkhuysen; José F Biscegli; Antônio C. F. Arruda; Wagner C. Cunha; Yukihiko Nosé.	Perform tests in vitro, in a simulator circuit of the human circulatory system, aiming to verify the hydrodynamic performance of the AAH.
3	A study of the artificial heart mechanism.	Lucas Gaio, Eduardo Moleirinho and Kauã Bussolin	Investigate how mechanical heart engineering contributes to its functioning.
4	Guideline of Mechanical Circulatory Assistance of the Cardiology Brazilian Society.	Ayub-Ferreira, SM et. al.	The objective is to describe the nursing care given to the patient with Heartmate II® implant in a clinical-surgical hospitalization unit.
5	"Artificial Heart" - The production of nonhuman hearts and their assumptions.	Marisol Marini	The research goal is to reconstitute the development of an artifact called "single or biventricular circulatory assistance device", developed by Brazilian engineers, immersing itself in the controversies present throughout the process.
6	History of Cardiology: Historical Aspects of Hypertension in Brazil.	LUNA, R. L.	Its goal is describe the historical aspects of hypertension in Brazil.
7	Cardiovascular diseases: overview of mortality in Brazil.	CHOR, D. et al.	Avaliar o panorama da mortalidade no Brasil. Evaluate the panorama of mortality in Brazil.

Frame 1: Articles distribution by title, authorship and goal (2019). Source: primary research data.

Discussion

The results demonstrated that the frequency conditions of the artificial heart take into consideration the adequate pressure and flow, without leaks and with a good response in the sensors that capture the pressure variation.

It was seen that the hydrodynamic performance of the AAH is evaluated by modifying the cardiac output as a function of the left preload. The AAH operating at a variable frequency - VF, raises the cardiac output that is caused by the increase of the left preface, demonstrating that there is high sensitivity.

The heart consists in an organ with muscular structure that has the function of pulsing distributing the blood through the body. The heart muscle contracts and relaxes at the same rhythm all the time, when it is overloaded, it is susceptible to the appearance of diseases, mainly, the cardiovascular ones.

Cardiovascular diseases in Brazil have undergone changes in the ways of producing and reproducing in society since the beginning of the last century. Such transformations of political, social, scientific, economic orders and also due to labor relations also change the lifestyles of people today, causing different diseases and also death [3].

In general, cardiovascular diseases present initially with shortness of breath, exhaustion, chest pain, palpitations, swelling and spots on the body. When presenting the symptoms, it is essential to look for a doctor, so that the diagnosis can be given as soon as possible.

Regarding the risk factors for the acquisition of cardiovascular diseases, there are the following ones: age (being more common in people aged between 50 and 60 years), sedentary lifestyle, obesity, family history, type of diet, and quality of life.

According to Luna [4], age, sex and ethnicity, socioeconomic factors, salt intake, obesity, alcohol consumption, smoking, sedentary lifestyle and stress are risk factors for hypertension. Therefore, as the advancement of age the prevalence tends to increase. The combination of risks is more dangerous in places where economic power is lower. The treatment of cardiovascular diseases can be done clinically through medical and pharmacological attention, or even through surgery depending on the clinical case of the patient, either for repair, or as palliative or even for organ transplantation.

The AAH is an electromechanical device, in which the heartbeat is obtained by the alternating ejection of the pumping chambers. The pumping unit - AAH subsystem is composed of two blood pumping chambers with propeller plates and diaphragms, and the energy converter consists of a brushless DC motor.

The first blood pump occurred in 1934, it was developed by the doctor Michael DeBakey, who used the peristaltic pumping principle for continuous blood transfusion [1].

Over the years, surgical techniques have been perfected and

new generations of ventricular assist devices (VADs) have been developed. In the year 1965, Dr. Yukihiko Nosé demonstrated that it was possible to implant a total artificial heart into the pericardial sack of calves. Currently, several types of Total Artificial Heart (TAH) have been developed with some limitations, such as removal from the patient's heart or the TAH control system [1].

The Brazilian artificial heart has advantages compared to other models, such as the fact that surgery is simpler and faster, with the presence of the patient's natural heart, can control the pressure levels contributing to the success of the technique, besides the work of the natural heart ends up being spared in the presence of an artificial heart [5].

The heart developed in Brazil has technology approved by Anvisa, being developed worldwide research on its circulatory assistance. Such technique decreases the mortality in the organ transplant waiting line [2].

Regarding the Heartmate II, it is up to the nursing team to supervise the device, verifying the flow parameters and pump speed. It is important to monitor the load of the battery pair in use, besides guiding the patient and family about the care that should be taken [6].

It was enlightened that an imported heart is much more expensive than the national one, since the Brazilian artificial heart is R\$ 60,000 and the imported one costs an average R\$ 500,000. The artificial heart is placed like a muscular pump that can be removed, replaced and remodelled. Its mechanism is based on the functioning of an organ under normal conditions, with no risk of rejection.

Conclusion

In this work, a study about the artificial heart was made. It was found, during the study, that it was possible to contemplate the objectives of the research. The AAH was mentioned, it was designed with reduced dimensions to allow its implantation from the chest cavity without the removal of the patients' natural heart.

It was also highlighted that cardiovascular diseases are mostly caused by the lifestyle of people in the current days, being intrinsically linked to life habits. So, it is necessary that the individual seek to control blood pressure with rigidity, thus avoiding morbidity and mortality by cardiovascular diseases.

The Brazilian artificial heart, which hits along the natural heart, can save lives of many heart patients who are unable to transplant. The Heartmate device excludes the reference to the anatomical model of the native heart, as it reproduces part of the movements and functions generating a continuous and non-pulsatile flow.

Regarding the study limitations, the number of publications that respond to the objective outlined for this study in relation to the artificial heart mechanism stands out. Thus, difficulties were encountered in finding articles related to this study goals.

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