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Títol de la tesi Transoesophageal Bioimpedance Analysis for the Detection of Graft Rejection after Cardiac Transplantation

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Resum de la tesi (màxim 4000 caràcters. Si se supera aquest límit, el resum es tallarà automàticament al caràcter 4000)

Heart transplantation is currently the best therapeutic option for patients with advanced cardiac insufficiency, as this operation lengthens significantly their lives and improves their quality of life. However, during the first year after the surgery, rejection is found in at least one biopsy in the 70—80 % of the patients. This complication represents one of the principal causes of death during this period. So, detection and early treatment of this syndrome are a fundamental objective in heart transplant programs.

Currently, the gold standard to identify cardiac rejection is the biopsy of the myocardial tissue by means of an intracavitary catheter. This is an invasive method and it is not exempt from morbidity.
Moreover, biopsy is not a perfect method, as it is subjected to sampling error due to the focal character of the rejection inside the heart.

The main objective of this thesis is to analyse if, by performing electrical bioimpedance measurements using a transoesophageal technique, it is possible to evaluate the cardiac rejection condition with the aim of reducing the number of biopsies to undergo in a year.
This study is original because nobody in the past has used transoesophageal measurements to detect rejection and because a model was created in order to simulate such measurements.

For this purpose, we have performed electrical impedance measurements in healthy and transplanted volunteers using a classical 4-electrode method. We inject an alternating current between the distal electrode of the oesophageal catheter and a reference electrode placed on the thorax of the patient and measure the voltage values between the proximal electrode of the catheter and another electrode placed also on the patient's thorax.

To achieve the main objective, we have carried out a series of studies with the following specific purposes:

A Finite Element (Comsol) analysis software was used to evaluate how the measured electrical impedance changes according to parameters different from rejection.

Measurements in five anaesthetized pigs, after the occlusion of the left anterior descending (LAD) artery, have been performed in order to estimate whether a transoesophageal methodology allows to measure a change in the electrical bioimpedance of the cardiac tissue. These measurements ensured us that we can detect a change in the electrical bioimpedance by means of a transoesophageal method.

We have performed bioimpedance measurements in healthy and heart transplanted volunteers to verify if it is possible to detect a rejection condition.

With the Finite Element analysis of the created model, we can affirm that the phases at the frequencies of 100 and 300 kHz are the best estimator for the detection of cardiac rejection. But we have to take into consideration other factors, such as: the effect of respiration, the accumulation of water inside the lungs, and the changes in the weight that could alter the measurement due to an increase of the subcutaneous fat.

The results of the study carried out in transplanted patients confirm the results of the developed Finite Element model. We have demonstrated the effect of the changes of weight and water in the lungs in the transoesophageal measurement. With regard to the viability of the detection of a moderate (3A) rejection, this study is not conclusive due to the low number of 3A cases and to the inter-patient variability of the measurements because of the above-mentioned reasons.

However, we do not dismiss the possibility to detect a rejection condition by means of an intra-patient analysis as long as there are no relevant changes associated to other factors (increase of the patient's weight, lung disorders, etc.) that cannot be detected simultaneously.

Barcelona, 5 de enero 2011

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