Design And Implementation Of A Digital Acquisition And Image Processing Which Allows For The Dosage Of A Drug With Vasodilatation And Vasoconstriction In Muscle Tissue Of The Thoracic Aorta In Vitro.


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Abstract

This study is framed within what is called Bioengineering since this is a study of the thoracic aorta vasoreactivity laboratory guinea pigs, in order to know which drug is best performing vasodilatation or vasoconstriction, but with the use of electrical and electronic integrated so that constitute a system. Based on the scientific study of Robert F. Furchgott (South Carolina, 1916), Louis J. Ignarro (New York, 1941), and Ferid Murad (Indiana, 1936) were the three Nobel Prize in Physiology or Medicine 1998 "for discovering that nitric oxide (NO) can be used to alter the behavior of the arteries and cause artificially increased or decreased blood flow "in various organs of the body. The researchers demonstrated that nitric oxide (NO) helps maintain stable cardiovascular system, protects the heart and stimulates the brain. In addition to inhibiting the contraction of the muscle cells of arteries, promotes dilation of blood vessels, distributes blood, regulates blood pressure and prevents the formation of thrombi (blood clots within a blood vessel, causing thrombosis).

This project has two major phases: in the first phase includes the construction and adaptation of an isolated organ chamber, the second phase of the acquisition system and image processing for evaluation saline through a graphical interface processing images using the Matlab tools for image processing using the Wavelet Transform, through this image processing was successfully visualize the difference between the control sample with Ringer's alone and the respective responses to vasodilatation and vasoconstriction, with acetylcholine (Ach) and KCL, respectively.

Keywords: Aorta, Guinea Pigs, Matlab, nitric oxide, Thoracic, Vasodilatation, Vasoreactivity.

1. Introduction

The present investigation was justified because there is no technical and economic good enough to test vasoconstrictor and vasodilator drugs. Bioengineering provides tools that allow us to assess measure and analyze physical phenomena, chemical and biological agents using techniques and methods to quantify physiological parameters. In our case gives us the ability to determine efficient and effective vasodilatation and vasoconstriction at relatively lower than in the market.

The current measurements are achieved in research laboratories are done manually on a television monitor and changes in percentage of relaxation of aortic ring are recorded by a voltage sensor (Force Displacement Transducer FT 10), which is connected to a Grass polygraph (Polygraph DC Driver Amplifier, which curves graph showing vasodilatation or vasoconstriction according to vasodilatation or vasoconstriction agent is being used for analysis. With the resolution of this problem can get more information that would assist in studies of hypertension and that with this acquisition and digital image processing more information is obtained both numerically and graphically that currently available, and you’re generating information that is not available in the middle, which will also be helpful for future research.

The limitations of the research are referred to the use of an isolated organ chamber and the conditions for in vitro assessment of tissue required in pre-clinical phase of drug development, which studies the therapeutic potential of compounds and studies are carried out chemical-pharmaceutical and biological (bioassay) as well as clinical and commercial phase where you control the quality and quantity of the active ingredients in drugs available on the market. Therefore be possible to develop an appropriate methodology to test the effect of drugs on the smooth muscle of the thoracic aorta of the cardiovascular system, using digital image processing and also the dose-dependent. For this purpose, determine the vasodilatation and vasoconstriction in vitro (thoracic aorta) resulting from stimulation by the different drugs, using digital image processing and also dose-dependent relationship, allowing us to measure the relationship between dose, quality drug (vasoconstrictor-vasodilator) and the responsiveness of the aorta.

Then they must design and implement an isolated organ chamber to maintain the muscle tissue in conditions for in vitro tests, with the respective drugs. Control the flow, temperature of the Ringer saline and drugs through the muscle tissue. Acquiring, storing and processing images captured during the conduct of muscle tissue (thoracic aorta) according to the stimuli applied (as the drugs used; acetyl chlorine or KCL).

The aorta is the body's main artery, comes straight from the heart, the left ventricle and gives rise to all the arteries of the circulatory system. Ends at the level of the fourth lumbar vertebra where it bifurcates to give rise to primitive iliac arteries. Its central or proximal portion known arc or aortic arch, which consists of a transverse ascending and descending another (descending thoracic aorta). The bottom part has a freely available (without pads), but in the transverse the aorta is the first division, it Braqueocephalic Trunk. [2]

It is the largest of our body and is located in the left ventricle and the rest of it out of the arteries. The maximum diameter in adults corresponds to the source (3 cm), decreasing caudal being at 2.5 cm portion of the descending thoracic aorta up to 1.8 to 2 cm in the abdominal portion of it. Fulfills
the important task of regulating blood flow to much of our body, being a body which occupies a transendent work. Traverses a large part of our body as it passes through the abdomen, chest and branches in the area of the pelvis. [2]

One of the main problems that may occur in the aorta is when they close, which makes the passage of blood through her heart goes to the blood vessels. [4]

Thus the arterial wall is composed of three layers:

- **Tunic intima**: Lining the vessel, consisting of endothelial cells (which are in contact with the blood in the lumen). Squamous epithelium-like tissue.
- **Tunic media**: Connective tissue and smooth muscle cells, the adventitia.
- **Tunic external**: Elastic fibers and connective tissue rich in collagen. These give ability to expand and recover.

![Fig. 2: Cross section of an aorta](image)

The vascular endothelium is a simple squamous epithelium that lines the inside of blood vessels and heart chambers facilitating laminar blood flow and preventing the adhesion of blood cells, given its strategic anatomical position between the circulating blood and the wall vessels regulates vascular structure and function. In recent decades, clinical and experimental evidence have shown that the endothelium is an active and dynamic tissue involved in the maintenance of homeostasis in physiological and pathological conditions. Controls many important functions including the maintenance of circulation and blood flow, regulation of vascular tone and remodeling, modulation of adherence of leukocytes and platelets and cells, regulation of the clotting process and inflammatory response. [1]

The endothelium synthesizes several molecules that are crucial for their motor functions and can be released in response to mechanical stimuli, such as flow and frictional forces (shear stress), metabolic conditions such as hypoxia or through receptor-mediated agonists such as acetylcholine. Among the vasodilator include endothelium-derived relaxing factor (in English, EDRF) whose chemical formula is nitric oxide (NO). [1]

Among the vasoconstrictors include endothelin and thromboxane. NO is undoubtedly the most important endogenous vasodilator both physiologically and pathophysiological.

Nitric oxide (NO) is a multifunctional molecule that interferes with the above mechanisms activated after endothelial denudation. NO inhibits the interaction of platelets with the vessel wall, leukocyte activation, the proliferation of CMLV and matrix protein synthesis.

NO is produced by the passage of L-arginine to L-citrulline, by a series of synthases which form a family called NO synthases. To date three isoforms have been identified, which in order of their purification and isolation of DNA were called: NOS I, neuronal tissue constituent (NOSn), NOS II, inducible by cytokines in macrophages and CMLV (NOSi) and NOS III, constitutive endothelial cells (NOSc). In the vascular wall express two isoforms of NOS, the Nose, which is expressed in normal conditions in endothelial cells and NOSi, which is not expressed under physiological conditions in the wall and whose expression in CMLV increases when these cells are stimulated with cytokines or endotoxins. [1]

This research study was used guinea pigs (Cavia porcellus), must take account of ethical considerations and common sense to restrict research on humans. For this reason the use of animal models for the study of “human disorders” has played a critical role in understanding disease processes and, indeed, have been of great value to design and test regimen. A variety of species, vertebrates and invertebrates, have been used for these purposes. Therefore, a laboratory animal is any animal species used for scientific experimentation. [3]

It considers the following minimum requirements for a research study by the biological sample:

- Appropriate genetic and environmental quality (micro-climatic, physical, chemical, housing, nutrition) according to the experiment.
- Experimental situation
- Ethical principles: to avoid unnecessary suffering; replace validated alternatives.

2. Digital Image Processing

The digital image processing can act directly on the visible results of the computation process, both as intermediary steps in the final phase of a project. The image processing is the basis of other strong research areas, image analysis and computer vision, from which are derived indirectly many commonly used tools. These originated mainly on the research of MIT, Harvard and Stanford University in California in the late sixties, in the field of robotics. In Japan developed similar projects among which we cite the PIPS (Pattern-processing Information
For image analysis conventionally refers to the set of techniques and methods to facilitate the automated extraction of the information contained therein. The main purpose would be to reach, more effective computer vision, that is, get a machine equipped with sensors to recognize more or less large fragments of space and objects.

4. Conditioning Subsystem of Isolated Organs
The design of this subsystem started the redesign of the cameras made in previous studies for isolated organs and agents of vasodilatation and vasoconstriction, which were small and inefficient in the recirculation of water. The new camera is connected to the Thermo Regulator parallel redesigned in the Applied Bioengineering Institute which was a Medinge / Sitz freital, which recirculates water at 37.5 ºC by the cameras described above, in order to bring to Bath Mary thoracic aorta, the aorta on hold, called Ringer saline solution, which is used to keep alive the aorta and aortas study on hold, and vasodilatation and vasoconstriction drugs. The subsystem mentioned above is shown in the figure below:

Fig. 2: Conditioning Organs Subsystem
The subsystem shown above is summarized in the following block diagram, this is intended to keep alive the aorta and aortas study pending the duration of the analysis also indicates the entry of oxygen by pressing the respective chambers as well helps to keep them alive for the duration of the analysis, the flow controller which controls the flow of Ringer internally crossing the thoracic aorta. The following figure shows an image of the thermo regulator.

5. Conditioning Subsystem for Image Processing and Analysis
The literature distinguishes two main areas of application. The image processing in order to improve the information so that is understandable by human observers and processing and image analysis, in order to be automatically recognized by specialized computers. Both groups address a wide variety of applications. Medicine, geography, archeology, astronomy, and industry sectors interested in automating tasks performed so far by human beings, are some of the areas pioneered applications in this field. The use of robots with the capacity to recognize ways that may lead to dangerous or difficult tasks in the construction sector is another area where research is being conducted with considerable intensity in recent years. For processing means generates the techniques and methods to enhance an image, somewhat independently of its contents, to facilitate its subsequent interpretation. Typical examples are: the treatment radiographs to highlight areas of interest, photo processing in poor condition to facilitate the recognition of people, processing of images taken from airplanes or from satellites to identify the land or building reliefs significant. In all these cases the techniques are aimed at ridding the image noise caused by interference or correct various distortions of the optical devices that have captured the images or to correct secondary deformities of the objects themselves or the area observed, as in For mapping to generate ortophotoplans.
human beings, are some of the areas pioneered applications in this field. The use of imaging techniques in cartography is one of the areas most directly related to architecture in which remarkable progress has been made.[5] The use of robots equipped with pattern recognition capabilities that can lead to dangerous or difficult tasks in the construction sector is another area in which it is being investigated with considerable intensity in recent years. For processing means generates the set of techniques and methods to enhance an image, somewhat independently of its content, in order to facilitate further interpretation. For image analysis conventionally refers to the set of techniques and methods to facilitate the automated extraction of information contained in them. The main purpose would be to make effective computer vision, that is, get a machine with sensors to recognize more or less large fragments of space and objects.[6]

The characteristic steps in processing and image analysis are:

a) Image acquisition. This requires a set of devices such as traditional cameras, digital cameras, video cameras or scanners, capable of recording information and digitizes it for further processing. They need to boot storage media and basic media handling, communication and image. b) Preprocessing. During this phase, carried out a series of actions that are intended to facilitate further work, actions such as eliminating parasite noise or properly calibrated monochrome and color ranges, contrast and definition of different areas. c) Segmentation. This term encompasses the processes to separate an image into its constituent parts, which entered the domain of analysis and thus, the core of the problems inherent in image processing and walk away from our field of application immediately. However there are points of interest worth stressing that appear to somewhat later. The segmentation of an image in a first stage involves the detection of points, lines and edges. From here you are looking for various procedures; identify continuous edges, borders and regions. Segmentation usually depends on the context of the application that dictates the visual properties of the elements of interest whose detection is sought. The general method is based on the detection of discontinuities and the more general problem stems from the fact that generally (but not always), the discontinuities resulting from significant edges. d) Representation and description. The result of segmentation is an image that, in ordinary cases, will have differentiated between pixels corresponding to pixels corresponding to edges and regions. Again, one or the other representation is most appropriate depends on context. If you are looking for funds to differentiate shapes, such as for buildings on land, the segmentation board is more appropriate. If you are looking to identify material properties, texture features, it is preferable to identify regions. And maybe you need both.[7]

The representation is the basis of the description is essentially a feature selection (feature selection) is enhanced and processed to obtain additional information usually given in numerical form or by specifications about the topology of the image (if it contains holes, the areas that are connected in a certain way, etc.).

e) Recognition and interpretation. From the description of the image is possible to compare data from the data in a database application and appropriate identification tag assigned to different elements.

This allocation process is called "recognition." By "interpretation" refers to the final step of assigning a particular meaning to a set of tagged objects. we can compare the process to recognize letters and words in meaningful sentences. This final phase usually involves having a database in relation to expert systems.

6. Software Development Acquisition and Processing

Biometric software designer needs general information regarding the analysis (specimen used, age of the specimen, vasodilator or vasoconstrictor used, name of investigator), which will be stored in a cell array and the end of the process used to generate the report. You have the option of selecting the imaging mode, which can range from video acquisition devices or directly from image files previously captured with the Software discussed in this research or images captured with other software.

All images are captured with SBAT-ABI are stored as JPG files extension, so you can repeat the analysis using acquisition mode "from file".

![Fig. 3: General Data Interface](image)

According to the mode selected will have to execute the sequence of step by step, so that once completed these step to commence proceedings, it also includes the option to generate a report HTML, for ease of transport or publication.

7. Results

7.1. Results obtained in the process of stabilization with Ringer
The results were standardized or confronted with an object pattern diameter of 2.00 mm, the thoracic aortas of guinea pig had a diameter of 2mm and a length of 2cm, which was kept alive in the isolated organ chamber where achieving stabilize the corresponding tissue under physiological conditions. The Ringer is a special saline their nutrients helpful to keep alive any tissue or cell to a pH of 7.45 and well oxygenated (95% de O₂ y 5% CO₂).

In this case the shots were made every 10 seconds, and then is shown in Fig. 4 in which we have obtained a graph of the ratio of outer diameter in mm versus time in 20 minutes, with a characteristic of living tissue. Given data, Max. 2.8915592mm, Min 2.79591513 mm and 2.84574813 mm.

7.3. Results obtained in the process of vasoconstriction to Potassium Chloride (KCl)

In this case the shots were made every 10 seconds, and then shown in Fig. 6 the response of the thoracic aorta to the interaction of potassium chloride at a concentration of 70 millimolar, for which one has the relationship of the outer diameter in millimeters with respect to time at 20 minutes, with a response characteristic of the tissue vasoconstriction vivo.

8. Table the data obtained and processed to the graphs shown above as the process developed and captured by our system SBAT-ABI.

9. Conclusions

Designed and implemented an isolated organ chamber suitable for the present investigation which kept the muscles of the thoracic aorta under conditions suitable for in vitro testing (Ringer) with the respective drugs.

The isolated organ chamber was provided by flow controllers, temperature of the Ringer saline and drugs through the muscle tissue and the respective control bath.

We generated software for acquisition, storage and processing of images captured during the behavior
of muscle tissue (thoracic aorta) according to the stimuli applied (as the drugs used, acetyl choline or KCL).

Having a greater amount of information was obtained numerically and graphically understands the behavior of the thoracic aorta compared with vasodilator and vasoconstrictor agents used. As demonstrated with tools generated in the MATLAB development environment can be measured vasoconstriction and vasodilatation of the thoracic aorta.

With the results obtained from the processing of data and images found again that acetylcholine is a good vasodilator and KCl fulfills its function as a vasoconstrictor.

10. References


