Annals

I Workshop on Biomedical Engineering UFABC

March 8-9 th, 2023

São Bernardo do Campo / SP

CATALOGAÇÃO NA FONTE
SISTEMA DE BIBLIOTECAS DA UNIVERSIDADE FEDERAL DO ABC

W919I

I Workshop de Engenharia Biomédica – UFABC (2023)
Anais do I Workshop de Engenharia Biomédica - UFABC [recurso eletrônico] / organização de Christiane Bertachini Lombello, Patricia Aparecida da Ana, Tiago Ribeiro Rodrigues... [et al.] — São Bernardo do Campo, SP: Universidade Federal do ABC, 2023.

133 p. : il.

Modo de acesso: internet.

Evento online realizado entre os dias 08 a 09 de março de 2023, pelo Programa de Pós-Graduação em Engenharia Biomédica da UFABC (PPGEBM-UFABC).

ISBN 9786557190562

1. Bioengenharia – Congressos. 2. Biomecânica. 3. Materiais biomédicos. 4. Tecnologias da Saúde. I. Lombello, Christiane Bertachini (Org.). II. Ana, Patricia Aparecida da (Org.). III. Oliveira,Tiago Ribeiro (Org.). IV. Título.

CDD 22 ed. – 610.28

Elaborado por Ana Letícia Olímpio da Silva David – CRB-8/10431

I Workshop on Biomedical Engineering - UFABC

The UFABC Graduate Program of Biomedical Engineering celebrated 11 years of existence with its first Workshop. The meeting was held virtually, organized from UFABC Campus at São Bernardo do Campo, SP, Brazil, on march, 8-9, 2023. There were 554 listeners inscribed to attend the meeting, and 62 expanded abstracts submitted and presented in 8 scientific discussion rooms. The participants were mainly from UFABC, but also from different Brazilian states. The abstracts were revised by the Organizing Committee, and the content is of author´s responsibility. All authors were advertized that the abstracts would be published with Institutional ISBN and divulgated open source. This publication summarizes the topics addressed at the event which covered the different axes of biomedical engineering. We pretend to share this knowledge with the scientific community through this Annals.

For further information please contact us:
Biomedical Engineering Graduate Program – UFABC
Site: https://ebm.ufabc.edu.br/
E-mail: ppgebm@ufabc.edu.br
Worskhop E-mail:ppgebm@gmail.com

Organizing Comitee

UFABC Professors:

Christiane Bertachini Lombello
Patricia Aparecida da Ana
Tiago Ribeiro de Oliveira

UFABC Masters Degree Student

Daniel Cavalcante de Oliveira
Elisabete Aparecida Ribeiro Jose
Gustavo Pinheiro
Jéssica Costa e Silva
Karin Moreira Santos
Patricia da Silva Souza

Abstract Evaluation Comitee - UFABC

Christiane Bertachini Lombello
Patricia Aparecida da Ana
Sônia maria Malmonge
Tiago Ribeiro de Oliveira

INDEX

ROOM 1

ROOM 2

The expandend abstracts are organized by each presentation **ROOM** during the event.

ROOM 7

ROOM 8

UFABC

Expanded Abstracts

I Workshop on

Biomedical Engineering

UFABC

2023

Characterization, sample preparation and comparative analysis of interaction between cells and biomaterials.

MORAES SG[1], LOMBELLO CB[1], FILHO TGL[1], ANA PA[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*sofiagdemoraes@gmail.com

Keywords: Biomedical Engineering, Biomaterials, Sample preparation, Bioimaging.

Introduction

Biomedical engineering is a multidisciplinary area in which the objective is to apply engineering knowledge in the areas of health. For this, one of the approaches is the creation of biomedical devices for diagnostic, monitoring and/or therapeutic purposes [1, 2]. Biomaterials are an instrument for the construction of these devices, and the evaluation of their performance, as well as their effects on a biological system, is an important step towards their future application. For such an evaluation, sample preparation is a fundamental step. This work intends to show different forms of sample analyses aiming at the evaluation of biomaterials and their interaction with cells, through different bioimaging techniques, as well as reporting their results [3, 4]. For this, various methodologies of cell interaction assays with biomaterials will be used for bioimaging. In this sense, it will be possible to evaluate which forms of sample preparation and which processing methodologies will be more compatible and efficient according to the desired practical application, as well as the understanding the cell-biomaterials relationships. For the analysis of these samples, bioimaging equipment available at the Central Experimental Multiuser of the Federal University of ABC (CEM-UFABC) will be used, through various techniques, such as light microscopy, optical coherence tomography, fluorescence, spectroscopy, among others.

Materials and Methods

Vero cells [5] will be inoculated onto PLLA ((poly(lactic acid)) samples. The cultures will be maintained with HAMF10 serum, supplemented with 10% fetal calf serum and antibiotics. The cultures will be incubated for 7 days at 37ºC and 5% CO_2. From samples of biomaterials with Vero cell culture, they will be analyzed in light microscopy techniques (phase contrast, bright field), fluorescence microscopy, cryostat (coloring and fluorescence), electron microscopy scanning and optical coherence tomography.

Results and Discussion

The expected results from the activities carried out, will be demonstrated the various techniques of sample preparation, its advantages, disadvantages and its particularities.

Thus, it will be defined which are the best techniques for targeted studies, thus helping to aid future research with similar materials. More specifically, the intention is to know if what is the best type of sample preparation for the equipment used in order to a good quality result.

Conclusions

The results of this work will contribute to the understanding of the operation of the equipment available by CEM-UFABC, as well as to a better understanding of sample preparation methods and various sample analysis techniques. Consequently, it will lead to a better understanding of the regenerative capabilities of biomaterials and their technological applications in biomedical engineering, thus improving their functions and practical uses.

Acknowledgment

The authors would like to acknowledge the UFABC's Multiuser Experimental Centers (CEMs) for technical support.

References

1 Zhang XY. Biomedical engineering for health research and development. Eur Rev Med Pharmacol Sci, 19(2):220-224. 2015.
2 Pires ALR, Bierhalz ACK, Moraes AM. Biomateriais: tipos, aplicações e mercado. Quim Nova 38(7):957-971. 2015.
3 Marin E, Boschetto F, Pezzotti G. Biomaterials and biocompatibility: An historical overview. J Biomed Mater Res A 108(8):1617-1633. 2020.
4 Othman Z, Cillero Pastor B, van Rijt S, Habibovic P. Understanding interactions between biomaterials and biological systems using proteomics. Biomaterials 167:191-204. 2018
5 Ammerman NC, Beier-Sexton M, Azad AF. Growth and maintenance of Vero cell lines. Curr Protoc Microbiol. 2008 Nov;Appendix 4:Appendix 4E.

Scaffolds on bones tissue engineering: bibliographic review

WAUKE AM[1]*, LOMBELLO CB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*m.wauke@aluno.ufabc.edu.br

Keywords: Bone Tissue, Bone Regeneration, Scaffolds, Tissue Engineering.

Introduction

There are several factors responsible for bone tissue commitment. Significant bone loss can be a result from severe accidents, risk sports trauma, surgical made failure, as in the case of tumor resection, pathologies, among others. Bone tissue can repair itself in response to some injury or surgical treatment, the fracture histodynamics, however, in cases of significant bone mass loss, the natural regeneration becomes insufficient to restore the bone integrity, often needing the use of grafts to supply this missing bone mass [1]. In many situations, the replacement of bone occurs though specific surgical techniques. Nevertheless, even though the grafts have been improved in the last decades, they are still limitations to be considered, such as irritation, inflammation and/or rejection of the implant [2]. The present work approaches basic concepts and techniques for bone tissue regeneration, focusing on scaffolds used for bone grafts , different biomaterials, which could be from natural origin or synthetic, and production techniques, such as electrospinning and 3D printing.

Materials and Methods

This study is based on a narrative literature review. The first step corresponds to the research theme delimitation, guiding the keywords of the bibliographic search and the databases Scielo, PubMed and Google Scholar, followed by the location and selection of published articles, and obtaining a critical evaluation and interpretation of results. Finally, it was applied inclusion criteria such as: scientific journal articles, annals of scientific events, final papers and clinical applications which were available electronically in english or portuguese and were published in scientific databases after the year 2000.

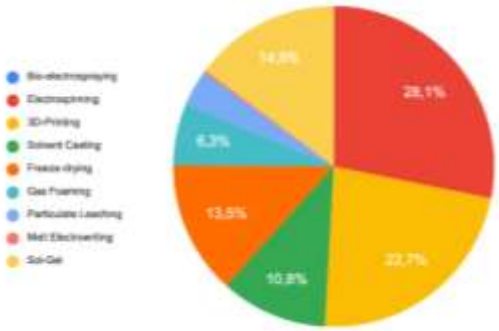
Results and Discussion

Currently, there are several approaches to treating tissue defects. Regenerative medicine aims to rebuild bone tissue from scaffolds like based on scaffold grafting. Scaffolds must be biodegradable, biocompatible, have osteoconductive, osteoinductive and osteogenic properties. Besides, it's It is expected that this will promote an adequate nutrient exchange, provide vascularization and bone ingrowth and have

porosity with dimensions between 100 and 500 µm. The most used biomaterials are natural and synthetic polymers, such as collagen, chitosan, and ceramic biomaterials, such as calcium fosfate and hydroxiapatite [3].

Also, different manufacture techniques of scaffolds can be used together. By analyzing the total number of articles found on the databases early mentioned, it was possible to verify the popularity of each technique among researches (Figure 1).

Figure 1. Techniques for bone scaffold production.



Font: Autor, 2022.

The electrospinning and 3D-printing techniques were identified as the most sought and currently used. Also, it was also possible to analyze the popularity of electrospinning until mid-2017, and them a development of 3D printing.

Conclusions

This review included some data on bone grafting, including biomaterials and manufacture techniques. The biomaterial selection and scaffolds production technique must be carefully considered. In this review, important aspects were shown about the application of scaffolds for human bone tissue regeneration, a subject which is gaining popularity among researchers of tissue engineering areas.

Acknowledgment

The authors thanks UFABC for the scientific support.

References

1 SANTOS AR, LOMBELLO CB, GENARI SC. Technologies applied to stimulate bone regeneration. Tissue Regeneration – From Basic Biology to Clinical Application, 2012.
2 RIESTER O, BORGOLTE M, CSUK R et al. challenges in bone tissue regeneration: stem cell therapy, biofunctionality and antimicrobial properties of novel materials and its evolution. Int J Molec Sci 22:1-25. 2021.
3 GIRÓN J, KERSTNER E, MEDEIROS, T. et al. Biomaterials for bone regeneration: an orthopedic and dentistry overview. Braz J Med Biolog Res 541-15. 2021.

Cardiac tissue engineering: literature review

CRUZ ACE*[1], LOMBELLO CB[1]

Affiliation: [1]Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*ana.estevao@aluno.ufabc.edu.br

Keywords: Cardiac Tissues, Tissue Engineering, Cardiovascular Diseases, Biomaterials, Scaffolds

Introduction

The heart is the organ that pumps blood to the lungs and from the rest of the body to to oxygenate tissues and organs and remove carbon dioxide waste. According to the World Health Organization (WHO), cardiovascular diseases are one of the leading causes of death in the world [1]. With the aging population and the difficulties of organs transplantation, the use of tissue engineering techniques appears as an alternative to enable the treatment of a greater number of patient affected by heart disease. This project addresses cardiac tissue engineering (TE), an area that brings together biomedical, biotechnological, and engineering techniques for the maintenance, regeneration, or replacement of tissues or organs. The positive interaction with the biological system replaces the tissue or improves its regeneration. In obtaining cardiac grafts one must consider the material for the scaffold, the cells and inductive biomolecules [2]. The biomaterials and routes of scaffold production, the type cells applied and respective culture systems, and biomolecules may impact the final result. In this review, the main possibilities to achieve promissing cardiac tissue engineering (TE) were addressed.

Materials and Methods

This work used the methodology of narrative review to analyze the main techniques of cardiac TE in order to analyze and group data on the main applications, biomaterials and techniques in this area [3].

Results and Discussion

Considering biomaterial selection to produce cardiac TE scaddolfs it must be considered the biocompatibility, biodegradability, mechanical properties and porosity. Some biomaterials most commonly applied are polystyrene, poly-L-lactic acid (PLLA), polyglycolic acid (PGA) and polylactic glycolic acid (PLGA), polyurethane, collagen, alginate-based substrates, and chitosan [4]. Composite materials seek a balance between the benefits of each material, and are also used for cardiac TE scaffold .

Among the techniques to create grafts to be implanted in the heart the most recent and promising are electro spinning and rotofiation, together with cell layer engineering [2]. Decellularization of cardiac muscle to create a whole bioartificial organ by recellularization, has also been cited by several authors [5].

Among the cell types used in the grafts there were cited adult, fetal, and neonatal cardiomyocytes; skeletal myoblasts; bone marrow-derived stem cells (mesenchymal, endothelial, and hematopoietic stem cells); embryonic stem cells; smooth muscle cells; adipose tissue-derived stem cells; cardiac stem cells; and induced pluripotent stem cells (iPSCs) [6]. *In vitro* culture of growth factors supplementation and other culture standards such as time, culture media composition, optimal oxygen and nutrient supply directly impact the quality of cardiac TE [7].

Conclusions

Based on this review, the main points to be considered when replacement of cardiac tissue are the scaffold, cell type and culture system, including induction factors. For each case, the best options must be analyzed according to the need and availability, but the advances of recent years points out to the use of ET for cardiac replacement.

Acknowledgment

The authors thanks UFABC for the research support.

References

1. World Health Organization (WHO). World Health Statistics 2021: monitoring health for the SDGs. Geneva: WHO; 2021. Available at: https://apps.who.int/iris/bitstream/handle/10665/342703/9789240027053-eng.pdf. Accessed in 04/24/2022.

2. Rodrigues IC, Kaasi A, Maciel FR, Jardini AL., Gabriel LP. Cardiac tissue engineering: current state of the art regarding materials, cells and tissue formation. Einstein (São Paulo),16(3):1-9. 2018.

3. Rother ET. Systematic review X narrative review. Acta Paulista de Enfermagem [online], 20(2):v-vi. 2007.

4. O'Brien FJ. Biomaterials & scaffolds for tissue engineering. Materials Today, 14(3):88-95. 2011.

5. Augustine R *et al*. Stem cell-based approaches in cardiac tissue engineering: controlling the microenvironment for autologous cells. Biomedicine & Pharmacotherapy, 138: 111425. 2021.

6. Boroumand S *et al*. Review Insights In Cardiac Tissue Engineering: Cells, Scaffolds, and Pharmacological Agents. Iran J Pharm Res, 20:467-496. 2021.

7. Hirt MN. *et al*. Cardiac Tissue Engineering State of the Art. American Heart Association Circulation Research, 114(2):354–367. 2014.

Optimization of orthopedic devices: proposal of bioinspired composite based on trabecular bone microstructure

PEREIRA ACDN[1,2], GRANDFIELD K[3], TITOTTO SLMC[1,2]*

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] 4D Printing and Biomimetics (4DB) Research Group, Santo André/ SP, Brazil
[3] McMaster University, Hamilton, Ontario, Canada.

* silvia.titotto@ufabc.edu.br

Keywords: Bioinspired Composites, Orthopedic Prosthesis/Implants, Trabecular Architecture, Osseointegration, Structural Optimization.

Introduction

Poor osseointegration usually leads to implant loosening. This represents a significant challenge to the medical community as it requires complex and expensive revision surgeries. Stress shielding is one of the main causes of implant failure and is triggered by a significant difference in the elastic modulus of the metal scaffold compared with the surrounding bone tissue [1]. Therefore, structural strategies have been explored in recent years to overcome this issue [2]. Research has shown that the optimal design of bone scaffolds should mimic bone structural characteristics from the nano-to macro-level [3]. Therefore, we aimed to assess the suitability of trabecular bone structure bioinspired strategies for the development of bioinspired composites for orthopedic applications. Moreover, we investigated the Bone-Implant Interface of implants manufactured through Additive Manufacturing to better understand the osseointegration phenomenon.

Materials and Methods

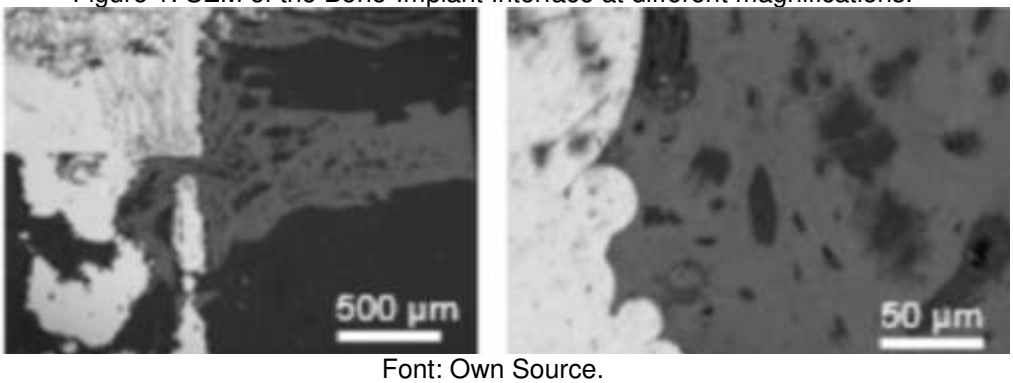
An extensive literature review on biocompatible orthopedic devices and trabecular bone microstructure was conducted. Moreover, we used the Representative Volume Element (RVE) strategy to design lattice structures using the student version of ABAQUS software at a low computational cost. Models to simulate the mechanical performance of structures under load-bearing conditions via Finite Element Analysis (FEA) as well as the overall conceptualization of the composite are currently in progress. Scanning Electron Microscopy (SEM) activities were performed at the Canadian Center for Electron Microscopy. The samples consisted of gyroid implants implanted in rabbit tibiae. Backscattered electron (BSE) images were acquired using a JEOL 6610 LV microscope. Parameters: 10kv, SS 50.

Results and Discussion

Data analysis enabled the identification of the trabecular bone as a promising biomimetic tool. Furthermore, lattice structures are considered suitable for biomedical applications owing to their light weight, resistance, and energy-absorption

characteristics. Porous lattice structures are an interesting alternative for the design of composites that can be implemented in orthopedic implant design. It was possible to extract ideal bone parameters under specific load-bearing conditions that could be used for simulation purposes. The overall performance of orthopedic implantable devices is mainly influenced by osseointegration at the bone-implant interface, biocompatibility, mechanical properties of the surrounding bone and the designed scaffold, and specific material properties, such as high corrosion resistance. Through SEM, we identified osseointegration spots and their relationship with the formation of new bone. Understanding bone remodeling is the key to improving osseointegration.

Figure 1: SEM of the Bone-Implant Interface at different magnifications.



Font: Own Source.

Conclusions

The outcomes of this study can potentially contribute to the development of customized bioinspired composites, as biomimetic translation also depends on the overall knowledge of structure-function relationships and bone response to implants manufactured by AM.

Acknowledgment

The authors would like to acknowledge funding from the São Paulo Research Foundation (FAPESP), grants #21/11702-2 and #22/04536-1. We would also like to thank the support of the Grandfield Research Group and the 4DB Printing and Biomimetics Research Group.

References

1 Zou, S, Gong, H, & Gao, J. Additively manufactured multilevel voronoi-lattice scaffolds with bonelike mechanical properties. ACS Biomat Sci & Eng, 8.7:3022-303. 2022.
2 Wang, X, Xu, S, Zhou, S, Xu, W, Leary, M, Choong, P, ... & Xie, YM. Topological design and additive manufacturing of porous metals for bone scaffolds and orthopaedic implants: a review. Biomat, 83:127-141. 2016.
3 Gómez S, Vlad MD, López J, & Fernández, E. Design and properties of 3D scaffolds for bone tissue engineering. Acta biomat, 42:341-350.2016.

Induction of the skin regeneration process: bibliography review and gelatin biomaterial biological evaluation

NEVES CK[1*], LOMBELLO CB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[*]carolina.kafka@aluno.ufabc.edu.br
Keywords: Tissue Engineering, Biomolecules, Skin, Collagen, Cell culture techniques.

Introduction

Although skin healing is an innate process of the human organism, there are some adverse scenarios that cause the interruption of this healing and regenerative course, such as external traumas and pathologies. As a consequence, the wounds originated can evolve to the chronic stage, for instance, infections and injuries in the region of the foot of diabetic patients, known as ulcers. Therefore, there is a need to resort to biomaterials, biomolecules or cellular therapies based on tissue engineering to induce the skin regeneration. Despite the advances in the area, the lack of the biomaterials and cellular therapies with affordable cost to the skin regeneration in critical cases encourage various studies. Thus, this project had the objective to present a bibliography review about biomaterials and biomolecules that act to assist in the healing process and regeneration of chronic wounds in the skin tissue. Furthermore, carried out cell culture experiments about biomaterials of hydrolyzed collagen, analyzing the cytotoxicity and the proliferation [1][2].

Materials and Methods

The bibliographical review of biomaterials and biomolecules that act to assist in the healing process and regeneration of wounds in the skin tissue was handled in the main scientific databases, Scielo, Pubmed e Google Academic.

Cell culture experiments were based on hydrolyzed collagen, Hemospon® during a period of up to 7 days, with analysis of cytotoxicity and cell proliferation, with scanning electron microscopy.

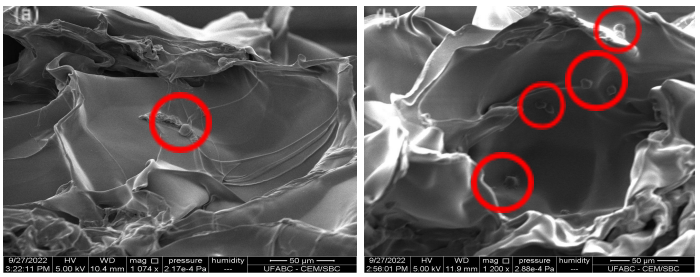
Results and Discussion

The skin represents the bigger organ in the human body. This organ is composed for three layers: epidermis, dermis and hypodermis. Certain conditions, pathological or traumatic, are capable of causing the manifestation of skin wounds, which makes the individual affected susceptible to infection. When this happens, the organism initiates the healing process, which is subdivided in three complementary phases: inflammatory, proliferative and maturation [3][4].

The collagen is one of the most abundant proteins produced by the human organism. There are approximately 28 different types of collagen, but collagen type I and type III are the most significant for the skin, once they are the main components of

the dermis. Nevertheless, hydrolyzed collagen is more beneficial for biomedical purposes, especially for the development of biomaterials, because of its biodisponibility and biocompatibility, beyond the properties of the hydrolyzed protein. In the biomedical industry, we can find the bioproduct Hemospon®, from Technew company, which is a hydrolyzed collagen sponge that can be used as a scaffold for cell culture [5][6]. The Hemospon® cytotoxicity assay carried out with Vero cells did not demonstrate any cytotoxic response. In addition, the cell proliferation assay showed a mitogenic process during the 7 days of experiment onto biomaterial surface (Figure 1).

Figure 1: Vero cell (→) (a) after 2 days; (b) 7 days. Scanning electron microscopy.



Conclusions

The concepts addressed in this project served as the basis for the search for new technologies that can assist the skin wound healing. Facing the formation of injuries and complications of the regeneration process, the hydrolyzed collagen shows as a great alternative for the tissue engineering, acting as a scaffold for the restructuring process of the dermis, besides the stimulation of migration of mitogenic cells.

The use of the Hemospon® is convenient because of the substances that can be combined with the sponge, such as growth factors, that can stimulate the natural production of collagen in the organism. Therefore, this bioproduct did not present any cytotoxicity to the *in vitro* environment and did not intervene in the cell proliferation process. Hence, the treatment of chronic wounds can be optimized and the quality of life of the patient can be restored.

Acknowledgment

I am extremely grateful for the Tissue Engineering and Biomolecules UFABC research Group for the support. I would like to thank UFABC for the undergraduate research scholarship and for the structure available for the development of my project, and the facility support provided by Central Experimental Multiusuário of the Universidade Federal do ABC (CEM-UFABC).

References

1 Barbanti SH, *et al*. Polímeros Bioreabsorvíveis na engenharia de tecidos. Polímeros: Ciência e Tecnologia, v. 15, n. 1, p.13-21, 2005.
2 Leal EC, Carvalho E. Cicatrização de feridas: o fisiológico e o patológico. Revista Portuguesa de Diabetes, v. 9, n. 3, p. 133-143, 2014.
3 Junqueira LC, Carneiro J. Histologia Básica - Texto e Atlas. São Paulo: Grupo GEN, 2017.
4 Vig K, Chaudhar IA, Tripathi S, *et al*. Advances in Skin Regeneration Using Tissue Engineering. Int J Mol Sci, v.18, n.4, p.789, 2017.
5 León-Lopez A; *et al*. Hydrolyzed Collagen-Sources and Applications." Molecules (Basel, Switzerland) v. 24, n. 22, p. 4031, 2019.
6 Shoulders MD, Raines RT. Collagen structure and stability. Annu Rev Biochem. V.78, p:929-58, 2009.

Estimation of the center of pressure during quiet standing using kinematic data from markers on the hip

VANZINI FS[1] , WATANABE RN[1*]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*fernanda.vanzini@aluno.ufabc.edu.br

Keywords: Biomedical Engineering, Postural control.

Introduction

During quiet standing, the variable typically measured is the center of pressure, which requires expensive equipment like a force plate to obtain. It would be interesting to estimate the center of pressure (COP) from easily obtainable signals, such as devices that can be placed on the wrist or hip. Therefore, this study proposes a method to estimate the center of pressure during quiet standing from a kinematic measurement of a point on the hip obtained during this task.

Materials and Methods

The investigation of human upright posture was based on publicly available data from a study [1] that utilized a platform to measure the reaction forces of a stationary body. The study focused on 49 subjects who remained on the platform for 60 seconds.

The data processing was performed using computer programs written in Python using the Numpy and Scikit-learn libraries.

The estimation method was based on the well known expression [2] used to estimate the center of pressure from the center of mass of the subject:

$$\hat{COP} = h_b * sin[\theta_A(t)] + \frac{J_b}{m*g} * sin[\theta_A(t)] * (\dot{\theta}_A(t))^2) - \ddot{\theta}_A(t) * \frac{J_b}{m*g} * cos[\theta_A(t)]$$

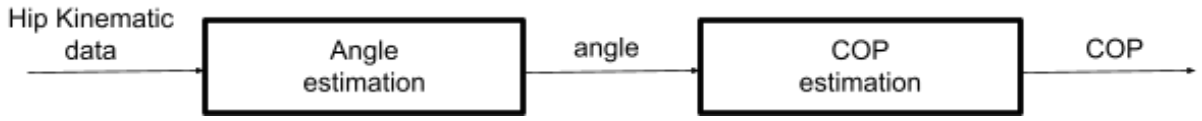
Where J_b is defined by:

$$J_b = \frac{4}{3} m_b h_b^2$$

And θ_A is the angle formed between the line linking the ankle and the center of mass and the ground.

The proposed method consists of estimating the angle θ_A from the kinematic data from a marker on the hip.

Figura 1 - Block diagram of the proposed method.



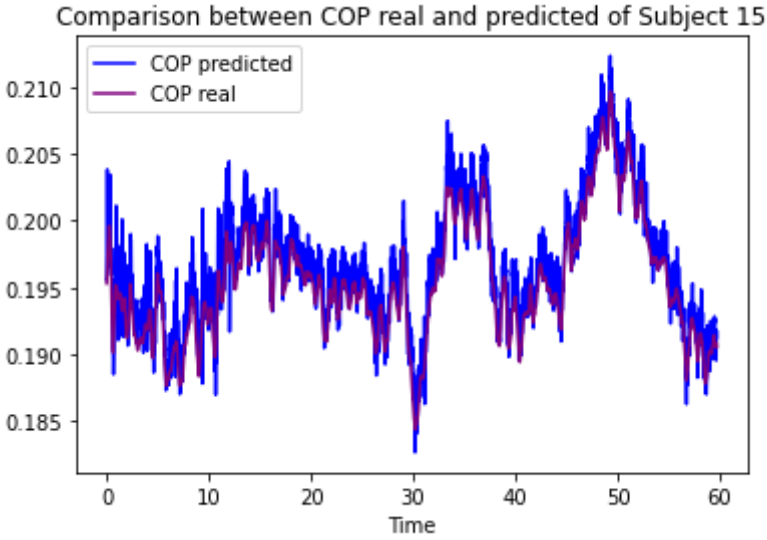
Font: own authorship.

The estimation of the angle θ_A was performed using multi-regression methods.

Results and Discussion

The example below is an estimation of the center of pressure during quiet standing. It has the same shape of the measured signal but presents some high-frequency components that must be removed in the future.

Figura 2 - Example of center of pressure estimation and the real center of pressure.



Font: own authorship.

Conclusions

The results are preliminary and can be further improved.

Acknowledgment

This work was funded by CAPES (164665/2021-8).

References

1 dos Santos DA, Fukuchi CA, Fukuchi RK, Duarte M, A data set with kinematic and ground reaction forces of human balance. PeerJ, 5:e3626 https://doi.org/10.7717/peerj.3626.2017.
2 Peterka RJ, Postural control model interpretation of stabilogram diffusion analysis. Biol Cybern, 82(4):335-43. doi: 10.1007/s004220050587. PMID: 10804065.2000 Apr.

Effects of photobiomodulation therapy in hippocampal cell death and neuroinflammation

ALVES G[1]*, TAKADA H S[2], KATO IT[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Federal University of ABC (UFABC), Center for Mathematics, Computing and Cognition (CMCC), São Bernardo do Campo/ SP, Brazil

*a.gabriel@aluno.ufabc.edu.br

Keywords: Photobiomodulation, Neuroinflammation, Neurodegenerative diseases

Introduction

There is a growing interest in studying photobiomodulation (PBM) in the nervous system. Researchers seek to determine the conditions for applying this phototherapy in various neurodegenerative and psychiatric diseases, as well as cognitive decline processes. In this application modality, PBM is performed with radiation in the red to near-infrared wavelength range, due to its greater tissue penetration capacity [1].

PBM is a therapy that uses light (laser or LED) to modulate tissue and cellular biological processes. This therapy provides tissue regeneration, analgesia, and modulation of inflammatory processes. PBM is widely applied in various tissues, such as skin, bones, muscles, and nerves, and has been studied in various comorbidities as a form of treatment or as an adjuvant therapy. The therapy is safe, with fewer side effects and presents an economical alternative for various comorbidities [1]. This work aims to seek evidence of the application of PBM and its benefits in comorbidities and processes of the nervous system in clinical and preclinical studies.

Materials and Methods

To study the effects of PBM on the CNS, two databases, PubMed/Medline and Exerpta Medica Guide DataBASE (EMBASE), were used. Preclinical and clinical studies that addressed the effects of PBM on certain CNS pathologies were selected.

Results and Discussion

In the central nervous system, studies on PBM have shown significant improvements in animal models and pilot studies in humans, including cognitive, motor, and behavioral improvements. Based on the observed results, the most crucial effects of brain PBM therapy are improvement in brain metabolic function, stimulation of neurogenesis and synaptogenesis, regulation of neurotransmitters, and neuroprotection through anti-inflammatory and antioxidant biological signaling [2].

An animal study found that PBM could alleviate Aβ-induced neurotoxicity in rats' hippocampus, indicating its potential as a therapeutic approach for Alzheimer's disease [3]. Two pilot studies [4,5] in dementia patients showed promising results, including improvements in sleep, anger outbursts, anxiety, and cognitive function. Additionally, an animal study investigated the effect of PBM on the survival of dopaminergic neurons in MPTP-induced(1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) Parkinson's disease (PD). The results indicated that PBM application before or after MPTP injection could increase the survival of these neurons [6]. Two pilot clinical studies were also conducted with PD patients, showing significant improvements in mobility, cognition, balance, fine motor skills, and mood [7,8].

The available studies suggest that PBM is safe and beneficial in the treatment of neurodegenerative diseases. However, further clinical research is necessary to confirm its efficacy in managing these comorbidities, and to establish the appropriate conditions and parameters for light application.

Conclusions

In summary, PBM presents great potential as a therapy for processes that affect the central nervous system and may be an important tool for diseases that currently have limited curative treatments or symptom management.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. The authors are funded by the grants numbers 18/14072-2 SHT; 19/17892-8 AHK, São Paulo Research Foundation (FAPESP).

References

1 Salehpour F, Mahmoudi J, Kamari F,et al. Brain Photobiomodulation Therapy: a Narrative Review. Mol Neurobiol. 2018 Aug;55(8):6601-6636.
2 Yang L, Tucker D, Dong Y, et al. Photobiomodulation therapy promotes neurogenesis by improving post-stroke local microenvironment and stimulating neuroprogenitor cells. Exp Neurol, 299, n. Pt A, p. 86-96, Jan 2018
3 Lu Y, Wang R, Dong Y, et al. Low-level laser therapy for beta amyloid toxicity in rat hippocampus. Neurobiol Aging, 49, p. 165-182, Jan 2017.
4 Saltmarche AE, Naeser MA, Ho KF, et al. Significant Improvement in Cognition in Mild to Moderately Severe Dementia Cases Treated with Transcranial Plus Intranasal Photobiomodulation: Case Series Report. Photomed Laser Surg, 35, n. 8, p. 432-441, Aug 2017.
5 Chao LL. Effects of Home Photobiomodulation Treatments on Cognitive and Behavioral Function, Cerebral Perfusion, and Resting-State Functional Connectivity in Patients with Dementia: A Pilot Trial. Photobiomodul Photomed Laser Surg, 37, n. 3, p. 133-141, Mar 2019
6 Peoples C, Spana S, Ashkan K, et al. Photobiomodulation enhances nigral dopaminergic cell survival in a chronic MPTP mouse model of Parkinson's disease. Parkinsonism Relat Disord, 18, n. 5, p. 469-476, Jun 2012.
7 Liebert A, Bicknell B, Laakso EL,. et al. Improvements in clinical signs of Parkinson's disease using photobiomodulation: a prospective proof-of-concept study. BMC Neurol, 21, n. 1, p. 256, Jul 2 2021.
8 Hong CT, Hu CJ, Lin HY, Wu D. Effects of concomitant use of hydrogen water and photobiomodulation on Parkinson disease: A pilot study. Medicine (Baltimore), 100, n. 4, p. e24191, Jan 29 2021.

Use of conductive polymers and indicator dyes to obtain sensing surfaces aiming their application in biosensors

LIMA LA[1]*, SOUZA APO[2], DUTRA RAF[3]

[1] Federal University of Pernambuco, Department of Pharmacy, Recife/ PE, Brazil.
[2] Federal University of Pernambuco, Department of Biological Sciences, Recife/PE, Brazil.
[3] Federal University of Pernambuco, Department of Biomedical Engineering, Recife/ PE, Brazil.

*lucas.alima@ufpe.br

Keywords: Biosensors, Conductive polymers, Polyethyleneimine, Methyl red.

Introduction

Conductive polymers have been used to improve the electrical conduction of biological sensors, Polyethyleneimine (PEI), an aminated and cationic polymer, has been applied due to the ease of film formation, biocompatibility and catalytic activity[1,2]. Methyl red, an indicator dye, is present in the development of conductive films mainly because it improves the conductivity of polymers[3,4]. Considering the range of existing components for biosensor electrical enhancement, this brief aims to develop a sensing surface based on polyethyleneimine and methyl red by dropcasting to determine its viability for use in biological sensors.

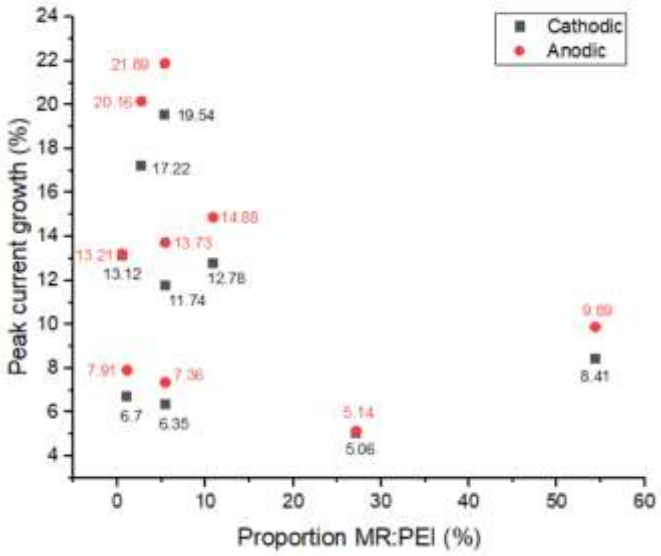
Materials and Methods

Glassy carbon electrodes were polished with 0.05m and 1m alumina, polyethyleneimine dispersions (Sigma-Aldrich, United States) 23.2 mM, 115 mM and 232 mM and methyl red (VETEC, Brazil) 1.25 mM were prepared , 6.25 mM and 12.5 mM in absolute ethyl alcohol (Química Moderna, Brazil). Polyethyleneimine, methyl red and their 1:1 associations were applied to the surface of the glassy carbon electrode. The electrodes were incubated in an oven at 37ºC for 30 minutes. The film was evaluated by cyclic voltammetry at a potential range of -0.25V - 0.75V in a redox probe of 10mM potassium ferricyanide/10mM potassium ferrocyanide 1:1.

Results and Discussion

The results obtained in Figure 1 demonstrate a proportional relationship between the increase in film conductivity and the association of polyethyleneimine and methyl red. There was positive synergism in the associations with methyl red and 232 mM polyethyleneimine with growth greater than 200% in the anodic and cathodic peaks in relation to the films with 232 mM polyethyleneimine.

Figure 1. Peak current growth as a function of associations between polyethyleneimine (PEI) and methyl red (MR).



Font: Own source.

Conclusions

The experimental results signaled the viability of both the materials of choice and the methodology for obtaining the sensing surfaces, enabling the construction of films with increased conductivity, which could be of great value for application in biosensors.

Acknowledgment

The work was carried out with financial support from the Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES), the Foundation for the Support of Science and Technology of the State of Pernambuco (FACEPE) and the National Research Council (CNPq) and FADE/UFPE.

References

1 Shumei GU, et al. Functionalized polyethyleneimine-gold nanoparticles-porphyrin nanocomposite for electrochemical glucose biosensing. Int. J. Electrochem, 12:5092-5103. 2017.
2 HUANG Y, et al. Auto-cleaning paper-based electrochemiluminescence biosensor coupled with binary catalysis of cubic Cu2O-Au and polyethyleneimine for quantification of Ni2+ and Hg2+. Biosensors and Bioelectronics, 126:339-345. 2019.
3 Shawkat ALI, et al. All-printed humidity sensor based on graphene/methyl-red composite with high sensitivity. Carbon, 105:23-32. 2016.
4 MINISY IM, et al. Methyl red dye in the tuning of polypyrrole conductivity. Polymer, 207:122854. 2020.

Crevice corrosion behavior of Ti-6Al-4V by cyclic potentiodynamic polarization

FRAGA NV[1]*, FERNANDES FAP[2]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), Santo André/ SP, Brazil
[2] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*nathan.valle@aluno.ufabc.edu.br

Keywords: Biomaterials, Ti-6Al-4V, Multiple-crevice assembly, Crevice corrosion, Cyclic potentiodynamic polarization.

Introduction

Ti-6Al-4V alloy is extensively used as a biomaterial based on its high corrosion resistance due to its passive film in addition to excellent biocompatibility. However, the presence of aggressive Cl^- in biological medium causes its susceptibility to film breakdown, aided by occluded crevice regions, where more aggressive medium can be formed. In these cases, crevice corrosion can act as an important corrosion mechanism for medical devices and implants due to its intrinsic geometric complexity. Therefore, the present study intends to evaluate the behavior of Ti-6Al-4V alloy under simulated conditions of biological environment with the presence of crevice regions by combining characterization techniques of multiple-crevice assembly (MCA) and cyclic potentiodynamic polarization (CPP) [1,2].

Materials and Methods

Ti-6Al-4V was characterized by scanning electron microscopy (SEM) and X-ray diffraction (XRD). Samples were prepared for CPP, tested in simulated Cl^- body fluid concentration medium using 0,9% NaCl (9 g/L). Two different test conditions were used: With MCA devices (creviced samples - CS) and without (free surface samples - FS) at room temperature. Open circuit potential (OCP) was monitored for 1 hour and then CPP was carried from 250 mV below the determined OCP up to 2 V with a scan rate of 1 mV/s. Samples were later studied by confocal laser scanning microscopy (CLSM) for surface evaluation. Assembly torque was kept constant at 1 N.m.

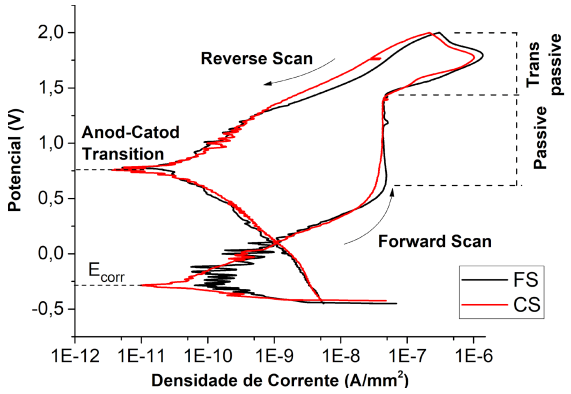
Results and Discussion

SEM and XRD indicated a microstructure formed by equiaxed grains of α-titanium in a matrix of β-titanium according to ASTM F136.

The OCP's for CS and FS conditions demonstrated an increase in passivity by growing towards nobler potentials, linked to passive film formation. The CPP curves

presented in Figure 1 demonstrate high agreement between CS and FS conditions. Both present a behavior of spontaneously passive materials and without active-passive transition. The passive regions started at potentials of 0.654 V for CS and 0.804 V for FS samples, remaining passive up to 1.4 V, where a transpassive region was observed due to oxygen evolution. Passive current densities of 4.5E-08 A/mm^2 were found for both CS and FS conditions, indicating a low and similar corrosion rate. The drop in current density (CD) for potentials of 1.8 V was caused by passive film thickening, hindering the transfer of electrons through the film and reducing the reaction rate. Negative hysteresis present in CS and FS, indicate the increase of the material passivity in nobler potentials, reducing CD in the reverse scan. However, the nobler anodic-cathodic transition potentials compared to E_{corr} indicate that the higher passivity is not stable. The micrographs obtained by CLSM did not detect the presence of corrosion along creviced and free surface regions.

Figure 1. CPP comparison for FS and CS conditions.



Font: FRAGA, NV, 2023.

Conclusions

Ti-6Al-4V alloy exhibited no passive film breakdown up to potentials of 2 V or significant change on its behavior due to the aggressive environment provided by crevices at room temperature and Cl^- presence. The results indicate the very high crevice corrosion resistance of the alloy in simulated conditions of the biological environment, justifying the use of Ti-6Al-4V as a biomaterial for the manufacture of implants, where the presence of the aggressive conditions of crevices is usual.

Acknowledgment

Prof. Dr. Renato Altobelli Antunes and UFABC Multiuser Centers are gratefully acknowledged for providing access to the characterization equipments used.

References

1 RATNER, Buddy e colab. Biomaterials Science An Introduction to Materials in Medicine. 2. ed. [S.l.]: Elsevier Ltd., 2004.
2 ASM INTERNATIONAL. ASM Handbook: Volume 13A, Corrosion: Fundamentals, testing and protection. 9. ed. Materials Park, OH: ASM International, 2003.

Tactile system for the description of simple bar graphs to individuals with visual impairment

SOUZA N[1*], MORAIS J [2]

[1]Federal University of Pará, Faculdade de engenharia elétrica e biomédica (FEEB), Belém/PA, Brasil.
[2]Federal University of Pará, Programa de Pós-Graduação em Ciência da Computação (PPGCC), Belém/PA, Brasil.

**Naynara.souza@itec.ufpa.br*

Keywords: Assistive Technology, Data Graph, Accessibility, 3D Braille.

Introduction

Data graphics are a set of elements used to facilitate the users' comprehension regarding the materials presented in the research. However, when taking into consideration individuals with visual impairment, barriers to understanding arise exponentially, since there is no default data graph description system in vogue, both for regular education as well as daily usage, that is to say, a visually impaired person cannot identify graph elements in texts. Considering that fact, the introduction of a method for the designing of the tactile graph is promising to insofar as graphs are present in the educational material of people with visual impairments.

Given the variation of scenarios suggested for the usage of data graphs, there are several projects utilizing vocalization as a way to mitigate the accessibility problem to data graphs [1].

Based on this context, this work proposes a methodology for the designing of a computational model for the description of the information contained in 2D images from simple bar graphs. This information will be transmitted to users through vocalization, 3D tactile objects with textual information translated to Braille impaired individuals can read.

Materials and methods

The subsequent stages of this work were the definition of the theme for the literature review, analysis of the scope of the work, elaboration of the system flux, choice of graphs to be described as well as the definition of relevant items. Following, there is the choice of technologies and materials to be used, the system implementation, proof of concept, and tests.

Due to the lack of multimodal systems for data graph description, generally limited by audio description, it was possible to limit the work's scope by utilizing a multimodal description system that has an audio and tactile description. The defined flux comprises the stages moduled separately and not simultaneously: text acquirement, voice synthesis, 3D modeling, and model printing.

The types of graphs, and their most relevant items, were defined by [2], establishing simple graph bars variation, with bar numbers 3, 5, 7, and 9 respectively. The chosen

items were labeled on the x and y-axis, the title graph, and bars with individual values. After the impressions of the models, tests on blindness simulation were conducted, this test consists of the obstruction of a voluntary view, leaving only his/her listening and tact.

After the previous part, the test was divided into three parts in which, firstly, the volunteer had access only to an audible description, and had to draw according to their understanding of the graph. Secondly, they had a tactile description and had to draw again. In the end, the volunteer received both descriptions simultaneously and had to draw once more.

It is important to state that the volunteers have not had previous contact with the defined graph models, taking into consideration that memorization is an assessment parameter.

Results and discussion

3D tactile objects were successfully designed, with all their information pre-set. The printing of each object took around 23 hours. The need for separate printing for each object was noted because of technical restrictions imposed by the hardware used to acquire the objects.

At the test stage, it was made clear that the lack of a multimodal system hurts graph comprehension, which means that just a single type of description is not sufficient for a user to have a good understanding of the graph, making the case for the need of simultaneous audio and tactile descriptions. Volunteers affirmed that the two descriptions simultaneously were better for reproducing a faithful copy of the graph.

Conclusions

Through this method, a full project for the physical production model for an audio and tactile graph data descriptor was possible. And the results show it improves, substantially, the comprehension of volunteers.

Afterward, it is expected that tests will be applied to individuals with visual impairment, allowing a new way of description, so people with such conditions have more access to a graph containing data.

Besides that, there is hope new works will be made, having this one as the basis, to make graph data more accessible to this audience.

Acknowledgements

I thank the Federal University of Pará, which provided the development of the research at its campus. I thank FAESPA for the donation of the required equipment for the research, and the CNPQ for the financial support for the research.

References

1 Scoralick Kelly. Audiodescrição no telejornalismo: a inclusão das pessoas com deficiência visual por meio da descrição das imagens Educação e Fronteiras. 2020; 10:90–102.
2 Oliveira Cinthya Leticia Teles. Proposta e Avaliação de Modelos de Descrição Textual para Vocalização de Gráficos de Barras Masters teses. Programa de Pós-Graduação em Ciência da Computação ICEN UFPA. Cinthya Leticia Teles de Oliveira. 2020.

Mapping of the electrical cardiac activity: A methodology for animal experimentation studies

SILVA VP[1*], PAREDES JG[1], CORREIA RC[1], WEBER GL[1], SANDOVAL I[1], UZELAC I[1], SALINET J[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

* silva.vinicius@aluno.ufabc.edu.br

Keywords: Biomedical Engineering, Medical Devices, Atrial Fibrillation, Electrocardiographic Mapping, Animal Experimentation.

Introduction

Atrial Fibrillation (AF) is the most common cardiac arrhythmia, affecting around 2% of the worldwide population [1]. Its mechanisms still in debate, and treatment is suboptimal for who AF persist for long periods [2]. In this project, is proposed the development of an experimental setup for the accurate characterization of AF in isolated rabbit hearts. More specifically, this project aims to: Contribute to the advancement of a Langendorff type reperfusion of an isolated heart setup; Assist in the development of the panoramic optical mapping setup; Aid in the development of the non-invasive electrical mapping setup, and an electrical mapping setup by direct contact with the epicardium. The research protocol proposed here was evaluated by the local committee of the Committee on Ethics in the Use of Animals (CEUA) and is in accordance with current legislation (CEUA no. 3947230519).

Materials and Methods

The proposed setup is presented in Figure 1A, and utilizes a Langendorff perfusion system to maintain the rabbit heart alive during experimentations, where the atrial fibrillation is induced by electric stimulation.

The optical mapping setup used three red LEDs to stimulate a fluorophore dye, the dye emits infrared radiation according to the electrical activity of the epicardium. To capture the images three GigaE cameras with band pass filters were placed equidistant to the heart and at 120° from one another (Figure 1A).

To capture the electrical activity from the heart, two methods were used, the invasive method with two micro electrode arrays (MEAs) placed on the epicardium of both atria, and the non-invasive method, which used 60 electrodes placed on the surface of a hexagonal tank, filled with a conductive perfusion solution where the heart was submerged. The signals were captured by a flexible PCB, connected to headstages by DB25 connectors, which then were sent to an Open Ephys acquisition board (Figure 1A).

The solution must be maintained at a constant 37°C, so it was recirculated by a water bath with external circulation, and had its flow controlled by two valves and two flow meters.

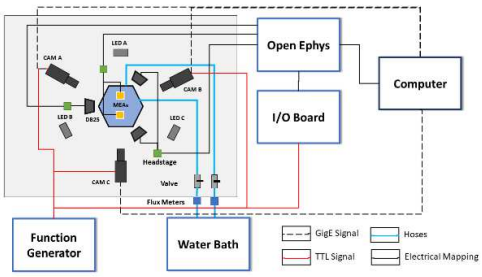
To capture images used in the 3D reconstruction of the heart's surface a special apparatus was designed to rotate the heart precisely. The rotation was made by a step motor controlled by an Arduino Uno board, a program was engineered in LabVIEW to control the motor, capture and save the images for the reconstruction (Figure 1B). Due to our main objective, it is imperative that all our acquired data is synchronized, to achieve that a function generator was used to generate a TTL signal to synchronize all the cameras and electrical mapping systems (Figure 1A).

Results and Discussion

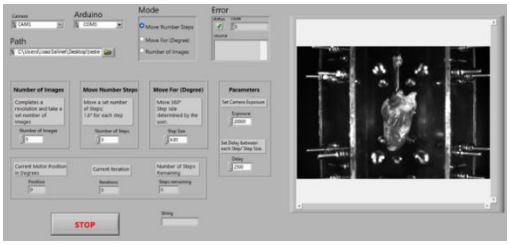
The methodology and setup in its different iterations were used in two pilot experiments, where problems were discovered and remedied in the following three experiments (Figure 1C).

Figure 1. (A) General Diagram of the Setup Connections. (B) Program in LabVIEW to control the step motor and capture the images. (C) View of the setup during an experiment.

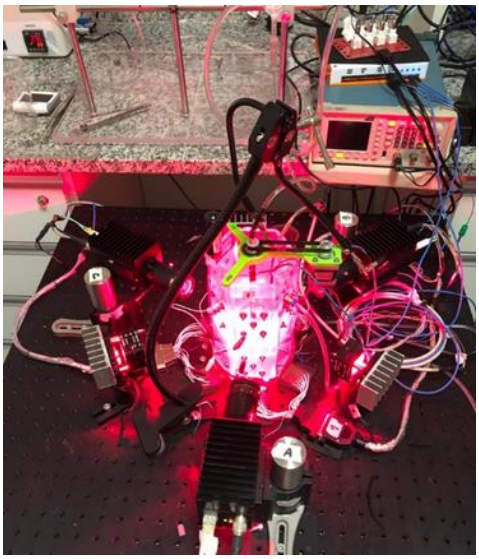
A



B



C



Font: Silva, Vinicius.

Conclusions

The setup and methodology show in this study went through several iterations, with modifications, optimizations and changes in various aspects. Up to now 5 experiments with isolated rabbit hearts were performed. Multiple areas of study were brought together to be able to develop the setup, such as Electrophysiology, Electrical Engineering, Software Development and Programming.

Acknowledgment

This project is associated with Projeto Jovem Pesquisador Fapesp 2018/25606-2.

References

1 Bollmann, A. and F. Lombardi (2006). "Electrocardiology of Atrial Fibrillation." IEEE Engineering in Medicine and Biology Magazine November/December: 15-23.

2 Takahashi, Y., P. Sanders, P. Jais, M. Hocini, R. Dubois, M. Rotter, T. Rostock, C. J. Nalliah, F. Sacher, J. Clémenty and M. Haissaguerre (2006). "Organization of Frequency Spectra of Atrial Fibrillation: Relevance to Radiofrequency Catheter Ablation." Journal of Cardiovascular Electrophysiology 17(4): 382-88.

Evaluation of The Effects of Photobiomodulation Therapy on Muscle Recovery in Female Soccer Athletes.

***COSTA CCG[1], KATO IT[1]**

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*carlos.cesar@ufabc.edu.br

Keywords: Female Soccer, Photobiomodulation, Muscle Recovery, Pain.

Introduction

Football is the most practiced and popular sport in the world [1]. In the last decade, women's football has gained popularity and attracted a large number of practitioners on all continents, with increasing support from the South American Football Confederation and the International Football Federation increasingly. Elite football involves a high number of competitive matches per season, including domestic, continental, and international matches [2]. Biomechanically, soccer is a sport characterized by short, fast and non-continuous movements, intense physical contact, acceleration, sudden changes in direction, jumps and braking [3]. As female athletes increasingly participate in soccer, they face greater physical and technical demands, which often lead to exhaustion and a higher risk of injury. Recent study with male athletes have shown that muscle recovery aims to restore baseline variables before the onset of fatigue [4]. Clinical thermography is gaining popularity as a tool to diagnose muscle atrophies and injuries [5]. One study suggests that thermography, along with creatine kinase (CK) and lactate levels, can determine the intensity and location of post-training muscle injuries [5]. Structural damage to muscle cells is common after strenuous exercise, resulting in increased plasma concentrations of muscle enzymes such as CK and lactate dehydrogenase (LDH) [4,5].

Among the new techniques widely studied and used for tissue recovery, we can highlight photobiomodulation therapy (PBM). The application of low power laser or light emitting diodes (LEDs) has been reported to reduce pain, inflammation and improve tissue repair. In addition, the combination of superpulsed laser with red and infrared LEDs has been reported to improve exercise performance and post-exercise recovery [4,5]. While several studies have demonstrated beneficial effects of PBM in male athletes, a study conducted with amateur female futsal players did not show similar results [2]. However, there is a lack of studies carried out with the PBM in female soccer athletes. Therefore, the growth of this sport and the beneficial effects of PBM in male soccer athletes stimulated the proposition of this study. Our hypothesis is that PBM will help in the post-match muscle recovery of female soccer players.

Materials and Methods

This is a blinded, randomized clinical trial that will be conducted with female professional football players from the Portuguese Sports Association in São Paulo. The study will be submitted to the UFABC Human Research Ethics Committee for approval. Athletes will be informed about the study, and after obtaining their consent, they will be enrolled. The inclusion criteria will be healthy athletes aged 18 years or olderwho participate in the São Paulo championship. The exclusion criterion will be a history of severe lower limb musculoskeletal injury in the past 6 months. The sample size will be determined in a pilot test. The athletes will be randomly allocated to one of two groups: PBM and placebo. Athletes will participate in a soccer match, and lactate levels, response to the adapted Q-Adom questionnaire, and thermographic evaluation will be conducted before and after the game, as well as 48 hours after the match.

The irradiation will be carried out with a commercial laser equipment (DMC, model E-Light IRL), which has 4 emitters of red laser (λ=660 nm) and 4 emitters of infrared laser (λ=808 nm). Each emitter has a power of 100 mW ± 20%. The other irradiation parameters (energy and irradiation time) will be defined based on the available literature. Irradiation will be performed on the quadriceps femoris, hamstrings and medial gastrocnemius muscle groups between 30 and 45 minutes after the end of the match. The data will be submitted to descriptive analysis and inferential analysis. Depending on the type of data and its distribution, the appropriate statistical tests will be chosen.

Results and Discussion

Through this study we seek to show the effectiveness of TFBM therapy in effectively improving physical performance by delaying the onset of fatigue, reducing the response to fatigue, improving post-exercise recovery and protecting cells from damage induced by exercise with portable equipment optimizing time and place of application.

Conclusions

It is hoped that the results obtained in this study can serve as a basis for other studies in the field of biomedical engineering and physiotherapy. Stimulating the search for optimized muscle TFBM application protocols and the creation of new smaller and more powerful red and infrared laser emission equipment are also goals pursued with our result.

References

1. Torres T, Santos VP, Barbosa C. **As Principais Lesões do Futebol Feminino e a Atuação da Fisioterapia Desportiva**. ANAIS CONGREGA MIC-ISBN: 978-65-86471-05-2 e ANAIS MIC JR.-ISBN: 978-65-86471- 06-9, v. 16, p. 619-623, 2020.
2. Cavalcante KHS. **Prevalência de lesões no futebol feminino** 43f, Universidade de Brasília, 2019.
3. Almeida PSM, Scotta AP, Pimentel BM, et al**. Incidência de lesão musculoesquelética em jogadores de futebol**. Revista Brasileira de Medicina do Esporte, v. 19, n. 2, p. 112-115, 2013.
4. Glória IPS, Junior ECPL, Politti F, Herpich CM, Smith D, et al. (2019). **Effect of pre-game photobiomodulation on muscle recovery in professional soccer players: study protocol for a randomized, cross-over, sham-controlled, triple-blind, clinical trial.** Manual Therapy, Posturology & Rehabilitation Journal, 1-6. https://doi.org/10.17784/mtprehabjournal.2019.17.620
5. Conduto JCM. **A importância da Termografia Clínica como Ferramenta de Auxiliar Diagnostico**. Facene/ Mossoró RN, 2020, 45 f.

Development and validation of a proprioceptive stimulation device for transfemoral prosthesis

TAMASHIRO DSU[1,3]*, BATTISTELLA LR[1,2], COELHO DB[3]

[1] Physical and Rehabilitation Medicine Institute of the University of Sao Paulo Medical School General Hospital (IMREA-HCFMUSP), São Paulo/SP, Brazil
[2] University of São Paulo, Faculty of Medicine (FMUSP), São Paulo/SP, Brazil
[3] Federal University of ABC (UFABC), Biomedical Engineering, São Bernardo do Campo/ SP, Brazil

*daniel.tamashiro@ufabc.edu.br

Keywords: Biomedical Engineering, Amputation, Prosthesis, Proprioception, Biomechanics.

Introduction

Amputation consists of a surgical procedure for total or partial removal of a patient's body segment caused, for example, by disease or trauma. In Brazil, according to SUS data, close to 50.000 cases of amputation were recorded in 2011 and more than 80% of amputations were of the lower limb [1].

The extent of impact on balance depends on the level and type of amputation, as well as the individual's ability to adapt and compensate for the loss of the limb. Research suggests that the use of biofeedback in gait training rehabilitation is effective in improving atypical movements in walking. Among the types of biofeedback there are visual, auditory, and haptic. Haptic systems use a tactile interface in which user responses are provided in the form of movement or vibration [2], [3]. These sensory stimulations provide additional information to the brain for awareness of body movements and positions.

In this context, the objective of this study is to develop and validate a vibro-tactile stimulation device for the rehabilitation of patients with lower limb amputation. This equipment uses vibro-tactile information as sensory support for the use of the prosthesis to provide safety and confidence to the patient during walking. The hypothesis is that the gait of patients with lower limb amputation improves with the use of vibrotactile sensory biofeedback.

Materials and Methods

At the base of the foot of the transfemoral prosthesis, there is a resistive force sensor. This transducer operates as an on/off switch that drives a vibration motor when the user unloads weight on the ground. The project consists of a system where pressure sensor triggers the vibration (Fig. 1).

For the study, 20 transfemoral amputees from the Physical and Rehabilitation Medicine Institute of the University of Sao Paulo Medical School General Hospital (IMREA-HCFMUSP) will be selected. This will be a randomized, controlled clinical trial,

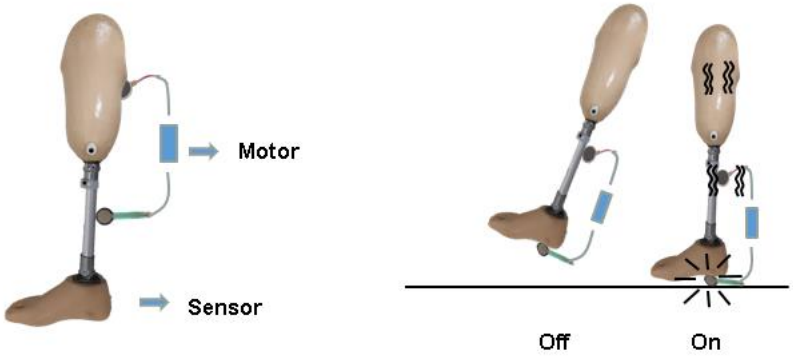
where a sensory feedback accessory developed by IMREA-HCFMUSP will be tested comparatively with a control with participants in conventional treatment.

Kinetic parameters will be measured with the device turned on and off, at the beginning and end of the post-prosthesis phase, whose 2-month period is marked by training and exercises where the patient adapts to using the prosthesis.

Results and Discussion

Expected results on walking are improvement in parameters such as cadence, step and stride length, speed, prosthesis support time and increase in knee flexion angle in patients using the device.

Figure 1. Project schematic of proprioceptive stimulation device for transfemoral prosthesis.



Font: Author source.

Conclusions

During the rehabilitation process, exercises are important for coordination, balance, posture, and body control. The development of the proprioceptive stimulation device aims to help the gait training of lower limb prosthesis users.

Acknowledgment

We thank the members of the IMREA-HCFMUSP, Dr Donaldo Jorge Filho and Eng José Augusto Fernandes Lopes for their continuous support. And a special thanks to Eng Milton Seigui Oshiro for guidance.

References

1 Ministério da Saúde. Diretrizes de atenção às pessoas submetidas a amputação Ministério da Saúde [Internet]. 2013. 38 p. Available from: www.saude.gov.br

2 Escamilla-Nunez R, Michelini A, Andrysek J. Biofeedback systems for gait rehabilitation of individuals with lower-limb amputation: A systematic review. Sensors (Switzerland). 2020;20(6).

3 Ma CZH, Wong DWC, Lam WK, Wan AHP, Lee WCC. Balance improvement effects of biofeedback systems with state-of-the-art wearable sensors: A systematic review. Vol. 16, Sensors (Switzerland). MDPI AG; 2016.

Critical analysis of social security leaves from 2017 to 2022: Impacts of SARS-CoV-2 on work leaves

LEITE D[1*] , TANAKA H[1], SIMOES PW[1], LEITE A[1]

1 Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
*daniela.leite@ufabc.edu.br
Keywords: Biomedical Engineering, Medical devices, Social security, Covid health services.

Introduction

Since 2020, in Brazil and in the world, society has been plagued by an unknown disease, with alarming health consequences, which led to a pandemic caused by the SARS-CoV-2.[4]. The disease caused by this virus leaves sequels and can lead to incapacity for work or even death, thus initiating a significant increase, noted daily, in the evaluations of requests for leave from work[1].

In general, when a worker who has a formal/registered relationship is removed, here in Brazil, the company is responsible for paying the first 15 days of leave. Therefore, if the return to work occurs within this period, the expert evaluation will not be forwarded. The Ministry of Social Security periodically monitors the granting of sickness benefits throughout Brazil, and this information is disclosed in annual tables and has an internal database, which we sought access to carry out our study [2].

The objective is to collect data from the INSS about work leave and make a quantitative analysis to apply statistical methods to analyze these data.

Materials and Methods

The project is making an analysis of the data available in the current literature, and accessing the social security websites, and other websites that involve and aggregate information on workers' health, to quantify the impact that the pandemic caused by COVID-19 has on the social security sector.

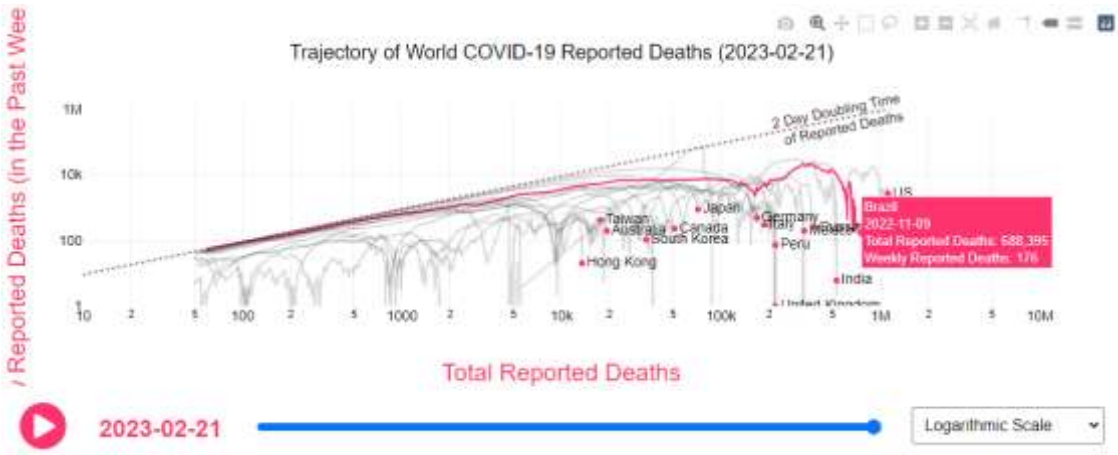
The analysis will be made from public data made available by the social security, on the website: www.gov.br/previdencia/pt-br/dados-e-estatisticas/painel-estatistico-da-previdencia.

From this survey it is possible to propose effective strategies for the social security sector.

Results and Discussion

We expect to find sick work leaves with elevation in relation to previous years, knowledge of the pandemic, and peaks in work leave requests in periods of increase in cases, as well as declines in the period after vaccines.

Figure 1. trajectory of word covid19 reported deaths.



Font: https://aatishb.com/covidtrends/?scale=linear&data=deaths in feb22,2023.

Conclusions

We expected to answer the hypothesis that the pandemic, and the increase in unemployment throughout this year, led to an increase in requests for leave and, consequently, an increase in the granting of benefits, whether for sickness benefits or assistance. Next, these requests will be quantified and qualified, which will help in the proposal of social measures to improve aid and assistance programs.

Acknowledgment

I thank the Federal University of ABC for supporting the development of this work.

References

1 ILO 2021. Assessment of the Social Security Responses to COVID-19: Lessons from the Western Balkans and Eastern Europe during the first stage of the pandemic; ILO Decent Work Technical Support Team and Country Office for Central and Eastern Europe (DWT/CO-Budapest). – Budapest: ILO. 2021.
2 Ministry social security and work in site: https://www.gov.br/trabalho-e-previdencia/pt-br.
3 Jussara A O B, Michael F M, Rodrigo F do C , Anderson da C A, Alan D dos S, Carlos D F de S, COVID-19 in Brazil: spatial risk, social vulnerability, human development, clinical manifestations and predictors of mortality – a retrospective study with data from 59 695 individuals. 2021.
4 The social challenge in times of COVID-19=ECLAC (Economic Commission for Latin America and the Caribbean) (2020a), COVID-19 Special Report, No. 3, 2020.
5 Davi H R, Sandra L. , COVID-19 no Brasil: um olhar social sobre a pandemia COVID-19 in Brazil: a social view of the pandemic. 2021.
6 Bosi M LM , Mercados F J, Pesquisa Qualitativa de Serviços de Saúde. Petrópolis: Vozes. 2004.
7 Melo, M P P, et al, A Decisão Pericial no Âmbito da Previdência Social; PHYSIS: Rev. Saúde Coletiva, Rio de Janeiro,13(2):105- 127. 2003.
8 Motta R C, Conceito Básicos de Perícia Médica; Editora: Alínea e Átomo. Edição 1a. ISBN 978-85-7670-189-7. pgs: 220. 2012.
9 Strauss A L, Qualitative Analysis for Social Scientists; Editora Cambridge University Press. ISBN: 9780521338066. 1996.
10 Vasconcellos L P W C, A Simulação na Perícia Médica. Subtítulo: A Arte e a Ciência de Investigas a Verdade Pericial. Editora LTR, Edição: 2a. ISBN: 9788536117263. pgs:128. 2010.

Electroencephalographic and electromyographic analysis of freezing of gait event in Parkinson's disease

COSTA JA[1]*, COELHO DB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*joao.antonio@aluno.ufabc.edu.br

Keywords: Parkinson's Disease, Biomedical Engineering, Biomechanics, Freezing of Gait.

Introduction

One of the most severe symptoms in individuals with Parkinson's Disease (PD) is the freezing of gait (FoG), defined as a "brief episode, in which there is absence or reduction in foot forward progression, even with the intention of walking" [1]. A recent cohort study found a prevalence of 63% and an incidence of 12.4% of FoG in individuals with PD [2].

FoG is identified in the more advanced stages of PD [3] and usually leads to falls, injuries related to falling and loss of independence [4]. During freezing episodes (FE), individuals with PD may have three characteristics [5,6]. First, a patient is suddenly unable to start or stop walking (a condition known as "akinesia"). A complete absence of movement is perhaps the most well-known clinical presentation, but it is not the most common presentation. In second place, the FoG is often associated with an effort to overcome the blockage, causing legs "shake in place" [7]. This is the most prevalent FE subtype [8,9]. The third type is taking small steps.

Management of FoG is not efficient with currently available drugs, neurosurgery and physical interventions, due to lack of knowledge of the pathophysiology of this complex phenomenon [10]. Knowing biomechanical aspects, such as cadence and characteristics in moments prior to a FE, would be beneficial in preventing these events. In addition, early detection of a FE can contribute to treatment measures being administered immediately before the onset of freezing [11,12].

However, there is no unified view on the biomechanical aspects that precede a FE. A study on the aspects that precede a FE in individuals with FoG is essential for a better understanding of this phenomenon and for future treatments. The objective of this project is to identify characteristics in the electroencephalographic and electromyographic data before and during FoG in Parkinson's Disease.

Materials and Methods

1. A public database with data from electroencephalogram (EEG), electromyogram (EMG) and accelerometers – which provide biomechanical data – during FoG events of individuals diagnosed with Parkinson's disease is going to be analyzed.
2. Then, the next step is to identify FoG episodes by analyzing accelerometer data.

3. Divide the measures into “previous period” and “during the FoG” moments.
4. At these moments, identify the main characteristics on EEG and EMG data.

Results and Discussion

Since it is still a project, there is no preliminary result. The analysis of EEG and EMG data will be carried out from the FoG moments identified in the accelerometer data. Then, the analysis of EEG and EMG signals will be made considering moments prior to the FoG, in which the FoG is imminent and during the phenomenon.

Conclusions

A study on the aspects that precede a FE in individuals with FoG is essential for a better understanding of the phenomenon and for future treatments. Studying this physiological phenomenon by analyzing data from EEG and EMG is an example of how Biomedical Engineering can act to the benefit of health sciences and people.

Acknowledgment

I would like to acknowledge Federal University of ABC (UFABC) for providing the opportunity to research Parkinson’s disease since my first year on graduation. I would also like to acknowledge Center for Engineering, Modeling and Applied Social Sciences (CECS), BMC Lab and Daniel Boari Coelho for supporting me during this project.

References

1 Nutt JG, Bloem BR, Giladi N, Hallett M, Horak FB, Nieuwboer A, Freezing of gait: moving forward on a mysterious clinical phenomenon, Lancet Neurol. 10, 734–744. 2011.
2 Forsaa EB, Larsen JP, Wentzel-Larsen T, Alves G, A 12-year population-based study of freezing of gait in Parkinson’s disease, Parkinsonism Relat. Disord. 21, 254–258. 2015.
3 Cucca A, Biagioni MC, Fleisher JE, Agarwal S, Son A, Kumar P, et al., Freezing of gait in Parkinson’s disease: from pathophysiology to emerging therapies, Neurodegener. Dis. Manag. 6, 431–446. 2016.
4 Gilat M, Ligia Silva de Lima A, Bloem BR, Shine JM, Nonnekes J, Lewis SJG, Freezing of gait: promising avenues for future treatment, Parkinsonism Relat. Disord. 52, 7–16. 2018.
5 Bloem BR, Hausdorff JM, Visser JE, Giladi N, Falls and freezing of gait in Parkinson’s disease: a review of two interconnected, episodic phenomena, Mov. Disord. 19, 871– 884. 2004.
6 Schaafsma JD, Balash Y, Gurevich T, Bartels AL, Hausdorff JM, Giladi N, Characterization of freezing of gait subtypes and the response of each to levodopa in Parkinson’s disease, Eur. J. Neurol. 10, 391–398. 2003.
7 Hausdorff JM, Balash Y, Giladi N, Time series analysis of leg movements during freezing of gait in Parkinson’s disease: akinesia, rhyme or reason? Phys. A 321, 565–570. 2003.
8 Schaafsma JD, Giladi N, Balash Y, Bartels AL, Gurevich T, Hausdorff JM, Gait dynamics in Parkinson’s disease: relationship to Parkinsonian features, falls and response to levodopa, J. Neurol. Sci. 212, 47–53. 2003.
9 Moore ST, MacDougall HG, Ondo WG, Ambulatory monitoring of freezing of gait in Parkinson’s disease, J. Neurosci. Methods 167, 340–348. 2008.
10 Pickering RM, Grimbergen YA, Rigney U, Ashburn A, Mazibrada G, Wood B, et al., A meta-analysis of six prospective studies of falling in Parkinson’s disease, Mov. Disord. 22, 1892-900. 2007.
11 Sweeney D, Quinlan LR, Richardson M, Meskell P, Cunnington AL, Rosenthal L, et al., Multifaceted sensory electrical stimulation cueing for freezing of gait in Parkinson’s disease, Parkinsonism Relat. Disord. 82, 106–108. 2021.
12 Sijobert B, Azevedo C, Andreu D, Verna C, Geny C, Effects of sensitive electrical stimulation-based somatosensory cueing in Parkinson’s disease gait and freezing of gait assessment, Artif. Organs 41, E222–E232. 2017.

Early diagnosis of osteoporosis by optical coherence tomography and optical clearing agents

SANTOS MH[1*], ANA PA[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

* marcos.humberto@ufabc.edu.br

Keywords: Mineral Loss, Nanoparticle, OCT, Imaging, Bone.

Introduction

Osteoporosis is a silent, painless skeletal disorder characterized by progressive loss of bone mineral density (BMD). It is a serious public health problem, according to the World Health Organization, due to its increasing prevalence, especially in postmenopausal women, with an important relationship with the drop in estrogen production that occurs in this period of life [1]. In Brazil alone, osteoporosis costs 1.2 billion reais annually, and affects about 10 million people [2].

Although quantification of BMD is routinely performed by bone densitometry test, it is necessary to develop alternative methods that are equally efficient and do not use ionizing radiation, which would allow better monitoring of patients, especially in the early stages of the disease. For this reason, the use of optical coherence tomography (OCT) has been proposed [3].

OCT is a non-invasive, real-time imaging technique that uses a laser or LED light source to obtain thin, high-resolution tomographic slices. A previous study carried out by our group showed the feasibility of diagnosing BMD using this technique in alveolar bone [3]. However, due to the bone depth, techniques are still needed to improve the imaging of these regions.

To improve the quality, contrast, and sensitivity of OCT images, as consequences of deeper optical penetration, some authors propose the application of optical clearing agents on the surface of hard tissues. These agents have higher refractive index than the hard tissue and, in this way, reduce the scattering and reflection of the surfaces. The presence of water or other high-refractive index fluids alter the penetration depth of OCT acquired images. The authors also say that the lower viscosity and biocompatibility are important for that to allow the material penetration into biological structures. The use of water, glycerol and propylene glycol were first suggested to improve the imaging of occlusal caries lesions [4] and, later, other agents such as BABB (33% Benzyl Alcohol + 67% Benzyl Benzoate) and a Cargille Liquid (hydrogenated terphenyl 1-bromo-naphthalene, Cedar Grove, NJ) were successful tested to better detect occlusal hidden subsurface lesions [5]. Recently, silver nanoparticles mixed in glycerol were applied together to OCT 930 nm to better diagnosis enamel hidden lesions and the glycerol and propylene glycol were combined

with OCT 1300 nm to allow the diagnosis of severity of root caries lesions as well as root fractures [6].

Based on these previous experiences, the objective of the present study is to evaluate the early diagnosis and monitoring of initial osteoporotic lesions in alveolar bone using the OCT technique, varying the sample imaging wavelengths, as well as different optical clearing agents.

Materials and Methods

Porcine mandible and maxilla bone blocks will be demineralized with EDTA for 5 weeks days. On each week, the samples will be imaged by optical coherence tomography (OCT) using two different wavelengths (930 nm and 1300 nm), as well as five different optical clearing agents, namely: no agent (control group), distilled water, glycerol, propylene glycol and silver nanoparticles solution. As a gold standard technique, the same samples will also be imaged using a dental cone beam tomography device.

The images obtained will be processed using an algorithm in MatLab previously developed by our group. It will be assessed the optical attenuation coefficient, mean optical attenuation coefficient, integrated reflectivity and BMD.

Conclusions

The project is included in the subarea of medical devices, within Biomedical Engineering, and aims to establish an alternative method, with greater diagnostic accuracy and that allows easier monitoring of osteoporosis.

Acknowledgment

The authors would like to thank to FAPESP (2017-21887-4), PROCAD-CAPES (88881.068505/2014-01), National Institute of Photonics (CNPq/INCT 465763/2014-6), Multiuser Experimental Center of UFABC (CEM-UFABC) and UFPE.

References

1 Anam AK, Insogna K. Update on Osteoporosis Screening and Management. Med Clin North Am, 105(6):1117-1134. 2021.
2 Aziziyeh R, Amin M, Habib M, et al. A scorecard for osteoporosis in four Latin American countries: Brazil, Mexico, Colombia, and Argentina. Arch Osteoporos 14:69. 2019.
3 Del-Valle M, Lins E, Ana PA. Assessment of simulated osteoporosis in alveolar bone using optical coherence tomography. J Biophotonics 12:e201900171. 2019.
4 RS Jones, D. Fried. The Effect of High Index Liquids on PS-OCT Imaging of Dental Caries. Proc. SPIE 5687, Lasers in Dentistry XI. 2005.
5 Kang H, Darling CL, Fried D. Enhancing the detection of hidden occlusal caries lesions with OCT using high index liquids. Proc SPIE Int Soc Opt Eng ;8929:89290O. 2014.
6 Carneiro, VSM, Mota CCBO, Gomes ASL et al. Optical Clearing Agents Associated with Nanoparticles for Scanning Dental Structures with Optical Coherence Tomography. Proceedings of SPIE, 10507, UNSP 1050719. 2018.

Development of a low-cost, double-insulated voltage source for medical equipment

SOUSA MR[1]*, CAMARGO EDLB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*mrslhp@gmail.com; marcos.sousa@ufabc.edu.br

Keywords: Power supply, electrical insulation, linear regulated power supply, switching power supply.

Introduction

Compact electronic devices are increasingly widespread, mainly due to the need to reduce costs and increase reliability combined with higher quality. The miniaturization of components provided the emergence of printed circuit boards as a support for electronic circuits, while at the same time, electronic components were improving their insulation quality. The use of boards brought advantages to electronics, such as low weight and volume, lower costs, simplified and organized assembly, and more robust and vibration resistant [1]. These devices are increasingly in demand, even in environments that pose risks to their integrity or humans. Exposure to high temperatures causes stress on the components, reducing their useful life and humidity causes corrosion on the tracks of the plates and consequently damages the electronic components [1].

Every electronic device needs a power supply, because the energy from the electrical network, to be used, first needs to be transformed into direct voltage to subsequently power and supply the device's circuits [2]. The power supply makes it possible to supply the energy needed for an electronic device.

An ideal DC (direct current) voltage source produces a constant voltage across the load. The simplest of ideal DC voltage sources is the perfect battery, one whose internal resistance is zero[3].

The source's function is to transform the alternating current (AC) from the outlet into a direct current at the correct voltages used by the components. It also serves as a last line of defense against voltage spikes and current instability after the stabilizer [4,5].

Medical equipment is classified as being class II by the IEC 60601-1 standard, according to [6], which refers to electrical equipment in which protection against electric shock is not based only on basic insulation but on additional precautions.

In recent years, there has been a great technological advance arising from research in the electronics area. This development is achieved due to studies carried out in well-structured university laboratories with equipment capable of analyzing the experimental results of the various equipment. As a result, power supplies have been gaining space in the current market. Analyzing this market, we see the need to develop a safe and low-cost power supply for medical equipment.

The general objective of this project is to develop a prototype of an electrical voltage source for EIT equipment used in a laboratory bench that is capable of obtaining satisfactory performance combined with cost-effectiveness during its development. Develop the housing of the voltage source prototype that will be double insulated as

recommended by the IEC60601-1 standard in order to meet the greatest possible number of regulatory requirements.

Materials and Methods

In this stage of the project, a bibliographical survey will be carried out, in the main databases of scientific works, about the topologies/architectures encompassing the power supplies used in medical equipment and their characteristics, the main standards applicable to the proposed power supply will be raised and the identified the main normative requirements present in these standards.

Simplified prototypes of both types of sources will be built, which will make it possible to choose the architecture that has the best cost-benefit ratio.

The prototype will then undergo electrical tests recommended by standards. To limit the financial cost of the project, it is intended to carry out only the electrical safety tests which can be carried out with equipment available at the University, such as the GM-300, an electrical safety test equipment from S.P.L. Elektronik capable of carrying out tests following the standards of the IEC 60601 family.

Results and Discussion

It is expected to obtain, as a result of this project, a voltage source that has a satisfactory performance combined with the cost-effectiveness for power supply and proper functioning of the medical equipment connected to it and that meets the electrical safety standards following the objective outlined for this project work.

Conclusions

This work is being developed at the Biomedical Engineering Laboratory and is in the initial phase of calculating and assembling the prototype, with expected delivery within the stipulated period.

Acknowledgment

This work was carried out with the support of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Financing Code 001.

References

1 ROSÁRIO, J. M. Industrial automation. [S.l.]: Editora Baraúna, 2012.
2 CAVALCANTE, A. S. et al. Service and inclusion: socio-environmental impacts of public electricity policy in building sustainability in the Amazon context. Federal University of Amazonas, 2015.
3 SILVA, M. M. da. Analysis of six-pulse ac/dc converter passive harmonic filters. Master's Dissertation, 2007.
4 SILVA, M. M. da. Analysis of six-pulse ac/dc converter passive harmonic filters. Master's Dissertation, 2007.
5 RODRIGUES, I. R. A. Electrical protection study of a microgrid based on the IEEE 34 bus network. Federal University of Minas Gerais, 2017.
6 SOARES, E. P. Safety of ophthalmology medical equipment. Thesis (Doctorate) — Faculty of Science and Technology of the University of Coimbra, 2008.

Optimizing control loop for ventilation systems

PEIXOTO MA, CAMARGO EDLB

Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

Murilo.peixoto@ufabc.edu.br*

Keywords: Biomedical Engineering, Medical Devices, Biomechanics, Bioinformatics, ventilation, lung ventilation.

Introduction

During covid pandemics, one of the main treatments to COVID-19 was lung ventilation which is a medical device that can through an invasive or non-invasive ventilation force these patients that cannot breathe on their own or are struggling with oxygen absorption [1]. The existent industries for lung ventilators were saturated with demand and even companies that manufacture components for lung ventilators could not keep with the demand. With that, several attempts of developing and producing new mechanical ventilators to keep up with the demand were made, however there was a few that could achieve a good performance which is controlling a set pressure, flux and oxygen rate as fast as possible. It has been attempted to develop, together with a company, a mechanical ventilator that does not make use of proportional valves, since they were one of the main causes of ventilation devices to miss deadlines of production, however control parameters that take into account compliance and resistance were our main challenge, since we did not had a full understanding of ventilation control loops, and well which variables to take into account, we could not develop a ventilator that could be fully used to treat several diseases.

This paper has the main objective to compare and improve control loops for mechanical ventilation medical devices, to do so, minor objectives have been set: understand human pulmonary physiology, list which variables must be taken into account in a ventilation control loop, review control loop optimization, review known control loops that were already used to simulate lung ventilation, compare them and give further steps to further improve control loops for lung ventilation

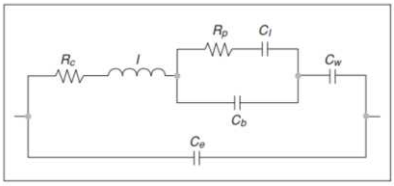
Materials and Methods

The main method to simulate a control loop of a human body is to compare it to a RLC system [2] , which the Resistance is the airways resistance between the point of air intake and the alveoli to the air flux, L is the pulmonary inertance, and C the pulmonary complacency with R typically in cmH2O/L/s or kPa/L/s,L in cmH2O/L/s2 or kPa/L/s2, and

C in L/cmH2O or L/kPa [3], while the air flux can be assumed as the system Current and the pressure difference is the DDP.

Mainly 4 RLC systems were compared that differ themselves in adding different human muscular structure, and pressure loss in the form of Capacitors and Resistances. The model that DIONG simulated that had the best result was MEAD model [4].

Figure 1. Mead model



Font: DIONG et al, 2007 [5]

When simulating these systems what must be aimed is which can simulate a better and smother pressure x volume x flow curve. The work will develop different control methods to guarantee that external stimuli does not affect the system.

Results and Discussion

The results are yet to be studied.

Conclusions

There are conclusions yet to be made after the results have been discussed

Acknowledgment

This work was carried out with the support of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Financing Code 001

References

1 MÖHLENKAMP, Stefan; THIELE, Holger. Ventilation of COVID-19 patients in intensive care units. **Herz**, v. 45, n. 4, p. 329-331, 2020.

2 BOGÁNYI, G. Identification Problems of a Non-Linear RLC Lung Model during Artificial Ventilation. In: **Advances in Biomedical Measurement**. Springer US, 1988. p. 305-310.

3 JABER, Mohammad et al. MATLAB/Simulink Mathematical Model for Lung and Ventilator. In: **2020 32nd International Conference on Microelectronics (ICM)**. IEEE, 2020. p. 1-5.

4. J. Mead, "Mechanical properties of lungs," Phys. Rev., vol. 41, pp. 281–330, Apr. 1961

5. DIONG, Bill et al. Modeling human respiratory impedance. **IEEE Engineering in Medicine and Biology Magazine**, v. 26, n. 1, p. 48, 2007.

A requirements-based approach to data modeling for heart failure data managing and analysis

DIAS ALD[1]*, ALMEIDA FN[1]

[1] Post-Gradutaion Program of Biomedical Engineering (PPG-EBM), Federal University of ABC, Brazil.

*alexandre.davi@ufabc.aluno.edu.br

Keywords: Heart Failure, Cardiovascular Diseases, Information Systems, Data Base, Modelling, Healthcare, Bioinformatics

Introduction

Cardiovascular diseases, including HF, are multifactorial diseases responsible for 15 million deaths worldwide [1]. Currently, about 26 million people are living with a diagnosis of heart failure (HF) [2]. Some of these factors are already known to the medical community and are key points in monitoring diseases such as HF, including non-modifiable risk factors such as gender, age, and genetic predisposition, but there are also risk factors that can be prevented [3]. The goal of this study is to better understand how HF can be monitored, what variables are important in the management of HF patients, and what challenges patients and the professionals caring for them face. We also hope to better understand the importance of modern technological tools to assist patients and professionals.

Materials and Methods

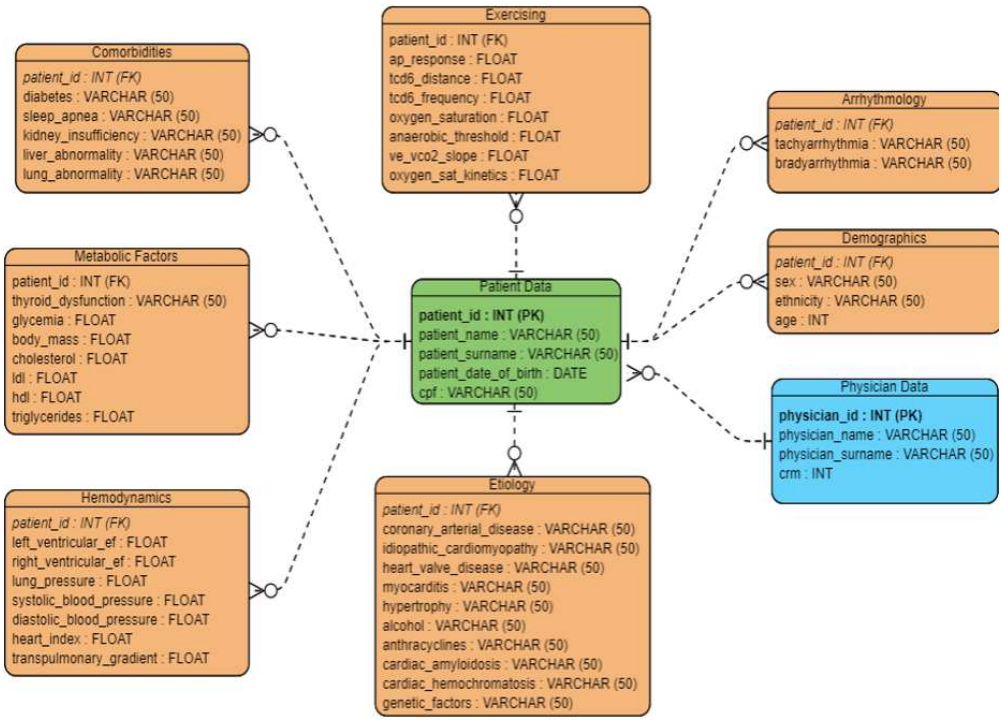
The following sources were consulted: PubMEd, Scientific Electronic Library Online – Scielo and Periódicos CAPES. The keywords used for the search were: Heart Failure, Medicine, Information Systems, Barriers, Challenges, Cardiovascular Disease, Telemedicine, Management, and Health Care.

Results and Discussion

The patient's history provides tools for discovering the etiology of the cardiomyopathy, including the diagnosis of genetic factors. In addition, the stepwise construction of the patient's history can help determine the severity of the disease as well as options for therapies and treatments and their placement in a specific guideline. Therefore, some clinical clues are critical in assessing the patient so that the physician can make his or her diagnoses and conclusions armed with these clues. In addition, it is important that healthcare providers have the means to collect, record, and store the data collected from patients according to the proposed variables. Therefore, with the variables in hand and already organized by type, a relational model for a database was created with this very goal in mind. The relational model was created as a proposed architecture for a database

that could hold and store the data collected from patients by the healthcare provider (Figure 1).

Figure 1. Relational model for the suggested database with the prognostic variables.



Source: Self elaboration.

Conclusions

For continuous and efficient follow-up of the patient, it is necessary to monitor prognostic variables related to the development of the disease, such as ventricular ejection fraction, blood pressure, renal function, blood glucose levels, habits and routines, and risk factors such as smoking, alcohol consumption, and others. Still, it is difficult for medical teams to manage patient data because there are no tools to help store and compare patient data. In light of this, studies have shown that the use of protocols helps maintain HF and reduces the rate of hospital readmissions. The use of technology, such as information systems, for data collection, management, and analysis of HF patients can serve as an efficient medical tool for patient capture, storage, and chronological monitoring, which can help control symptoms and maintain the patient's quality of life.

References

1 Benjamin EJ, Blaha MJ, Chiuve SE, et al. Heart Disease and Stroke Statistics - 2017 Update: A Report from the American Heart Association. American Heart Association. 2017.
2 Ponikowsnki P, Anker SD, Alhabib KF. Heart Failure: Preventing Disease and Death Worldwide. ESC and HFA Paper. Pages 4-25. 2014.
3 Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA Guideline for the Management of Heart Failure. Journal of the American College of Cardiology. American College of Cardiology. 62:e147-e239. 2013.

PSD-LFP parameterization shows increased synaptic noise level in high-β for Parkinson's Disease patients during movement state

BIANQUETI BL[1,2], SILVA LRT[1,2], NETO AF[1,2], LUCCAS JB[1,2], TAKAHATA AK[1,2], ROCHA MS[3], GODINHO F[1,4,5], SORIANO DC[1,2]

[1] Center of Engineering, Modeling and Applied Social Sciences, UFABC,
[2] Brazilian Institute of Neuroscience and Neurotechnology, Campinas, Brazil,
[3] Department of Neurology, Santa Marcelina Hospital, São Paulo, Brazil,
[4] Department of Functional Neurosurgery, Santa Marcelina Hospital, São Paulo, Brazil,
[5] Division of Functional Neurosurgery of Institute of Psychiatry, USP

brunobianqueti@gmail.com

Keywords: Parkinson's Disease, Deep Brain Stimulation, Spectral Parametrization

Introduction

Parkinson's Disease (PD) is a chronic neurological condition that affects both motor and non-motor symptoms [1] and the To investigate the disease's electrophysiology, a classical method is power spectral analysis (PSD) of local field potential (LFP) signals recorded during Deep Brain Stimulation (DBS) procedures. However, recent studies suggest that the PSD analysis should be carefully executed since different electrophysiological changes in the LFP attributes can lead to the same change in the PSD power. Therefore, it is critical to decompose the signal into aperiodic and periodic components to obtain a more effective estimation of the change in PD attributes [2].

The aperiodic or 1/f component of LFP-PSD has gained special attention in recent studies, which may be related to "synaptic noise", a high intense background activity related to the thousands of synapses caused by cortical neurons. [3] This theory is quite relevant because the fluctuating activity can be related to the ratio of excitatory and inhibitory synapses (balance E:I) and the disbalance between these fluctuations can imply neurological and psychiatric disorders such as epilepsy, schizophrenia, and autism, as well as deficiencies in information processing and social exploration [4]

This study aims to contribute to the understanding of the possible roles of the 1/f component in PD, specifically during rest and movement conditions. The results could potentially provide insights into the aperiodic component's role in PD and place it as a possible biomarker for PD patients during daily activities.

Materials and Methods

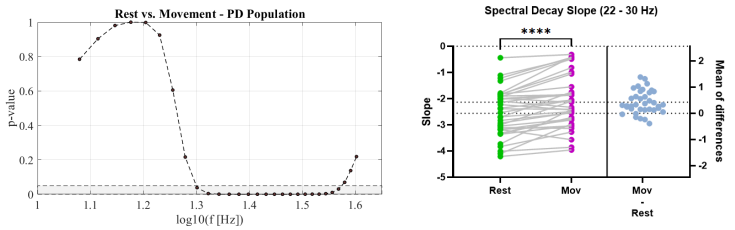
37 LFPs from 25 PD patients were recorded from the sensorimotor portion of the STN during 60s in rest and 60s in movement condition during intra-operatory procedure for DBS electrode implant (CAAE: 62418316.9.2004.0066). Data were sampled at 24 kHz, notch filtered at 60 Hz, and downsampled to 1 kHz before z-scoring. PSD was evaluated through the Welch method and was decomposed into

aperiodic (1/f) and periodic curve with superimposed Gaussians as described in [2]. The best fit to the aperiodic curve was calculated considering ranges of 8 Hz, from 12 Hz (i.e, 8 to 16 Hz), sweeping the spectrum by 1 Hz increments up to the central frequency of 40 Hz (36 to 44 Hz). The angular coefficient parameter (also known as slope) of the best fit was then determined for each frequency and used as a feature for statistical comparison between the conditions rest *vs.* movement using a permutation test. Significant differences were considered for $p < 0.05$.

Results and Discussion

Figure 1 shows the p-valor from the permutation test considering the slope of the aperiodic curve per central frequency for each condition. The statistical results show a significant p-value ($p < 0.05$) between rest and movement along the spectrum after 20 Hz (1.3 Hz in log scale) approximately. Looking into the slope distribution for all PD populations for rest (green) and movement (magenta) conditions in the central frequency 26 Hz (1.41 Hz in log scale), it is possible to observe a flattened aperiodic curve during the movement condition in this range ($p < 0.001$). This result indicates that a higher level of synaptic noise is observed in this narrowband, related to more intense excitatory fluctuations in the balance E:I.

Figure 1. P-value from permutation tests of the aperiodic slope in rest *vs.* movement. Panel B shows the slope for rest and movement and their differences within the narrowband 22-30 Hz.



Source: From the Author

Conclusions

This work contributes to elucidating the differences in the excitatory and inhibitory synaptic balance, reflected in high-β, between the rest and movement conditions. These results can bring more accuracy in the understanding of the electrophysiology attribute changes in PD when compared to the β power, the main biomarker of PD.

Acknowledgment

This work is the result of a 5-year partnership between UFABC and Hospital Santa Marcelina, which has yielded publications and recognitions in Biomedical Eng. forums.

References

1 OLANOW CW, STERN MB, SETHI K. The scientific and clinical basis for the treatment of Parkinson disease. Neurology, 72(21 Suppl 4):S1-S136. 2009.
2 HALLER M, et al. Parameterizing neural power spectra. BioRxiv, 299859. 2018.
3 DESTEXHE A, RUDOLPH M. Extracting information from the power spectrum of synaptic noise. Journal of computational neuroscience, 17:327-345. 2004.
4 GAO R, PETERSON EJ, VOYTEK B. Inferring synaptic excitation/inhibition balance from field potentials. Neuroimage, 158:70-78. 2017.

E-SUS Primary Health Care: Implementation of the information system in the 15 municipalities of Roraima

JOSE EAR [1*], TANAKA H [1]

[1] Federal University of ABC (UFABC), Engineering Biomedical , São Bernardo do Campo/ SP, Brazil.

*elisabete.jose@ufabc.edu.br

Keywords: Information Systems, Health Service, Basic Health Care, e-SUS

Introduction

A major premise of the Health Information System must be the decision support tool for construction of the knowledge from socioeconomic, demographic and epidemiological realities, for planning, management, organization and evaluation of the Unified Health System (SUS) [1]. In this context, the Health Information System (SIS) is being introduced throughout the entire national territory, since 1975 [1]. The Health Information System (SIS) is defined as a system containing tools for information gathering, processing, analysis and transmission, necessary for planning, organizing, operation and evaluation of health services [1].

Primary healthcare is the first contact with a person and the Health Care Network (RAS), within the scope of the SUS. Considering the strategic importance of the SIS implementation at primary healthcare, in 2013, the Ministry of Health defined and developed the primary healthcare SIS e-SUS AB as the strategy to restructure the information of this complex attention level [2].

In that sense, considering the regional and municipal singularity, the e-SUS AB was created containing two software systems modules for information collection: first, the Simplified Data Collection System (CDS) - developed with the purpose of meeting the needs of the Primary Health Services (BHU) which computerized system is not required as the transition to the implementation of the PEC and second, the Electronic Medical Record System (PEC) - system developed for computerized or partially computerized primary healthcare [2].

In prospect of all the above, considering the relevance of the theme for the healthcare services, specifically for the improvement of computerized information systems at primary healthcare, the goal of this study to analyze the Implementation of the e-SUS AB strategy in the 15 municipalities of the Roraima State in Northern Region of Brazil.

Materials and Methods

This is a descriptive and exploratory study, with quantitative-qualitative analyses, performed in the 15 municipalities of Roraima state.

It was used as data collection method of the semi-structured interview, it was accomplished from February 2022 to March 2022 in the Roraima State. The software used for data and content statistical analysis was the Free Jamovi Statistical Software.

Results and Discussion

Considering the implementation of the e-SUS AB Strategy in the Roraima state, it was demonstrated that 70% (10) of the municipalities have connection with the internet, however slow and unstable, 14% (2) with fast and stable internet connection, 14% (2) with internet connection with only SMS, however slow and unstable, and 7% (1) does not have no connection with the internet. Studies demonstrate that the lack of connectivity frequently is the subject of discussion in the CONASS and COSEMS meetings, which it shows that this fragility has been focused as the major concern for the 3 entities of the federation: Federation, State and Municipality [3].

60% (9) of the municipalities use two softwares, CDS and PEC to send data to SISAB, 20% (3) use PEC, 13% (2) use only CDS and 7% (1) use software other than recommended by MS. The data points out that the transition from CDS to PEC is not homogeneous in the state of Roraima. The absence or low quality of the internet connection is the cause of the difficulties to implement the PEC[4]. Studies point out that in almost all territory of the North Region, the internet connection has poor quality with limited coverage, speed and instability [4].

Conclusions

The e-SUS AB system is a powerful tool to be used by SUS managers to support decision-making processes in the management of Primary Care. Therefore, to ensure its proper implementation, one of the main barriers to overcome is the low quality of internet connectivity. However, even under the circumstances and other challenges, the efforts of the health managers to implement the e-SUS are evident.

Acknowledgment

We acknowledge and appreciate the support from the President of COSEMS of the State of Roraima.

References

1 ROUQUAYROL MZ, SILVA MGC. Epidemiologia & saúde. 8. ed., Rio de Janeiro: Medbook, 752 p. il. ISBN 978-85-8369-029-0. 2018.
2 BRASIL. Ministério da Saúde. Secretaria de Atenção à Saúde. e-SUS Atenção Básica: Manual do Sistema com Coleta de Dados Simplificada: CDS – Versão 3.0. 2018.
3.CONASS. Resumo executivo da 1ª reunião extraordinária da Comissão Intergestores Tripartite. Brasília: CONASS. 2017.

Acquisition of atrial epicardial electrical activity in an isolated rabbit heart through multiple-electrode arrays

WEBER GL[1*], CORREIA RC[1], PAREDES JG[1], SILVA VP[1], SANDOVAL I[1], UZELAC I[1], SALINET JL[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
*glweber@aluno.ufabc.edu.br

Keywords: Biomedical Engineering, Biomedical Instrumentation, Electrocardiographic Mapping, Digital Processing, Langendorff.

Introduction

High-density recordings of the cardiac electrical activation sequence are valuable in both research and clinic, since they provide spatiotemporal and electrophysiological characterization of the cardiac tissue [1]. Commercial micro-electrode arrays have been widely used to acquire this high-density electrophysiological electrical activity, but unfortunately they cannot be used for mapping a whole heart/chamber of a rabbit, due to their small mapping area and non-conformant geometry to the curvature of the epicardium.

This project goal is to measure through two different approaches of multiple-electrode arrays (MEA), a commercial and a custom-built MEA, the electrical activity on the left atrium epicardium of an isolated rabbit heart, for a later comparison of the data acquired with an optical based electrical activity mapping and a non-contact electrical activity mapping.

Materials and Methods

The commercial MEA to be used is a FlexMEA36 (Multichannel Systems, Germany), with 36 30 µm TiN electrodes spaced by 300 µm in a 6x6 matrix with a mapping area of roughly 2.25 mm^2.

For the custom built solution, using the reconstructed geometry of the isolated rabbit's heart, a 3D model of the MEA's main surface with the corresponding curvature and size of the left atrium is generated and added to a shaft for manipulation of the MEA and cable routing.

With the aid of a standard FDM 3D printer, a two part mold of the MEA is built and using isolated 0.3 mm silver wires as the electrodes the MEA is wired and then silicone casted to form the body and shaft of the MEA.

After the heart has been isolated, perfused and inserted into the mapping tank, both MEAs are placed in different moments on the left atrium and connected to a 64-channel headstage (Intan, US) which then are connected to a 256-channel acquisition board (Open Ephys, US) sampling at 2 KHz/s each channel.

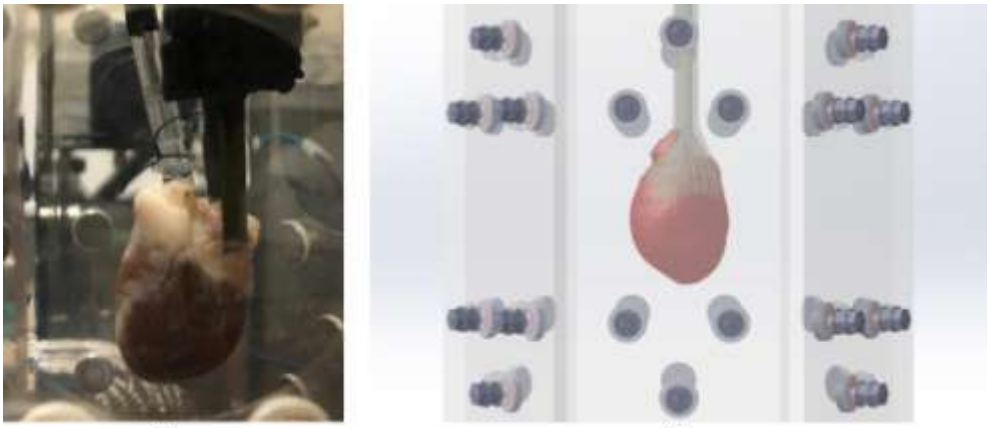
The data is visualized live with the Open Ephys GUI and stored for later analysis in conjunction with the optical based and non-contact electrical maps created.

Results and Discussion

A preliminary experiment was made with the FlexMEA36 (figure 1.a) and the electrical activity has been recorded. As expected it was noted that the geometry of the MEA made it difficult to achieve reliable contact with the surface of the heart.

A 3D model of the heart used in that experiment, created through means of a multi-projection optical reconstruction, was used for the modelling of a custom MEA (figure 1.b), allowing for a personalized and possibly more reliable solution for measuring the epicardium electrical activity.

Figure 1. FlexMea36 on the left atrium of an isolated rabbit's heart inside the experimental tank (a). 3D model of a custom MEA inside the same setup in contact with a reconstructed heart (b)



Source: Author.

Conclusions

The commercial MEA has been used on a preliminary experiment and data analysis will follow. The custom built MEA has been modeled and is in fabrication process for later validation tests. Experiments with both MEAs will be done on the next phases of the project.

Acknowledgment

This study is supported by grant #2018/25606-2, FAPESP. The validation will occur in the Experimental Cardiac Electrophysiology Laboratory (HEartLab) at the host institution.

References

1 Cohen ML, Hoyt RH, Saffitz JE, Corr PB. A high density in vitro extracellular electrode array: description and implementation. . Amer J Phys - Heart Circ Phys, 257(2): .H681-H689. 1989.
2 Reppel M, Pillekamp F, Lu ZJ, Halbach M, Brockmeier K, Fleischmann BK, Hescheler J. Microelectrode arrays: a new tool to measure embryonic heart activity. J Electrocardiol, 37(104-9). doi: 10.1016/j.jelectrocard.2004.08.033. PMID: 15534818. 2004.

The use of the smartphone for kinematic analysis in a wheelchair: Preliminary results

RODRIGUES H.O [1]* , SILVA O.L. [1]

Affiliation: [1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
helirodriguesto@gmail.com*

Keywords: Biomedical Engineering, Kinematics, Smartphones, Wheelchairs.

Introduction

Several studies have been carried out describing the straight trajectory in a wheelchair, however, moving in curvilinear trajectories is part of the daily life of wheelchair users [1].

These trajectories favor the appearance of turning resistances [2] that will affect the force required for propulsion and maneuvers. Among the skills necessary for using a wheelchair, it is possible to verify 3 basic curvilinear trajectories, for development in daily life, rotating on its own axis; turn while moving; maneuver the wheelchair laterally left and right [3].

In the same way that basic skills are corroborated in two of the canonical maneuvers defined by [4] they are: straight trajectory, curve with fixed wheel and rotation around its own axis.

Data capture in studies performed for kinematic analysis are usually developed by dedicated sensors, through the use of accelerometers and gyroscopes [5] [6] [7].

Currently, there are studies in the literature that use smartphones to capture data, most of which are analyzes of shoulder movements[8]. study of trunk kinematics in the elderly [9] assessment of dynamic balance [10].

In this way, this work aims to present the partial results of using the smartphone to analyze the kinematics in a wheelchair in curvilinear trajectories (8 and L trajectory). as part of the master's project, Development of a methodology for kinematic analysis of curvilinear trajectories in a wheelchair using a smartphone..

Materials and Methods

Experimental study, with the researcher as the subject of the research, different tests were carried out with the wheelchair in an 8 and an L trajectory, using two smartphones, Galaxy A32 5G models and a Moto G 9 play. Both cell phones of the lead researcher.

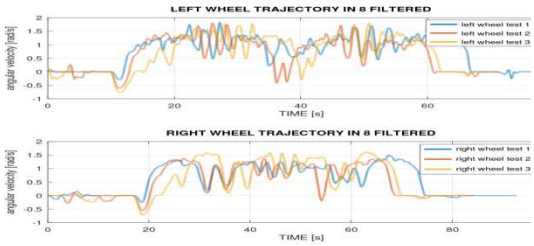
The Physics Toolbox Sensor Suite Pro application, manufactured by Vieyra Software Inc., was used to capture the data. [11]

To filter the data obtained, the moving average filter was applied, as they present noise that interferes with the analysis. In addition to performing a graph alignment as a function of time. For data analysis Data analysis will be done through the OCTAVE application.

Results and Discussion

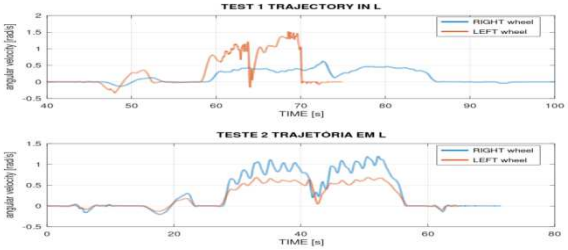
In the graphs of figure 1, we observe a collection carried out in 3 moments, with repetition of the trajectory, at the moment in which both graphs a depreciation occurs reaching angular velocity at -0.5rad/s is the moment that the data collection starts, for be considered the starting point, the wheelchair is reversed and the trajectory begins

Figure 1. Trajectory of the Wheelchair in 8



Font: Own creation

Figure 2. Trajectory of the Wheelchair in L



Font: Own creation

As it is a 3 in 8 figure trajectory, where it has curved movements both to the right and to the left, it is possible to observe the difference between the data capture wheels, because to make a curve it is necessary to pull it behind a wheel and perform the thrust of the other, so there is a difference in the graph.

The trajectory was carried out in an L (figure 2), It is observed that the graph of test 1, presents a difference between the collections, with the right wheel with angular velocity reaching just over 0.5rad/s and the left wheel reaching up to 1.5rad /s.

In Test 2, the right wheel is observed to have the highest angular velocity, passing 1.0rad/s and the left wheel passing a little 0.5rad/s. in both graphs it was still not possible to identify the variables that caused this difference in data collection.

However, in test 2, the speed peaks of both wheels are observed, presented in the first straight line up to the 90º curve, the right wheel with 6 peaks and the left wheel

Conclusions

From the data presented, it is understood that it is possible to use smartphones for kinematic analysis of wheelchairs in curvilinear paths. However, it is necessary to make adjustments in the calibration of the devices. Thus, from the creation of the methodology, it will be possible to optimize the kinematic analysis within biomedical engineering studies, also allowing this analysis to be performed by health professionals such as the Occupational Therapist, within their clinical practice.

References

1. SONENBLUM, SE.; SPRIGLE, S.; LOPEZ, RA. Manual wheelchair use: bouts of mobility in everyday life. Rehabilitation research and practice, Hindawi, v. 2012, 2012.
2. BOUÇA-MACHADO, R. et al. Feasibility of a mobile-based system for unsupervised monitoring in parkinson's disease. Sensors, MDPI, v. 21, n. 15, p. 4972, 2021.
3. KIRBY, R. et al. The Wheelchair Skills Program Manual Version 4.3. Published electronically at Dalhousie University, Halifax, Nova Scotia, Canada. 2020.
4. SPRIGLE, S.; HUANG, M. Manual wheelchair propulsion cost across different components and configurations during straight and turning maneuvers. Journal of rehabilitation and assistive technologies engineering, SAGE Publications Sage UK: London, England, v. 7, p. 2055668320907819, 2020
5. COOPER, RA. Validation of an accelerometer-based method to measure the use of manual wheelchairs-editor's comment. Medical Engineering & Physics, v. 35, n. 4, p. 555–555, 2013
6. HIREMATH, SV.; DING, D.; COOPER, RA. Development and evaluation of a gyroscope-based wheel rotation monitor for manual wheelchair users. The journal of spinal cord medicine, Taylor & Francis, v. 36, n. 4, p. 347–356, 2013
7. COULTER, EH. et al. Development and validation of a physical activity monitor for use on a wheelchair. Spinal cord, Nature Publishing Group, v. 49, n. 3, p. 445–450, 2011.
8. ROLDÁN-JIMÉNEZ, C. et al. Reliability of a smartphone compared with an inertial sensor to measure shoulder mobility: Cross-sectional study. JMIR mHealth and uHealth, JMIR Publications Inc., Toronto, Canada, v. 7, n. 9, p. e13640, 2019
9. GALÁN-MERCANT, A.; CUESTA-VARGAS, AI. Differences in trunk kinematic between frail and nonfrail elderly persons during turn transition based on a smartphone inertial sensor. BioMed Research International, Hindawi, v. 2013, 2013
10. KUZNETSOV, NA. et al. Validity and reliability of smartphone orientation measurement to quantify dynamic balance function. Physiological measurement, IOP Publishing, v. 39, n. 2, p. 02NT01, 2018.
11. VIEYRA, R. et al. Transforme seu smartphone em um laboratório de ciências. Associação Nacional de Professores de Ciências, v. 82.

Circle method for estimation of local conduction velocity to characterize ablation sites using optical mapping data

SILES JG[1*], CROWLEY CJ[2], FENTON FH[2], BHATIA N[2], IRAVANIAN S[3], SANDOVAL I[1], POLLNOW S[4], DÖSSEL O[4], UZELAC I[2], SALINET JL[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2]Georgia Institute of Technology, School of Physics, Atlanta, GA, United States
[3] Emory University Hospital, Division of Cardiology, Atlanta, GA, United States
[4] Karlsruhe Institute of Technology, Biomedical Engineering, Karlsruhe, Germany
*Jimena.gabriela@ufabc.edu.br

Keywords: Atrial Fibrillation, Optical Mapping, Conduction Velocity, Ablation

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia. AF impacts the patient's quality of life and elevates the risk of sudden cardiac death. Radiofrequency catheter ablation (RFA) is an invasive treatment to terminate and prevent AF. Conduction velocity (CV) slowing is an important metric after ablation. Optical mapping (OM) is a novel technique providing a higher resolution than traditional commercial systems. This study introduces the “circle method” (CM) which utilizes OM to estimate CV and evaluate the impact of RFA through numerical simulations as well as ex-vivo animal and human heart experiments.

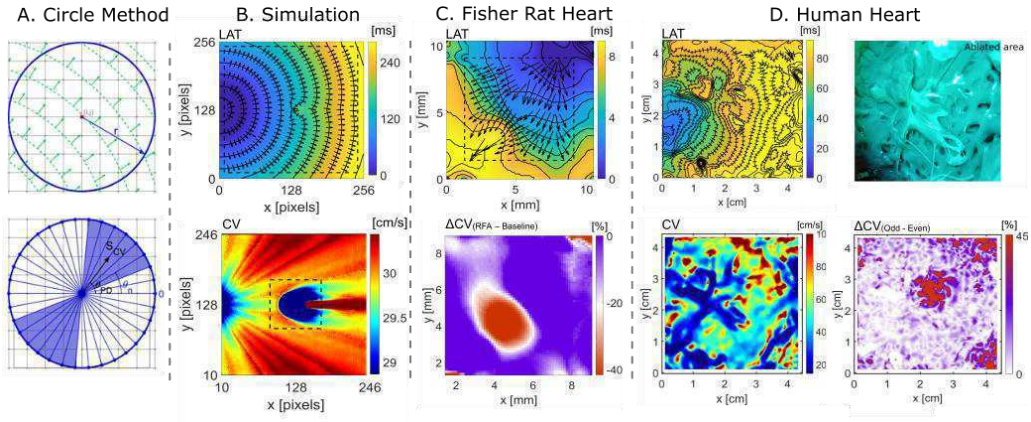
Materials and Methods

The CM employs a circle of radius r centered around each local activation time (LAT) grid point and calculates CV based on the differences in the LAT across the endpoints of chords passing through the center of the circle (Fig. 1A), To evaluate effectiveness of this method simulations were conducted using Fenton–Karma’s three variables model, with ablation achieved by increasing the time constant of the fast inward Na+ current. White Gaussian noise was added with different signal-to-noise. The right atrium Fisher rat (N = 2), approved by the local Committee for Animal Welfare (35-9185.81/G-61/12), was stained with Di-4-ANEPPS dye and excited for a green LED (525 nm). Images were acquired using an EMCCD camera. The explanted human hearts (N=2) were obtained with the patient's consent via the Emory Hospital Heart transplant program. The left ventricle was stained with Di-4-ANBDQPQ. Two red LEDs (660 nm) and two green LEDs (525 nm) were used in alternating sequences (fs = 500 Hz). Guinea pig heart (N = 1) had and similar setup and was approved by the Office of Research and Integrity Assurance at Georgia Institute of Technology. The RFA procedure was performed for all cases. LAT maps were calculated with the 50% criteria [1] and generated CV maps. The ΔCV was calculated as a relative difference between before and after ablation for each of the two excitation bands and separately for even and odd beats to study beat-to-beat CV alternans. Finally, CV maps were compared with another standard method.

Results and Discussion

Simulations demonstrated that the region of conduction velocity (CV) decrease (shown in blue) corresponded to the location of the simulated ablation, as depicted in Figure 1B. This was observed even in the presence of high noise levels (SNR < 5Db). In the case of Fisher rats, it was necessary to calculate the ΔCV(RFA-Baseline) to obtain a more precisely defined ablation area, as illustrated in Figure 1C. Finally, in the highly trabeculated human endocardium, the ΔCV (Odd - Even) map was computed to determine the spatial extent of the lesion and its depth (which was found to be over 3 mm), and this information was reflected in the corresponding image to depict the extent of the ablation accurately.

Figure 1. A. Circle method; B. Simulation LAT and CV map C. Fisher rat heart LAT and $\Delta CV_{(RFA - Baseline)}$ map; D. Human heart LAT, CV, $\Delta CV_{(Odd - Even)}$) map and tissue image with the ablated area,



Font: Siles JG and Uzelac I authorship.

Conclusions

Through the developed method was possible to characterize the ablation effect over the cardiac substrate, being teste in numerical simulation and ex-vivo animal and human experiments.

Acknowledgment

Siles JG was supported by the Program of Alliances for Education and Training (OEA-GCUB-2017) and currently is supported by grant #2020/03601-9 (FAPESP), Grant #2018/25606-2 (FAPESP), Uzelac I and Salinet J are supported by grant #2018/25606-2 (FAPESP). This study was also supported in part by the NIH under grant 1R01HL143450-01, and the NSF under CMMI-1762553.

References

1 Siles J, Salinet J, Pollnow S, Dössel O, Uzelac I. Estimation of the Ablated Area size based on Local Conduction Velocity Simulations and animal experiments. Computing in Cardiology (CinC), Brno, Czech Republic, pp. 1-4, doi: 10.23919/CinC53138.2021.9662765, 2021.

Characterization of cerebral autoregulation in patients with stroke: a pilot study.

ROMANELLI R*[1], SALINET JL[1], SALINET ASM[2]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Neurology Department, School of Medicine, University of São Paulo, Hospital das Clínicas, São Paulo, Brazil

**romanelli.c@aluno.ufabc.edu.br*

Keywords: Cerebral blood flow, cerebral autoregulation, stroke, cerebral hemodynamic

Introduction

Cerebral Autoregulation (CA) is an intrinsic mechanism of the brain responsible for maintaining constant cerebral blood flow (CBF) despite the variation in arterial blood pressure (ABP) [1]. CA mechanism is critically changed in stroke, since this cerebrovascular disease significantly alters brain hemodynamics [2]. A better understanding of the CA functioning in stroke patients could contribute to the development of neurological outcome predictors as well as therapeutic strategies. In addition, the assessment of CA, in a non-invasive way, is performed using traditional techniques and advanced physiological signal processing. However, there is no consensus on which AC calculation method accepted as the gold standard in the academic community [3]. In this context, we aim to assess CA in acute ischemic stroke patients using different metrics of CA calculation, also to compare those results to what was obtained from healthy control group.

Materials and Methods

ABP and bilateral CBF velocity of 24 participants (12 control and 12 post-stroke subjects) were recorded for 5 minutes on baseline (Fs: 100Hz, CAPPesq no.126713 HCFMUSP). Signals were pre-processed including calibration, filtering, syncronization and surrogated to beat-to-beat signals.

Four methods of calculating CA were applied, namely Transfer Function Analysis (TFA), Cerebral Autoregulation Index (ARI), ARI with Autoregressive Moving Average (ARMA-ARI) and Non-invasive Mean Flow Index (nMx). Results of TFA methods are divided in tree frequency ranges: very low frequency (VLF), low frequency (LF) and high frequency (HF). The National Institutes of Health Stroke Scale (NIHSS, acute phase) and the modified Rankin Scale (mRS, after 3 months) were used for the evaluation of the clinical aspects of the post-stroke patients.

For statistical analysis, Shapiro-Wilk normality test and Levene's homogeneity test were initially performed. For groups that presented at least one of the conditions, one-way ANOVA test was applied to conduct the groups (stroke affected hemisphere, stroke

unaffected hemisphere and healthy control) comparison of CA measures. Values of p ≤0.05 were considered statistically significant.

Results and Discussion

Results of CA metrics studied are presented in table 1. The only metric that presented statistical difference between the groups was the nMx method. TFA_{Gain} for VLF presented ANOVA's p-value very close to the range considered significant. The mean of NIHSS e mRS of the stroke patients is 7.58 ± 2.07 and 2.17 ± 2.08, respectively, indicating mild to moderate disability at acute and chronic phases.

Table 1 - Descriptive statistics and One-way ANOVA results of control and post-stroke groups

group		TFA_{Gain}			TFA_{Phase}			$TFA_{Coherence}$			ARI	ARMA -ARI	nMx
		VLF	LF	HF	VLF	LF	HF	VLF	LF	HF			
Control	Mean	1.02	1.46	1.62	0.52	0.46	0.08	0.57	0.64	0.66	5.35	4.74	0.25
	STD	0.55	0.75	0.62	0.87	0.37	0.29	0.23	0.18	0.18	2.40	2.00	0.23
Stroke affected	Mean	2.23	2.77	1.91	0.76	0.45	0.16	0.68	0.70	0.70	4.64	4.07	0.42
	STD	2.96	4.40	1.03	0.83	0.27	0.22	0.21	0.16	0.16	2.86	2.83	0.32
Stroke unaff.	Mean	1.49	2.05	3.50	0.74	0.39	0.10	0.69	0.69	0.79	5.01	4.87	0.49
	STD	0.59	2.09	6.49	0.73	0.27	0.35	0.20	0.21	0.18	2.00	2.35	0.27
	ANOVA	0.09	0.33	0.28	0.62	0.83	0.58	0.20	0.62	0.11	0.71	0.65	0.04

Conclusions

The results of the study suggest that mil-to-moderate acute stroke patients do not have a compromised CA, or CA was minimally compromised. There was no significant difference in CA metrics between post-stroke patients and controls groups. However, this was a pilot study, and the small number of subjects was a major limitation. Our study, therefore, need to be validated by a larger sample size study.

Acknowledgment

RR is supported by grant #2021/10288-8 FAPESP. JS is supported by grant 2018/25606-2, FAPESP. ASMS was funded by PNPD/UFABC of the CAPES (2018–2019), (UFABC—2020–2021) and CNPq #426440/2018-8.

References

1 Salinet, J et al. "CAAos platform: an integrated platform for analysis of cerebral hemodynamics data." *Physiological measurement* vol. 42,10 10.1088/1361-6579/ac0c0b. 2021.

2 Salinet, ASM et al. "The longitudinal evolution of cerebral blood flow regulation after acute ischaemic stroke." *Cerebrovascular diseases extra* vol. 4,2 186-97. 2014.

3 Beinshon L, et al. INFOMATAS multi-center systematic review and meta-analysis individual patient data of dynamic cerebral autoregulation in ischemic stroke. 15(7):807-812. 2020.

Numerical evaluation of SAR distribution and temperature changes during 7T MRI procedures

SANTOS D[1], PAPOTI D[1], OLIVEIRA TR[1*]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*tiago.ribeiro@ufabc.edu.br

Keywords: SAR deposition, MRI, RF safety, Ultra-high field (7T)

Introduction

MRI is the most powerful diagnostic imaging technique in terms of spatial resolution and tissue contrast, and it does not use ionizing radiation. It only uses energy in the range of radio frequency (RF). Preventing excessive RF deposition and its consequence heating plays a vital role during MRI procedures (1). Historically, RF safety in MRI procedures has been monitored by the quantity Specific Absorption Rate (SAR) that indicates a parameter of energy that can be safely delivered to the patient. However, understanding the whole phenomena of electromagnetic field propagation in the human body is still challenging. There are several issues, including thermal distribution behavior with experimental measurements. Therefore, it is essential to have a robust method to predict how SAR distribution will be in a specific situation (2). This project aims to evaluate local electromagnetic field deposition and temperature elevation on the Human Knee Model due a dedicated MRI transmission volume coil. and translate the calculated deposited energy into a temperature distribution Map.

Materials and Methods

To perform the 3D numerical analysis, we used the commercially available software COMSOL Multiphysics 5.4 (COMSOL Inc., Sweden). The designed high-pass birdcage coil for □0=7T is made of copper, has a cylindrical shape, and 15 capacitors and one variable capacitor (5 to 15pF) that are located at its end-rings, and its excitation is done through a single port. An EM shielding apparatus is connected to the coil to avoid EM interference from other hardware components of the MRI scanner. An MRI procedure is simulated by using the voltage of V0=68.7V for the coil's excitation value. A spherical phantom with a complex geometry positioned in the center of the coil will be created to represent the subject submitted to the MRI procedure.

Human thermal behavior is a highly complex phenomenon, and modeling this system has been traditionally done on two levels of complexity: the passive part and the entire thermoregulatory system (3). The modeling of the passive living tissues involves mainly the mechanisms by which heat diffuses, and the control functions appear only as prescribed variations of boundary conditions and parameters. The living

tissues are materials intrinsically inhomogeneous and anisotropic (4). For thermal analysis purposes, the 3D SAR maps generated for different human Knee models will be assigned as an external heat source in the thermal modeling. The 3D temperature distribution will be numerically calculated by using the Finite Element Method (FEM) to solve the continuum bioheat transfer equation (Pennes' equation) (5). In Pennes' equation, the thermal conductivity, perfusion rate, and metabolic heating are assumed to be uniform.

Results and Discussion

This study still needs to present results, as the numerical simulations are still under performance. Nevertheless, there is an expectation to overcome some of the scientific challenges: 1) Numerical convergence and stability of the solutions for the coils based on the B1 field and local SAR map calculations; 2) estimation of SAR maps for various objects and human knee models as an input to the temperature simulations and comparison to experimental results; 3) Design of a reliable computational bioheat transfer process in patients; 4) Assign the tissue effective thermal properties, due to the lack of accurate knowledge of thermal conductivity and diffusivity of tissues; 5) Account the Inter-patient variability of tissue properties.

Conclusions

Accurate and realistic modeling of coils for the ultra-high field (7T) MRI is a crucial prerequisite for this project. A stable and convergent solution for the magnetic (B1) and electric (E) field will trigger the calculation of energy per mass unit absorbed, i.e. SAR, in various materials, especially in phantoms and human body models. This project aims to numerically calculate the local temperature and energy distribution of individual human body models during MRI measurements at ultra-high field MRI at 7T.

Acknowledgment

I would like to thank UFABC for the opportunity to develop this project.

References

1 Shellock F, Radiofrequency energy-induced heating during MR procedures: A review. J Magn Reson Imaging, 12(1): 30-36. 2000.
2 Ibrahim T, Abduljalil A M, Baertlein BA,et. al. Analysis of B1 field profiles and SAR values for multi-strut transverse electromagnetic RF coils in high field MRI applications, Phys Med Biol, 46(10): 2545-2555. 2001.
3 Gabriel S, Lau R and Gabriel C. The dielectric properties of biological tissues: II. Measurements in the frequency range 10 Hz to 20 GHz. Phys Med Biol, 41(11): 2251-2269. 1996.
4 Moros E. Physics of thermal therapy – Fundamentals and clinical applications. CRC Press. 2013.
5 Fiedler T, Ladd M and Bitz A, SAR simulations and safety, Neuroimage, 168: 33-58. 2018.

Development of 3D bioabsorbable cardiovascular stents for pediatric aortic coarctation

OLIVEIRA DC[1*], CARBONARI RC[1], MALMONGE SM[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/SP, Brazil

*cavalcante.daniel@ufabc.edu.br

Keywords: Biomedical Engineering, Medical Devices, Bioabsorbable, 3D-Printing.

Introduction

Aortic coarctation is a discrete narrowing of the thoracic aorta, most commonly at the insertion of the ductus arteriosus. In addition to anatomic obstruction, it can be considered an aortopathy with abnormal vascular properties characterized by stiffness and impaired relaxation. There are surgical and transcatheter techniques to address the obstruction but, despite relief, adult and child patients with aortic coarctation are at risk for hypertension, aortic complications and abnormalities with left ventricular performance [1].

Currently, the use of metal stents is the common treatment for aortic coarctation, both for adults and children, with good results in long-term for adults and short-term for children. The complication of the use of metal stents for children with aortic coarctation is that the stents do not keep growing according to the development of the child's vessels through their growth, leading these children susceptible to perform future surgeries to the stent removal [2].

Thus, the objective of this study is the development of an 3D-printed bioabsorbable stent using Poly(L-Lactic Acid) (PLA), the most commonly used polymer for the production of bioabsorbable stents and Polycaprolactone (PCL), a polyester which has been used in bioabsorbable medical applications. It is expected that these polymers will be able to accompany the growth of the children's vessels and after a certain period of time be reabsorbed from its body safely, making this a one-time solution for the treatment of pediatric aortic coarctation.

Materials and Methods

Prototypes of bioabsorbable stents will be manufactured using bioabsorbable polymers PLA and PCL.

PLA is an aliphatic polyester composed of the L-enantiomer of lactic acid (2-hydroxy propionic acid) and PCL is a polyester which has been used in bioabsorbable medical applications. It is a semi-crystalline polymer with good flexibility and a low melting point of approximately 60 degrees Celsius. It is nontoxic and causes minimal local inflammation during degradation [2].

The design of the bioabsorbable stent will be made using Python Version 3.10 and exported to ".stl" format for printing.

3D Printing will be used to develop the final prototype of the bioabsorbable stent, as it is known for its advantage in geometric freedom of the parts. Steep structures, with sharp angles and non-repeating shapes would be unfeasible in other production methods [3].

The best polymer to be used in the development of the bioabsorbable stent will be chosen by the following tests: Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Scanning Electron Microscopy (SEM), Visible light and polarized light optical microscopy, Tension x Deformation test under tension, Elastic Recoil Test.

Results and Discussion

The best polymer to be used in the printing of our bioabsorbable stent is expected to be chosen after the tests aforementioned are completed.

In addition to these tests, after the bioabsorbable stent is printed in different orientations (horizontally and vertically), mechanical and thermal properties will be assed, as well as thermal stability and transitions to ensure compliance to clinical rules.

Conclusions

The global increase in the number of children with aortic coarctation is a medical problem that needs to be addressed in order to overcome its barriers. Bioabsorbable stents can solve this problem right at the beginning, improving the quality of life of these patients in long-term care, without having to resort to multiple surgeries in their lifetime. The development of our 3D-printed bioabsorbable stent will bring a series of benefits to the clinical area with its ease of use and more accessible materials to clinics around the world.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

References

1 Kim YY, Andrade L, Cook SC. Aortic Coarctation. Cardiol Clin. 38(3):337-351. 2020.
2 Alexy RD, Levi DS. Materials and Manufacturing Technologies Available for Production of a Pediatric Bioabsorbable Stent. BioMed Research International. 2013:1-11. 2013.
3 Jacinto, TAJ. Desenvolvimento de stent polimérico biorreabsorvível de rápida expansão por balão para coarctação de aorta. Dissertation (Master's in Biomedical Engineering) – Federal University of ABC. 2020.

Prototype of upper limb prosthesis with gradual force control

KUNKEL ME, THIAGO NERI*

*Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil.

*thiago.neri@ufabc.edu.br

Keywords: Additive Manufacturing,Upper Limb Prosthesis,3D Printing.

Introduction

Adults and children with partial or total amputation of an upper limb, caused by disease, malformation, injury or trauma, can improve their quality of life with the use of a prosthesis [1]. Currently, the market offers numerous options for upper limb prostheses that can be mechanical, aesthetic, myoelectric or hybrid [2]. In a previous research, version 1 of the upper limb mechanical prosthesis prototype with gradual force control was developed. The prototype consists of a hand, arm, forearm and mechanical device for gradual force control. During the bench tests, the prototype responded well to the tests, in gripping rigid and flexible objects, in closing, remaining closed and handling, with only a flexion movement performed by the elbow. Difficulties of the unified health system (SUS) in serving everyone, and the high cost of prostheses on the market, make their acquisition difficult [3]. As the level of amputation defines the most suitable type of prosthesis, people with an amputation level or malformation above the elbow have a limited number of models available. As an alternative, in recent years, the supply and options of customized upper limb prostheses produced by additive manufacturing have increased [4].

Objective: To develop and test a mechanical prosthesis prototype, activated by a gradual force control, through the movement of the elbow. The gradual force control is a mechanical device that measures all traction transferred from the elbow to the prosthesis. All force exerted by flexing the elbow, passes through the device, converging in opening, closing and keeping closed, holding the object, dispensing with effort and repetition of the continuous movement of the elbow.

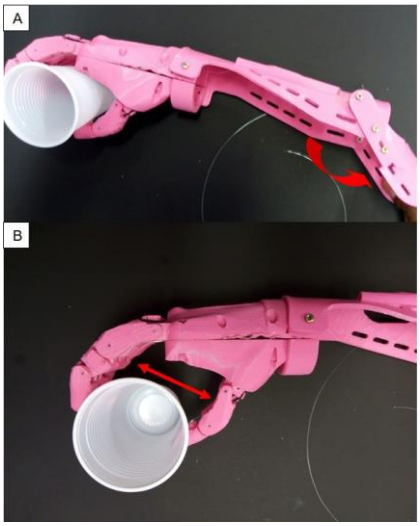
Materials and Methods

Version 2 of the prototype was developed with the same processes and resources as version 1, but adjustments and remodeling of some parts were performed. For greater anatomical similarity to the human hand, the entire design was remodeled, providing more familiarity between patient and prosthesis. Improved drive mode, with nylon line replacement for fishing line. And for a better aesthetic look and comfort, the mechanical device was transferred to the inside of the prosthetic hand.

Results and Discussion

Version 2 of the prosthesis prototype with gradual force control, through bench tests and with the author, with just one flexion of the elbow, it was possible to open, close, remain closed and manage a full and empty plastic cup without damaging it. it. However, the lack of friction between the cup and the hand made it difficult to hold it securely. For better performance of the device, in order to increase the friction between smooth surfaces and the palm of the hand, some coatings will be tested in the next prototypes.

Figure 1. Mechanical Prosthesis Prototype. A) Closed hold; B) Open grip.



Font: Author.

Conclusions

Through additive manufacturing technology, it was possible to design a mechanical prosthesis prototype, controlled by a mechanical device gradually controlling force. Tests will be carried out with amputees to assess whether this alternative is viable, safe and affordable to trigger an upper limb prosthesis.

Acknowledgment

Rede FabLab Livre SP

References

1 BRASIL. Ministério da Saúde. Secretaria de atenção à saúde. Diretrizes de atenção à pessoa amputada. Ministério da saúde, secretaria de atenção à saúde, departamento de ações programáticas estratégicas. 1. ed. 1. reimp. – Brasília: Ministério da Saúde, 2013.
2 CUNHA FL. Mão de São Carlos, uma prótese multifuncional para membros superiores: Um estudo de mecanismos, atuadores e sensores. 2002. V. Tese (Doutorado) - Escola de Engenharia de São Carlos, Universidade de São Paulo, São Paulo.
3 Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde.Departamento de Ações Programáticas Estratégicas. Diretrizes de atenção à pessoa amputada. Brasília: Ministério da Saúde; 2014. 2 ed.
4 Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde.Departamento de Ações Programáticas Estratégicas. Diretrizes de atenção à pessoa amputada. Brasília: Ministério da Saúde; 2014. 2 ed.

Study of the synergistic effects of high-intensity Q-switched laser and glass-ceramic modified with fluoride and antimicrobial agent on the adhesion of cariogenic biofilm and in stopping root radiation related- caries

SANTOS FKC[1] , ANA PA[1 *]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

[*] patricia.ana@ufabc.edu.com.br

Keywords: Laser, Carie, Dentine, Fluoride, Glass-ceramic, Radiotherapy.

Introduction

Radiotherapy, in particular, can be used as a definitive treatment, adjuvant or as a palliative in head and neck cancers [1]. One of the late side effects of radiotherapy in the head and neck are radiation related – caries [2].

Even today, the preferred approach to radiation related - caries is prophylaxis with fluorine [3]. High-intensity laser irradiation has shown good results, by allowing the chemical and compositional modification of the dentin, capable of make it less soluble in an acidic environment [4]. Previous work carried out by our group showed that bioactivity of Biosilicate®, a bioactive glass-ceramic with national technology, can be improved after irradiation with Q-switched Nd:YAG laser provided that the irradiation is carried out after 24 hours in Biosilicate® [5]. Of these equipments, although the irradiation with emission wavelength laser in the ultraviolet region (355 nm) has providing good adhesion and compositional changes that favor bioactivity of Biosilicate® [6].

Still nothing is known if the combination of treatments interferes with the durability of the promoted effects. In this way, it is necessary to modification of the material and treatment to be carried out in patients at high risk of caries, seeking to improve the functionality of the biomaterial. It is therefore suggested to add of fluoride ions and silver nanoparticles to the material, as a way to guarantee an effect additive in the remineralization and reduction of the formed cariogenic biofilm. In this way, this study is proposed.

Materials and Methods

Ninety (90) samples of cervical root dentin will be prepared in bovine teeth of 4 x 4 x 2 mm , obtained from a certified slaughterhouse, according to standardized methodology [7]. In these samples, created incipient chemically induced carious lesions according to the QUEIROZ protocol [8].

Afterwards, all samples will be submitted to an in-house radiotherapy procedure. in vitro, for 5 days consecutive, for 6 weeks until reaching a total dose of 60 Gy.

After radiotherapy, the samples will be randomly distributed into 9 groups different experiments for treatments, some with Biosilicate®. The samples will be positioned individually in front of the laser beam (Q -SWITCHED), so that one single pulse strikes the entire sample surface at once. On each board will be data 3 pulses after application of a photoabsorber [9].

After the treatments, the progression of caries lesions will be carried out through microbiological challenge with S. mutans for 5 days, after film formation acquired [7]. It It will be analyzed: compositional changes of the dentin surface (Fourier transform infrared – FTIR); evaluation of optical properties by optical coherence tomography (OCT); morphological analysis will be carried out by electronic microscopy; form of analysis results, statistical analysis of all experimental data will be performed separately for each response variable, using SSS 13.0 Software for Windows.Analysis of variance will be used or not, always considering the statistical significance level of 5%.

Results and Discussion

Research project, still no results.

Conclusions

It is expected to obtain a treatment that is more effective in stopping lesions rampant and extremely aggressive, combining biomaterial activation effects, modification of dentin, formation of hydroxyapatite, calcium fluoride and decrease of formed biofilm.

Acknowledgment

UFABC Multiuser Centers, IPEN- CNEN/SP

References

1 RAY-CHAUDHURI A, SHAH K, PORTER RJ. Radiotherapy: Oral management of patients who have received radiotherapy to the head and neck region. Vital, 10(2): 30-36. 2013.
2 ROLIM AEH, COSTA LJD, RAMALHO LMP. Repercussões da radioterapia na região orofacial e seu tratamento. Radiologia Brasileira, 44: 388-395. 2011.
3 SROUSSI HY et al. Common oral complications of head and neck cancer radiation therapy: mucositis, infections, saliva change, fibrosis, sensory dysfunctions, dental caries, periodontal disease, and osteoradionecrosis. Cancer Medicine, 6(12):2918-2931. 2017.
4 ANA PA et al. Effect of Er,Cr:YSGG Laser and Professional Fluoride Application on Enamel Demineralization and on Fluoride Retention. Caries Research, 46(5): 441- 451. 2012.
5 PEREIRA GS. Caracterização e avaliação do Biosilicato® associado a laser de Nd:YAG para prevenção da cárie radicular. Dissertação (Mestrado em Biotecnociência). Universidade Federal do ABC. São Bernardo do Campo 2019.
6 RODRIGUES M, Daguano JMFB, Ana PA. Chemical Effects of Nanosecond HighIntensity IR and UV Lasers on Biosilicate When Used for Treating Dentin Incipient Caries Lesions. In: CBEB 2020;
7 FIGUEREDO DC. Efeitos da associação do Biosilicato® e laser em alta intensidade na paralisação da cárie de radiação. Dissertação (Mestrado em Engenharia Biomédica). Universidade Federal do ABC. São Bernardo do Campo. 2019.
8 QUEIROZ CS et al. pH-cycling models to evaluate the effect of low fluoride dentifrice on enamel de- and remineralization. Brazilian Dental Journal, 19: 21-27. 2008.
9 ZEZELL DM et al. Nd:YAG laser in caries prevention: A clinical trial. Lasers in Surgery and Medicine, 41(1):31-35. 2009

Development of multi-channel rf coils and circuitry for parallel transmission mri of the thorax and abdomen at 7 tesla

STEIN JHI[1], PAPOTI D*

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*julio.stein@aluno.ufabc.edu.br

Keywords: Biomedical Engineering, MR Coils, TR Switch, Magnetic Resonance.

Introduction

This master's degree project proposes the development of a modular radiofrequency (RF) duplexer, also known as a T/R switch[1], designed to operate with RF transducers for transmission and reception at a 7 Tesla clinical Magnetic Resonance Imaging (MRI) scanner for imaging torax and abdomen. This set of duplexer and transducer will be developed within a cooperation between the Federal University of ABC and the Institute of Radiology of the Faculty of Medicine of USP (InRad-FMUSP) to operate as part of the MAGNETOM 7T MRI equipment (SIEMENS, Erlangen, Germany).

FMUSP, through the PISA project, acquired the first ultra-high magnetic field Magnetic Resonance equipment in Latin America to carry out different projects in the areas of respiratory diseases, cardiovascular diseases, neurological diseases, aging and virtual autopsies. This MRI system, as it is used exclusively for a research environment, currently has only one RF coil available from the manufacturer for acquiring head images. In order to take full advantage of the whole body 7T scanner in terms of image quality for anatomies other than the head, such as the thorax and abdomen, it is fundamental to develop specific geometries of RF coils. In addition to making it possible to obtain images of the thorax and abdomen through methodologies that allow the correction of RF fields during parallel transmission[2], known as RF shimming, the modular RF duplexers will allow the use of future coil geometries for other anatomies.

Materials and Methods

In order to develop the duplexer and coil elements for 297 MHz, which is the resonant frequency of ^{1}H at 7T, electrical simulations using ADS software, followed by electromagnetic simulations using Remcom XFdtd software will be performed. Afterwards it will be designed using a CAD software, and build in order to run bench characterizations with a Vector Network Analyzer (VNA) and move forward to the test on the 7 T scanner to acquire images.

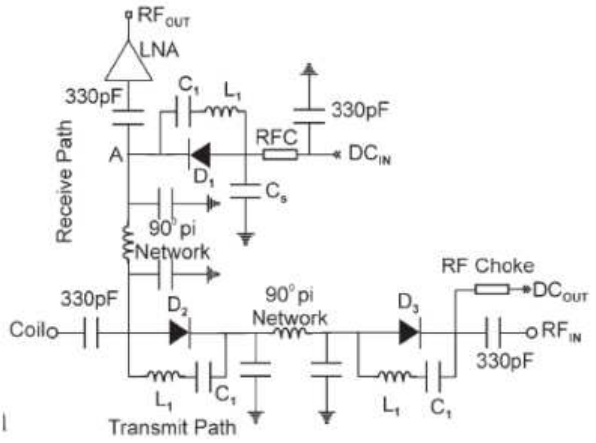
Results and Discussion

This project aims to develop two components that are part of the RF transmission and reception chain for 7T MRI applications, namely:

1. RF duplexer (T/R switch[3]) operating at a frequency of 297 MHz using a modular concept, allowing its use with different geometries of RF coils for transmission and reception. The electrical schme of a typical TR switch for MRI applications is shown by Figure 1.
2. Optimization and construction of a resonant RF coil element, operating as a transmitter/receiver also at the 297 MHz, with specific geometry for MRI acquisition of anatomies with a large field of view (FOV), such as the thorax and abdomen[4]. The geometries we intent to study for this application will be based on the dipole elements, possibly combined tihe loops for receiveing, design known as loopole[5].

Both items described above will operate within the MAGNETON 7T 7 Tesla Human MRI Equipment., located at INRAD-FMUSP.

Figure 1. Circuit diagram of a T/R switch typical of MRI systems.



Font: Siemens MRI Systems

References

1 R. H. Caverly, “PIN diode-based transmit-receive switch for 7 T MRI,” in BioWireleSS 2016 - Proceedings, 2016 IEEE Topical Conference on Biomedical Wireless Technologies, Networks, and Sensing Systems, 2016, doi: 10.1109/BIOWIRELESS.2016.7445574.

2 U. Katscher and P. Börnert, “Parallel RF transmission in MRI,” NMR in Biomedicine. 2006, doi: 10.1002/nbm.1049.

3 B. Thapa, J. Kaggie, N. Sapkota, D. Frank, and E. K. Jeong, “Design and Development of a General-Purpose Transmit/Receive (T/R) Switch for 3T MRI, Compatible for a Linear, Quadrature and Double-Tuned RF Coil,” Concepts Magn. Reson. Part B Magn. Reson. Eng., 2016, doi: 10.1002/cmr.b.21321.

4 U. Katscher, P. Börnert, C. Leussler, and J. S. Van den Brink, “Transmit SENSE,” Magn. Reson. Med., 2003, doi: 10.1002/mrm.10353.

5 ZHENG, Mengxuan; GAO, Yang; ZHANG, Xiaotong. Loopole Antenna for Uniform RF Transmission in 7T MRI. 2021 International Conference on Microwave and Millimeter Wave Technology (ICMMT). [S. l.]: IEEE, 23 maio 2021. DOI 10.1109/icmmt52847.2021.9618590. Disponível em: http://dx.doi.org/10.1109/ICMMT52847.2021.9618590.

Protocol for electroencephalogram (EEG) phase-bound transcranial magnetic stimulation (TMS) pulses

SANTOS KM[1] *, TANAKA H[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*karin.santos@aluno.ufabc.edu.br

Keywords: Biomedical Engineering, Medical Devices, EEG, TMS, Phase-bound.

Introduction

Electroencephalography (EEG) is a non-invasive technique to register and measure electrical potentials from electrodes placed on patients' scalp, with a millisecond resolution. Transcranial magnetic stimulation (TMS) is also a non-invasive technique that induces electrical brain changes by individual magnetic pulses. The TMS have been largely used in neuroscience research and for treatment in neurological disorders such as depression [1,2].

Despite the fact that TMS is a promising treatment option for different disorders of the central nervous system, the optimal way to deliver this intervention is still unclear especially if analyzed in different patients and clinical conditions [3].

The association between both techniques, EEG and TMS, enables the study of the whole brain oscillatory activity in consequence of a specific TMS pulse and brain region. This leads physicians and researchers to investigate causal relationships, improving the understanding of the brain connectome and treatment outcomes by using personalized stimulation protocols. The present study intends to develop a computational algorithm that recognizes different EEG oscillation phases with the intention to customize the delivery of TMS pulses, according to the EEG phase chosen for synchronization [2,3].

Materials and Methods

In the first experiment EEG data will be collected in one healthy volunteer during 5 minutes resting, with gTEC 64 channels equipment (gTEC Medical Engineering GmbH, Austria). The patient will be comfortably seated during the data collection.

These data will be analyzed with the intention to detect periodic EEG signal features that permit the investigation of the time characteristics of brain oscillations to build a pattern allowing the recognition of different EEG phases, as peaks and valleys. The analyses will be done with Matlab.

A closed loop setup between a TMS Rapid 2 system (The Magstim Company Limited, United Kingdom), the EEG monitoring equipment and a computer with Matlab software will be prepared.

After choosing and defining the EEG features as pattern, this information will be used in the closed loop parameters of the setupalong with an open source toolbox for external control of TMS devices, called Magic. The ultimate goal of this study is the development of a Matlab tool that allows the manipulation of the TMS pulses according to the feedback from the oscillatory EEG phase bound, collected in a volunteer in real time.

Results and Discussion

The real time software tool will analyze the EEG oscillations and send a trigger signal to the TMS stimulator, according to a predetermined condition. It will allow researchers and physicians to customize TMS pulses according to EEG signals for different clinical studies, helping them to use different approaches in order to understand TMS-EEG relationship and clarify different uses of TMS therapy.

This study has the aim to contribute to better understanding of treatment options for disorders with a central nervous system component and, more specifically, improving TMS therapy outcomes.

Conclusions

The importance of this study to Biomedical Engineering is to develop and offer a tool that opens up a range of possibilities in studies for a better understanding of basic brain functions for healthy individuals and also for patients with neurological and psychiatric disorders.

One of the main goals is to demonstrate that it is possible to manipulate when the TMS pulse will be delivered to the patient, as well as study the oscillatory effect based on different TMS pulses.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001. We thank CAPES and Universidade Federal do ABC (UFABC) for supporting the development of this study.

References

1 Bortoletto M, Veniero D, Thut G, et al. The contribution of TMS-EEG coregistration in the exploration of the human cortical connectome. Neuroscience and Biobehavioral Reviews, 49: 114-124. 2015.
2 Stefanou MI, Baur D, Belardinelli P, et al. Brain State-dependent Brain Stimulation with Real-time Electroencephalography-Triggered Transcranial Magnetic Stimulation. J. Vis. Exp., (150): e59711. 2019.
3 Tervo AE, Nieminen JO, Lioumis P, et al. Closed-loop optimization of transcranial magnetic stimulation with electroencephalography feedback. Brain Stimulation, 15(2): 523-531. 2022.

High intensity 808nm diode laser in the remineralization of dental caries in dentin

ALVES CB[1], OLIVEIRA MRC[1], OLIVEIRA LHC[2*], OLIVEIRA PHC[1], CASSONI A[1], BENETTI C[2],DA ANA PA[2], KATO IT[2], PRATES RA[1]

[1] Biophotonics Applied to Health Science Program, Nove de Julho University, São Paulo, Brazil
[2] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

* luiz.cabral@ufabc.edu.br

Keywords: Diagnosis, Caries Lesion, Diode Laser, OCT, Fluoride Therapy

Introduction

Caries is a chronic, multifactorial disease caused by the process of demineralization of the tooth surface by organic acids from the fermentation of carbohydrates in the diet, by specific bacteria.[1] Caries leads to the progressive destruction of mineralized tissues, resulting in a loss of mineral deposits, caused by organic acids from microbial fermentation of fermentable carbohydrates in the diet. [2]

In this context, many researches show the inhibition potential of several lasers in demineralization, alone or in combination with fluoride. Lasers have been seen as a complement to conventional preventive therapies. [3] The use of fluorides enhances the demineralization process due to the electronegativity of this element, in addition to modifying the tooth structure, making the mineral tissue more acid resistant.[4] The objective of the present study is to evaluate the optical behavior of caries lesions in dentin irradiated with a diode laser at a length of 808nm associated with laser fluortherapy and OCT.

Materials and Methods

48 fragments of bovine incisor teeth will be used, which will be ground until a flat surface is obtained. The samples will be evaluated after the induction of demineralization and to serve as a comparative parameter, a part of the sample will be protected, which allowed an independent comparison to be made for each sample, which will have its non-demineralized control. The induction of the caries lesion will occur through a cariogenic biofilm formed by *S. mutans*, the samples will be immersed in a salivary pool for 3 hours, then they will be placed in BHI broth with the microorganism, where they will grow for 48 hours, after adhesion bacteria on the surface of the sample, the sample will be immersed in BHI broth with different concentrations of 1% and 3% sucrose every 3 hours for 7 days to induce the microorganisms to produce acids.

After treatment, samples will be analyzed after 7, 14, and 28 days. After the demineralization process, the samples will be divided into groups according to the treatment of the samples (n=12), Laser + Fluorine (LF), Fluorine (F), Fluorine+Laser

(FL) and Laser (L). In the groups that contain lasers, an 808nm diode laser (Therapy, DMC, São Carlos, Brazil) will be used, adjusted to continuous irradiation (CW) and 1 W of output power, blurred in an area of 0.5 cm^2. analyzed by optical coherence tomography (OCT) at all times evaluating the attenuation coefficient and optical scattering pattern in the spatial domain. Subsequently, data will be collected and Anova and Bonferroni statistical tests will be performed.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

References

1. SHIBATA S, VIEIRA LCC, BARATIERI LN, FU J, HOSHIKA S, MATSUDA Y, et al. Evaluation of microtensile bond strength of self-etching adhesives on normal and caries-affected dentin. Dent Mater J, 35(2):166–73. 2016.
2. Gomez J. Detection and diagnosis of the early caries lesion. BMC Oral Health [Internet],15(1):S3. 2015. Available from: http://www.biomedcentral.com/1472-6831/15/S1/S3
3. Zadeh Moghadam NC, Seraj B, Chiniforush N, Ghadimi S. Effects of laser and fluoride on the prevention of enamel demineralization: An in vitro study. J Lasers Med Sci [Internet, 9(3):177–82. 2018. Available from: https://doi.org/10.15171/jlms.2018.32
4. Pitts NB, Zero DT, Marsh PD, Ekstrand K, Weintraub JA, Ramos-Gomez F, Tagami J, Twetman S, Tsakos G, Ismail A. Dental caries. Nat Rev Dis Primers, 3:17030. 2017.
doi: 10.1038/nrdp.2017.30. PMID:28540937.

Evaluation of the electromagnetic safety of transcranial magnetic stimulation devices in ICU environment

FERREIRA MCA[1*], BAPTISTA AF[2], ZANA Y[2], OLIVEIRA TR[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Federal University of ABC (UFABC), Center for Engineering, Center for Mathematics, Computing and Cognition (CMCC), São Bernardo do Campo/ SP, Brazil

[*]mcaferreira@gmail.com

Keywords: Transcranial Magnetic Stimulation, TMS, Safety, Electromagnetic Exposure, ICU.

Introduction

Transcranial Magnetic Stimulation (TMS) is a non-invasive electromagnetic technique of brain stimulation that a coil positioned on the scalp can magnetically induce regulatory and/or stimulating role. TMS has shown great diagnostic and therapeutic potential for several pathologies of the central nervous system, such as neurological and mental health diseases. With the rise of severe respiratory distress syndromes linked to the novel coronavirus disease (COVID-19), many patients are submitted on mechanical ventilation to reduce the impact of respiratory distress and preserve life. Despite the use of mechanical ventilation, many patients continue to suffer from dyspnea and others side effects. Therefore, researchers have sought non-invasive methods, to try to modulate the perception of acute or chronic pain.

In addition to the patient exposure, the strong magnetic fields also permeates the surrounding area which may also promote unnecessary exposure to the clinical staff, or electromagnetic interference with other equipment present in the Intensive Care Unit (ICU). This study seeks to evaluate, from the point of view of exposure to electromagnetic fields, the feasibility and safety of using TMS equipment in ICU setting and offer solutions for quantification of the environment level of exposure. In this risk assessment study, we will numerically simulate and measure the magnetic flux densities at different distances from the application coil to obtain a map on possible interference with electronic equipment in the ICU environment.

Materials and Methods

The TMS apparatus to be used in this study is a MagVenture system (MagVenture A/S, Denmark). The measuring system will use a measuring coil and a data acquisition.

For evaluation of the TMS system, it will be necessary to simulate the typical ICU environment to (1) measure distances between the patient and existing medical equipment in the typical surrounding environment and (2) measure the magnetic flux density generated by the application coil that will be used. A typical ICU patient room will be simulated and equipped with a mechanical ventilator, a multiparameter monitor to investigate ECG disturbances during pacing, and an infusion pump. A resuscitation dummy will be used to simulate the patient's position in bed. Stimulation will be

simulated on the neck just above the medial clavicle. To generate the highest possible magnetic flux density, a repetitive biphasic pulse at maximum intensity will be used.

The magnetic flux density will be measured at different distance vertical to the center of the coil. Electromagnetic noise will be measured in the environment with all equipment turned off. Second, the magnetic fields generated only by ICU equipment will be measured. Then we will measure the magnetic fields generated by the application coil alone. Finally, the magnetic fields will be measured with both the application coil and all ICU equipment turned on, to assess the combined fact. Finally, possible heating of the metallic environment and disturbances in electrocardiogram monitoring will be tested.

Results and Discussion

This study does not yet present any results, as the data acquisition stage has not yet started.

Conclusions

TMS has been shown to be a great tool for research and treatment of central nervous diseases [1,2]. TMS safety issues are discussed through different guidelines such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the EMF Directive (Directve2013/35/EU) of the European Union [3].

As there are few studies using electromagnetic stimulation in the ICU, patient safety remains an issue. Current Guidelines from the International Commission on Non-Ionizing Radiation Protection describe any magnetic flux density up to 0.1 mT as not harmful to humans [4,5]. However, the current European Respiratory Society statement on respiratory muscle testing at rest and during exercise states that it is possible to assess diaphragmatic contractility in critically ill and intubated patients by magnetic stimulation of the phrenic nerve.

Acknowledgment

I would like to thank my supervisor for all his help, UFABC for the opportunity to develop this project. The author is an employee of MagVenture in Brazil.

References

1 Perera, T., George, M.S., Grammer, G., Janicak, P.G., Pascual-Leone, A. and Wirecki, T.S. The clinical TMS society consensus review and treatment recommendations for TMS therapy for major depressive disorder. Brain stimulation, 9(3), 336-346. 2016.

2 Tearo, Y. and Ugawa, Y. Basic mechanisms of TMS, Journal of clinical neurophysiology, 19(4), 322-343. 2022.

3 Rossi, S., Antal, A., Bestmann, S., Bikson, M., Brewer, C., Brockmöller, J., Carpenter, L.L., Cincotta, M., Chen, R., Daskalakis, J.D. and Di Lazzaro, V. Safety and recommendations for TMS use in healthy subjects and patient populations, with updates on training, ethical and regulatory issues: Expert Guidelines. Clinical Neurophysiology, 132(1), 269-306. 2021.

4 Kuhn, K.F., Grunow, J.J., Leimer, P., Lorenz, M., Berger, D., Schefold, J.C., Weber-Carstens, S. and Schaller, S.J. Assessment of magnetic flux density properties of electromagnetic noninvasive phrenic nerve stimulations for environmental safety in an ICU environment. Scientific reports, 11(1), 1-7. 2021.

5 Karlström, E.F., Lundström, R., Stensson, O. and Mild, K.H. Therapeutic staff exposure to magnetic field pulses during TMS/rTMS treatments. Bioelectromagnetics: Journal of the Bioelectromagnetics Society, The Society for Physical Regulation in Biology and Medicine, The European Bioelectromagnetics Association, 27(2),.156-158. 2006.

Characterization of the clinical engineering sector in health care establishments

KOCH NCBL[1]*, OLIVEIRA TR[1], ROMANI AP[1], TANAKA H[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*koch.natalia@ufabc.edu.br

Keywords: Biomedical Engineering, Clinical Engineering, Clinical Engineer, Health Care Facility.

Introduction

Few areas of science have been benefited by the technological progress of recent decades as health care service. The same level of technology used by the 'National Aeronautics and Space Administration' (NASA) for an astronaut being safe in space, is also available in 'Health Care Establishments' (EAS) [1].

The clinical engineering is the sector that manages health technology, inserted as a strategic sector in the hospital environment or as a third party company, providing services in the EAS. Clinical engineering emerged in Brazil in the early 70's [2]. After incorporating medical technology into hospitals, the demand for management and repair services of this technology emerged. Then, in the early 1990s, the first postgraduate courses of Lato sensu were created for the formation of the clinical engineer, with the objective of meeting the demand for existing services in the EAS [3].

The present work proposal aims to characterize the provision of the clinical engineering services within the EAS in the region determined for this work. The chosen region includes 64 cities in the state of São Paulo - Brazil, delimited by the perimeter of the direct distance Code nº 11 (DDD 11).

According to Antunes and their employees [4], there are no official data in the national publication that can be used as a source of formal information for the presentation of the current image of the implementation of clinical engineering in Brazil.

Materials and Methods

The characterization of the provision of the clinical engineering services within the EAS will be guided by the 'Brazilian Technical Standard' NBR 15943: 2011, which describes the guidelines of a health equipment and service infrastructure equipment management program [5], and by RDC 02/2010 resolution that provides for Health Technology Management in Health Units [6].

The number of hospitals in each city will be raised within the selected perimeter and grouped according to size, management, and the legal nature of each EAS.

Once grouped, contact with each institution for data collection will be carried out, which will happen through quantitative and qualitative research.

Results and Discussion

The aim of this work is to obtain information about the current scenario of clinical engineering within the EAS.

With the data collected, it will be possible to understand how the management and assistance process with technology in the hospital environment is like.

Conclusions

The information collected will characterize the clinical engineering sector with the particularities of each EAS.

This will provide conditions to understand the current scenario and contribute to the identification of non-compliance factors.

The health technology management requires the information of the managed location. Given the information collected, the clinical engineering sector can develop tools for the search for continuous improvement of services provided to society.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001

References

1 Paradoxo Tecnológico na Gestão Hospitalar [Online]., 2020.
Available: http://equipacare.com.br/paradoxo-tecnologico-saude/. Access 23 02 2023.
2 Ramirez EFF, Calil SJ. Engenharia Clínica: Parte I-Origens (1942-1996), Semina: Ci. Exatas/Tecnologia, 21: 27-33, dezembro 2000.
3 Antunes,Vale Md, Mordelet P, Grabois V. Gestão da Tecnologia Biomédica - Tecnovigilância e Engenharia Clínica, Paris: ACODESS, p. 210. 2002.
4 Almeida ESF, Cária JDP. Perfil da Engenharia Clínica em Hospitais de Grande Porte de Belo Horizonte, Seminários INATEL. 2016.
5 Norma Brasileira ABNT NBR 15943 de 28 de abril de 2011. Diretrizes para um programa de gerenciamento de equipamentos de infraestrutura de serviços de saúde e que equipamentos para a saúde. 2011.
6 Agência Nacional de Vigilância Sanitária (ANVISA). Resolução RDC nº 02 de 25 de Janeiro de 2010. Dispõe sobre o gerenciamento de tecnologias em saúde em estabelecimentos de saúde. Publicado no DOU nº 16 – seção 1 – p. 79. 2010.

Spectral Characterization of Freezing of Gait in Parkinson's Disease

DE LUCCAS JB[1]*, BIANQUETI BL[1], FIM NETO A[1], TRAJANO LR[1], TAKAHATA AK[1], ROCHA GUIMARÃES MS[3], SORIANO DC[1], GODINHO F[1,2]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/SP, Brazil
[2] University of São Paulo (USP), Division of Functional Neurosurgery of Institute of Psychiatry, Department of Neurology, São Paulo/SP, Brazil
[3] Santa Marcelina Hospital, Neurology Department, São Paulo/SP, Brazil

*j.baldi@aluno.ufabc.edu.br

Keywords: Parkinson's Disease, Freezing of Gait, Deep Brain Stimulation.

Introduction

Freezing of Gait (FOG) is a symptom of Parkinson's Disease where effective steps cannot be produced [1]. Efforts have been made to characterize PD electrophysiology to enhance Deep Brain Stimulation (DBS) and improve its effectiveness.

In this scenario, this study aims to identify frequency bands correlated with FOG in PD patients by predicting FOG scores through linear regression using Subthalamic Nucleus (STN) records.

Materials and Methods

Fourteen PD patients from Santa Marcelina Hospital (São Paulo, SP, Brazil) were evaluated using UPDRS. LFP signals were recorded from both STN hemispheres' dorsolateral portions. The patients gave prior written consent approved by the Santa Marcelina Hospital Ethics Committee (CAAE: 62418316.9.2004.0066).

The power spectral density (PSD) of each record was obtained by Welch's Method [2]. Band power was estimated for the frequency bands: theta (4 to 8 Hz), alpha (7 to 13 Hz), beta 1 (13 to 22 Hz), beta 2 (22 to 35 Hz), gamma 1 (35 to 100 Hz), gamma 2 (100 to 150 Hz), gamma 3 (150 to 200 Hz).

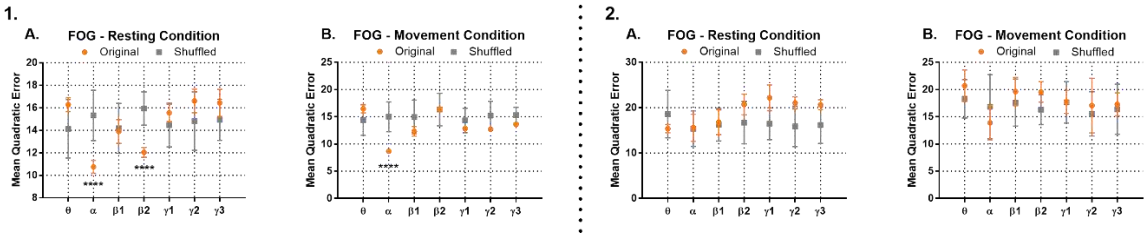
FOG score prediction was performed using contralateral and bilateral STN data, assessed by 10-fold cross-validation, repeated 20 times, with mean quadratic errors and standard deviations obtained. Shuffled FOG scores were used for random prediction regression comparison. Results were compared using a permutation test with 1000 permutations and a t-Student test at a 95% confidence level [3].

Results and Discussion

FOG's prediction using only contralateral data (Fig. 1.1) showed lower errors at rest for alpha and beta 2 bands than shuffled data. In movement condition, only alpha band

achieved lower errors. By using data from both hemispheres (Fig. 1.2), no frequency bands showed lower errors than shuffled data, for both resting and movement conditions.

Figure 1. Linear regression for predicting FOG score.
Data of the contralateral hemisphere to the most affected side of the body (1), data of both hemispheres (2), resting (A) and movement (B) conditions, comparing original (orange) and shuffled (grey) scenarios (**** p-value < 0.001).



Font: By author.

Contralateral data predicts FOG consistently with existing knowledge that alpha activity is a biomarker [4, 5, 6]. Combining data from both hemispheres was expected to improve prediction, but this wasn't observed. Literature reports FOG characterized by low-frequency cortical-subthalamic decoupling in the hemisphere with less dopamine [1].

Conclusions

Our findings indicate that contralateral STN data from the more affected side may correlate with FOG symptoms in PD patients, particularly in the alpha band. However, including information from the ipsilateral hemisphere worsens the prediction. Further analysis is needed to assess the interhemispheric role in FOG. These results aim to enhance DBS protocols and ultimately enhance the quality of life for PD patients.

Acknowledgment

Acknowledgments to Federal University of ABC, Santa Marcelina Hospital, FAPESP (2018/14283-8, 2018/14285-0, 2019/09512-0, 2017/00319-8), CNPq (117659/2018-5), Capes (2019/1814368), BRAINN (2013/07559-3) and FINEP (n. 01.16.0067.00).

References

1 Pozzi NG, Canessa A, Palmisano C, et al. Freezing of gait in Parkinson's disease reflects a sudden derangement of locomotor network dynamics. Brain, 142(7), 2037-2050. 2019.
2 Welch P. The use of fast Fourier transform for the estimation of power spectra: a method based on time averaging over short, modified periodograms. IEEE Trans Audio Electroacoust, 15(2), 70-73. 1967.
3 Groppe D. mult_comp_perm_t1(data,n_perm,tail,alpha_level,mu,reports,seed_state) (https://www.mathworks.com/matlabcentral/fileexchange/29782-mult_comp_perm_t1-data-n_perm-tail-alpha_level-mu-reports-seed_state), MATLAB Central File Exchange. Retrieved February 27, 2023.
4 Herz DM, Eickhoff SB, Lokkegaard A, et al. Altered functional connectivity in patients with Parkinson's disease and freezing of gait. Cortex, 56, 119-131. 2014.
5 Shine JM, Matar E, Ward PB, et al. Exploring the cortical and subcortical functional magnetic resonance imaging changes associated with freezing in Parkinson's disease. Brain, 137(4), 1204-1215. 2013.
6 Fim Neto A, Rocha MSG, Trajano LR, et al. Resting-State Exaggerated Alpha Rhythm from Subthalamic Nucleus Discriminates Freezers from Non-freezers Phenotypes in Parkinson's Disease: Possible Association to Attentional Circuits. In Computational Neuroscience: Third Latin American Workshop, LAWCN 2021, 8–10, 2021, 225-232. 2022.

Automated pipeline to aid atrial fibrillation treatment

SANDOVAL I[1]*, COSTA GV[1], RESTIVO CR[1], MARQUES VG[2], RODRIGO M[3], GUILLEM MS[4], SIMS JA[1], SALINET J[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Physiology Department, Maastricht University, Maastricht, Netherlands
[3] ITACA Institute, Universitat Politècnica de València, Spain

*italo.sandoval@ufabc.edu.br

Keywords: Atrial Fibrillation, Electrocardiographic Imaging, Convolutional Neural Network.

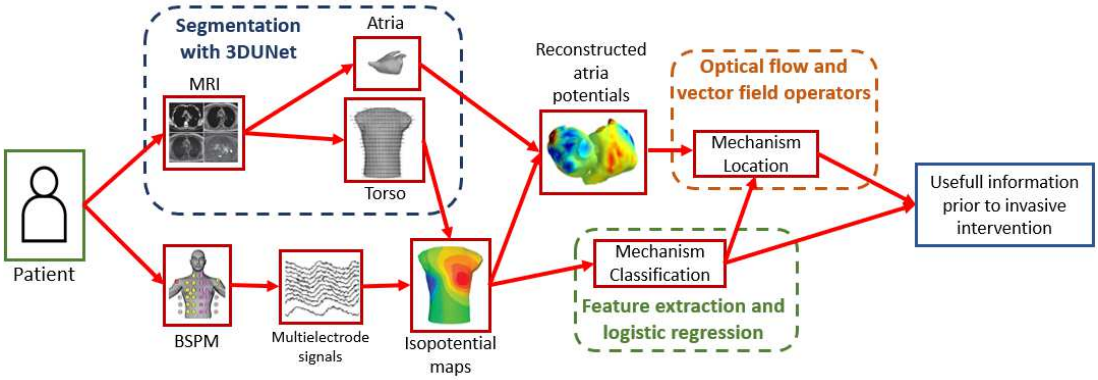
Introduction

Atrial fibrillation (AF) is among the most common supra-ventricular tachyarrhythmias, with a negative impact in life quality from those who suffers from this. Location of the endocardium areas for ablation is the current challenge for clinicians, been invasive, expensive and with collateral risks to the patients [1]. Therefore, a non-invasive customized automatized method for AF, to aid specialist, prior intervention, would minimize the intrinsic risks, and increase the treatment success rates [1]. In this study, is proposed a customized pipeline for AF, from its detection, to patterns characterization, and then cardiac tissue location responsible AF triggering and maintaining.

Materials and Methods

Figure 1 illustrates the study pipeline of signal and image processing, applied to high density body surface maps (BSPM), through 5 different acquisition leads layouts (64 to 567 electrodes), with the atria and torso geometries obtained from the patient's magnetic resonance scanning (MRI), to estimate atria electrograms (Electrocardiographic

Figure 1. Pipeline for automated AF characterization and location of its mechanisms.



Source: author.

Imaging technique [1]). The atria are segmented by a convolutional neural network (3DUNet), and the torso segmented by thresholding. Up to 21 biomarkers were extracted from the BSPM maps, allowing non-invasive detection of AF mechanisms (i.e., ectopic foci - EF; and functional rotors - FR), through the use of logistic regression [2]. Moreover, with the 3D torso/atria surfaces and BSPM signals, a high density of reconstructed atrial electrograms (rEGM) from the epicardium was performed through the inverse solution with Tikhonov regularization. From the rEGM, the driven mechanisms were located with the curl and divergent vectors field obtained from the Optical Flow [3]. The study also investigates the impact of different levels of noise into the mechanisms' identification and locations.

Results and Discussion

The 3D torso/atria automatic segmentation algorithm did show a good performance (Dice similarity of 83%). The AF mechanism classification, performed with logistic regression, showed a very high accuracy even with low number of electrodes (100% with 567 electrodes decreasing to 94.7% with 64). The mechanism location in the atria was possible, with a mean normalized error of 7% for the EF mechanism, and 19% for FR mechanism. Varying the SNR, did not affect the mechanisms' location.

Conclusions

In this study, a pipeline of signal and image processing has been proposed, allowing customization of current electrophysiological maps to AF, used by the commercial systems to guide catheter ablation. It could be of great help to effective treatments.

Acknowledgment

I. Sandoval is supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES). G.V. Costa and C.R. Restivo are supported respectively by grants #2020/13017-2 and #2020/12841-3, São Paulo Research foundation (FAPESP). VGM is funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 860974. J. Salinet and J. Sims are supported by grant #2018/25606-2, São Paulo Research foundation (FAPESP)

References

1 Salinet J, Molero R, Schlindwein FS, Karel J, Rodrigo M, Rojo-Álvarez JL, Berenfeld O, Climent AM, Zenger B, Vanheusden F, Paredes JGS, MacLeod R, Atienza F, Guillem MS, Cluitmans M, Bonizzi P. Electrocardiographic Imaging for atrial fibrillation: a perspective from computer models and animal experiments to clinical value. Front Physiol, 12:653013. 2021.

2 Sandoval I, Marques V, Sims J, Rodrigo M, Guillem MS, Salinet J. Non-invasive mechanism classification and localization in supraventricular cardiac arrhythmias. 48th Computing in Cardiology, Brno, Czech Republic. 2021.

3 Sandoval I, Costa, GV, Restivo CR, Guillem MS, Sims J, Salinet J. Non-invasive mechanism location of atrial arrythmias with optical flow from electrocardiographic imaging. IX Congresso Latino-Americano de Engenharia Biomédica (CLAIB 2022) e XXVIII Congresso Brasileiro de Engenharia de Engenharia Biomédica (CBEB 2022), Florianópolis, Brasil. 2022.

Noninvasive Electrocardiographic Imaging of Atrial Fibrillation: Preliminary Results from Animal Model

SILVA J[1*], SANDOVAL I[1], NEVES T[1], VICTOR G[1], PAREDES JG[1], CORREIA RC[1], WEBER GL[1], SANDOVAL I[1], UZELAC I[2], SALINET J[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Georgia Institute of Technology, School of Physics, Atlanta, GA, United State

*silva.jessica@ufabc.edu.br

Keywords: Atrial Fibrillation, Inverse Problem of Electrocardiography, Non-Invasive Estimation, ECGi.

Introduction

Atrial fibrillation (AF) is a cardiac arrhythmia characterized by irregular and fast heartbeats that originate in the atria of the heart [1]. Mechanisms diagnosis is performed through invasive procedures, which require direct measurement of cardiac electrograms in the atria through mapping catheters. However, this approach has a high cost and presents risks of complications to patients. Therefore, non-invasive methods, such as non-invasive electrocardiographic imaging (ECGi) technique, have been developed to identify regions that sustain AF [2].

The ECGi method uses electrocardiogram signals recorded at various points on the chest surface of the body to estimate the electrical potentials on the surface of the heart, projecting the biopotentials onto two-dimensional and/or three-dimensional maps of the heart. This study aims to present the preliminary results from the ECGI applied to a recent developed AF animal model setup.

Materials and Methods

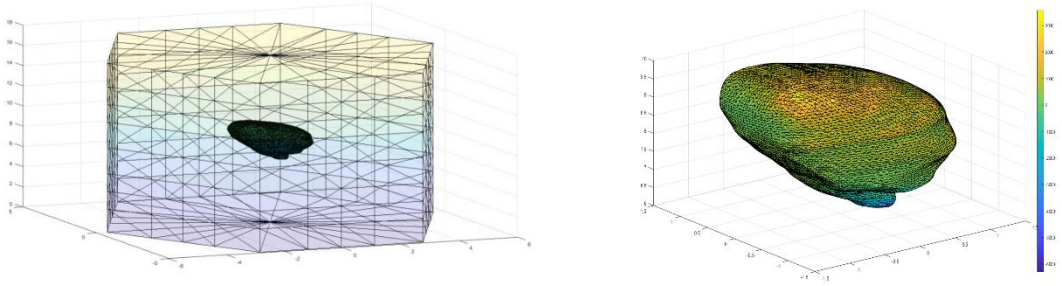
This work used data from the existing experimental setup in the Experimental Cardiac Electrophysiology Laboratory at the host institution, which consists of a tank-torso with a Tyrode solution embedding a rabbit heart with arrhythmia induced by programmed electrical stimulation. The 24 electrodes were used to collect surface potentials from the tank-torso, sampled at 30kHz. Next, the estimation of potentials in the heart, ϕC (mV), was calculated using the Laplace equation within the volume of the tank-torso, using the electrical potentials from the tank-torso, ϕT (mV), and the geometric relationship between the 3D surfaces of the heart and tank-torso was obtained using the boundary element method and regularized using the Tikhonov method to construct the transfer matrix $A_{\mathrm{tc}}{}^{+}$ allowing the relationship between ϕT e ϕC, expressed by the equation below [2].

$$\phi C = A_{\mathrm{tc}}{}^{+} . \phi_{\mathrm{t}} \qquad \text{(Eq.1)}$$

Results and Discussion

The proposed solution enabled the estimation of potentials at 5,594 distinct points in the atria shell of the heart. The figure below shows the three-dimensional maps of the estimated electrical potentials in the heart's epicardium, as well as the meshes constructed from the tank-torso and heart 3D geometry, which are essential for the calculation of the solution.

Figure 1. a) Heart and Tank-Torso Geometry. b) 3D map of the estimated potentials in the atrium.



a) b)

Source: own autorship.

Conclusions

ECGI allows estimation of atria electrical activity during atrial fibrillation. In the first stage of this study, it was able to reconstruct the 3D geometry from tank and heart, to validate the technique. It will be followed by characterizing atrial fibrillation wavefronts for customization of this mapping technique for AF.

Acknowledgment

The research protocol proposed here was evaluated by the local committee of the Committee on Ethics in the Use of Animals (CEUA) and is in accordance with current legislation (CEUA no. 3947230519). J. Silva is supported by grant # 2022/15801-8, São Paulo Research foundation (FAPESP). This study is supported by grant #2018/25606-2, FAPESP.

References

1 Li H, Song X, Liang Y, Bai X, Liu-Huo WS, Tang C, Chen W, Zhao L. Global, regional, and national burden of disease study of atrial fibrillation/flutter, 1990-2019: results from a global burden of disease study, 2019. BMC Public Health. 2022 Nov 3;22(1):2015. doi: 10.1186/s12889-022-14403-2. PMID: 36329400; PMCID: PMC9632152.

2 Salinet J, Molero R, Schlindwein FS, Karel J, Rodrigo M, Rojo-Álvarez JL, Berenfeld O, Climent AM, Zenger B, Vanheusden F, Paredes JGS, MacLeod R, Atienza F, Guillem MS, Cluitmans M, Bonizzi P. Electrocardiographic Imaging for Atrial Fibrillation: A Perspective From Computer Models and Animal Experiments to Clinical Value. Front Physiol. 2021 Apr 30;12:653013.

Evidence-based decision making applied for breast cancer survival prediction

SANTOS PD[1], YAHATA E[2], PINHEIRO TS[1], OLIVEIRA FS[1], SIMÕES PW*[1,2]

[1]Federal University of ABC (UFABC), Graduate Program in Biomedical Engineering, Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/SP, Brazil

[2]Federal University of ABC (UFABC), Graduate Program in Information Engineering, Center for Engineering, Modeling and Applied Social Sciences (CECS), Santo André/SP, Brazil

**pritsimoes@gmail.com*

Keywords: Breast Cancer, Meta-Analyses, Machine Learning, Algorithms

Introduction

Breast cancer is a significant health issue affecting women worldwide, with an estimated 2.1 million newly diagnosed cases in 2018, representing nearly 25% of all cancer cases among women. It is the most frequently diagnosed cancer in most countries and the leading cause of cancer death in over 100 countries. Incidence rates are highest in certain developed regions, while the highest mortality rates are observed in Malaysia. The high incidence and mortality rates of breast cancer underscore the need for greater awareness, screening, and improved treatments to reduce its global burden [1].

Systematic reviews and meta-analyses provide a reliable method to research complex health issues like breast cancer. As the volume of research literature is vast and growing, it is impossible for individual decision-makers to assess it all. Systematic reviews avoid bias in selecting and synthesizing primary research, providing up-to-date and comprehensive research evidence to make informed healthcare decisions on interventions, diagnostic tests, prognostic factors, and other healthcare topics [2].

In addition, machine learning is useful in identifying complex interactions between genes and environment. It is well-suited to clinical decision support tools where accurate diagnosis and automation are essential [3]. By incorporating machine learning techniques in systematic reviews, it may be possible to enhance the identification of these complex interactions and improve breast cancer management and treatment decisions.

Although machine learning models have been used to predict breast cancer diagnosis and recurrence, a systematic review and meta-analysis on their accuracy for predicting survival is lacking. This project aims to provide evidence on this topic, as machine learning has the potential to improve accuracy and be a valuable tool for clinicians.

Materials and Methods

Systematic review and meta-analysis [2].

Results and Discussion

This meta-analysis project does not yet have results to be demonstrated, but we intend to present a comparative analysis of Machine Learning studies applied to the prediction of Breast Cancer Survival [4].

Conclusions

This Biomedical Engineering project predicts breast cancer survival, advances personalized medicine, and improves patient care quality. Machine learning identifies trends in large-scale patient data, leading to more accurate predictions and better-informed treatment decisions. The project highlights the importance of rigorous research methods to inform clinical decision-making.

Acknowledgment

This study was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Finance Code 001, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and Universidade Federal do ABC (UFABC).

The study was conducted under the Brazilian Institute of Data Science's Center for Applied Research in Artificial Intelligence (BI0S), supported by the process number 2020/09838-0 from the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP).

References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2018;68(6):394-424. 2018.
2. Higgins JP TJ, Chandler J, Cumpston M, Li T, Page MJ, Welch VA, editor(s). Cochrane Handbook for Systematic Reviews of Interventions Version 6.2 (updated February 2021). Cochrane. Available from: training.cochrane.org/handbook. 2021.
3. Bi Q, Goodman KE, Kaminsky J, Lessler J. What is Machine Learning? A Primer for the Epidemiologist. Am J Epidemiol;188(12):2222-39. 2019.
4. Schillaci O, Danieli R, Romano P, Santoni R, Simonetti G. Scintimammography for the detection of breast cancer. Expert Rev Med Devices;2(2):191-6. 2005.

Development of an experimental setup for the non-invasive characterization of atrial fibrillation with surface electrocardiographic mapping

CORREIA RC[1] *, WEBER GL[1], PAREDES JG[1], SILVA VP[1], SALINET JL[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*rcastro@aluno.ufabc.edu.br

Keywords: Biomedical Instrumentation, Medical Devices, Atrial Fibrillation, Electrocardiographic Mapping, Digital Processing.

Introduction

This project aims to develop an acquisition interface for a tank-torso with a Tyrode solution embedding an isolated rabbit heart and a programmed electrical stimulation-induced arrythmias for the electrophysiologic characterization, extracting information for image reconstruction regarding activation sites of either torso mapping or cardiac tissue. Validation will consist of evoked Atrial Fibrillation (AF) and its patterns, since it is the mostly frequent in clinical practices, affecting about 2% of population worldwide [1].

In applications such as continuous sinus monitoring and/or characterization of AF, the information in unipolar recordings pretended in this work wishes to achieve the maximum correlation within a gold standard ECG instrumentation.

The research protocol proposed here was evaluated by the local committee of the Committee on Ethics in the Use of Animals (CEUA) and is in accordance with current legislation (CEUA no. 3947230519).

Materials and Methods

The acquisition of non-invasive electrical activity will be performed by 64-screw electrodes fixed homogeneously to the faces of a hexagonal translucent acrylic tank in contact with a flexible printed circuit board (PCB), modeled to be a straightforward electrode vest to compound a body surface potential mapping in the rabbit tank-torso model.

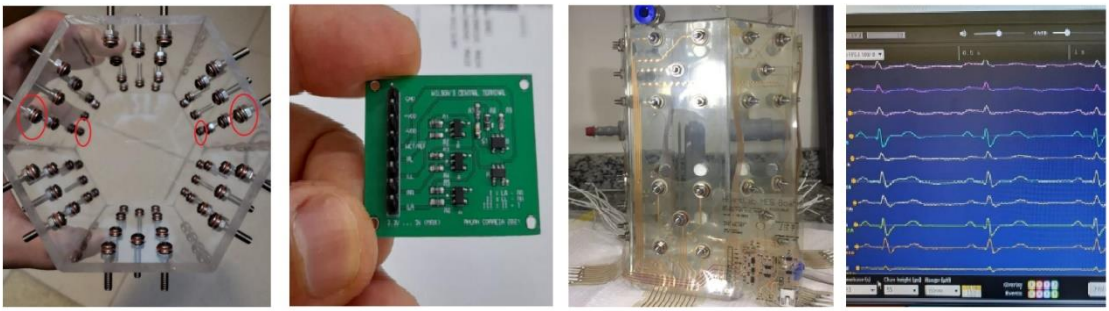
The flexible PCB is projected for 64 electrodes coupling, whereas 60 are displayed for unipolar purposes. They must be referenced by a Wilson's Central Terminal (WCT), which uses the last 4 electrodes for voltage averaging of geometrically determined right arm (RA), left arm (LA) and left leg (LL) electrodes [2]. The right leg (RL) electrode will be used for common noise reduction purposes. The flexible board delivers the analog signal to the RHD2000 multi-channel headstage for Open Ephys open-source tool, which provides a dedicated software for visualization of filtered electrophysiology data acquired with a recording feature.

Results and Discussion

The current low power instrumentation that has been done is therefore well suited for wearable and long-term applications as described in Figure 1.

Regarding the maps to be generated, they can be classified as: isochrones, frequency, phase and singularity points. From these maps, the observed patterns will be classified to those related to the AF mechanisms and their space-time occurrences in the rabbit tank-torso model. In addition, with the signals measured in the epicardium, it is possible to know important information related to the moment of activation and repolarization and frequency between activations, helping to generate more realistic non-invasive maps.

Figure 1. Top view of rabbit tank-torso model in (a), rounded electrodes (in red) represent the anthropomorphic electrodes for LA, RA, LL and RL. During instrumentation validation phase, it was used a rigid PCB (c) for external WCT circuitry. The project second phase consisted of a flexible PCB for signal acquisition containing an embedded WCT circuitry (c). After the acquisition through Open Ephys software (d), the signals could be acquired and recorded for post processing of AF electrocardiographic imaging.



(a) (b) (c) (d)

Font: own authorship.

Conclusions

The hardware has been developed and it is under validation tests. The next plhase will be apply the hardware in experimental models.

Acknowledgment

This master's project is associated with Projeto Jovem Pesquisador Fapesp 2018/25606-2. The validation will occur in the Experimental Cardiac Electrophysiology Laboratory at the host institution.

References

1 SBC. II Diretrizes brasileiras de fibrilação atrial. Sociedade Brasileira de Cardiologia. Arq Bras Cardiol. 106, 1-22 (2016).

2 Bacharova, Ljuba, et al.” Where is the central terminal located? Insearch of understanding the use of the Wilson central terminal for production of 9 of the standard 12 electrocardiogram leads.” Journalof electrocardiology 38.2, 119-127 (2005).

Democratization of data and maintenance parameters generated by medical devices

PETAGNA M[1*], TANAKA H[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*manuela.petagna@aluno.ufabc.edu.br

Keywords: Biomedical Engineering, Clinical Engineering, Medical Devices, Data, Data Democratization.

Introduction

According to RDC 16/2013, which approves the Technical Regulation of Good Manufacturing Practices of Medical Products and Diagnostic Products for In Vitro Use and provides other measures, all medical equipment must have a manual in which are available "methods and procedures of installation, maintenance and technical assistance" [1], however there is no determination as to what information should be available to users and holders of the equipment, leaving open the possibility of full dependence on the manufacturer.

Leaving the scope of health products, airplanes are built following standards of good practice that determines the existence of controls that allow: (i) "operate easily, smoothly and positively enough to allow the proper performance of their functions" and (ii) "protect against probable risks" [2].

The objective of this work is to determine, in the environment of medical devices, what are the parameters already existing and which should be made available to ensure protection against probable risks in the care operation and a good operability.

Materials and Methods

For the development of this work will be analyzed the technical manuals of some classes of equipment, in order to identify what information is available to users and maintenance teams. Maintenance history of some of these chosen classes will also be analyzed to estimate the benefit of the information already available and the need for others that should be monitored.

Results and Discussion

It is expected to obtain, at the end of this work, the current scenario of parameters and information that are made available to users, and their scope in risk monitoring to anticipate defects and failures. Secondly, to propose, in view of the analysis of maintenance histories, what other parameters should be free to access and consultation, in addition to a standardized error log, which allows deeper analyses of specialized teams, such as clinical engineering, ensuring that both assistance and maintenance teams, each in their role, can ensure the safe and effective use of medical devices.

Conclusions

The development of this work is in favor of the movement of democratization of data and information, which has already been established in other areas, allowing the leverage of patient safety and hospital environments. Biomedical engineering professionals will be responsible both for the availability of these data, as manufacturers, as well as for reading and analyzing them, when users and maintainers of technologies.

Recognition

I thank the Federal University of ABC for supporting the development of this work, and offering grants so that it can be developed.

References

1 Agência Nacional de Vigilância Sanitária (ANVISA). Resolução RDC nº 16, de 28 de março de 2013. Determina a todos fornecedores de produtos médicos, o cumprimento dos requisitos estabelecidos pelas "Boas Práticas de Fabricação de Produtos Médicos". Publicada no DOU, em 01 de abril de 2013.
2 Agência Nacional De Aviação Civil (ANAC). Regulamento Brasileiro da Aviação Civil RBAC nº 023 EMD nº 64, de 02 de agosto de 2019. Requisitos De Aeronavegabilidade: Aviões Categoria Normal. Publicada no DOU, em 07 de agosto de 2019.

Surface modification of bioactive materials for ceramic scaffolds

SANTOS KF[1,2], GOMES GHM[2], MORASSUTI CY[2], SOUZA MT [3], RODAS AC[1,2*], DAGUANO JKMB[1,2]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

[2] Renato Archer Information Technology Center (CTI), Campinas/ SP, Brazil

[3] VETRA Startup – Research and development of high-tech ceramic products, São Carlos/ SP, Brazil

*acdrodas@cti.gov.br**

Keywords: Bioactive Materials, Surface modification, Cytotoxicity, Ceramic Scaffold.

Introduction

In tissue engineering, ceramic scaffolds have been investigated as bone repair elements or substitutes due to their high biocompatibility [1]. Bioactive materials are a potential solution because in their constitution there are osteoinductive elements, as silicon, calcium, and phosphorus oxides. These compounds have the ability to induce cell proliferation and bone remodeling [2]. However, when they are subjected to aqueous environments, their ionic components are dissolved, altering the pH of the medium, as a result, these ions can interfere in cell viability [3]. In this work, we carry out the surface treatment of the biomaterials: Biosilicate glass-ceramic, F18 bioactive glass, and 45S5 Bioglass to improve their biocompatibility evaluated by physical-chemical and cytotoxicity tests for future applications as ceramic scaffolds.

Materials and Methods

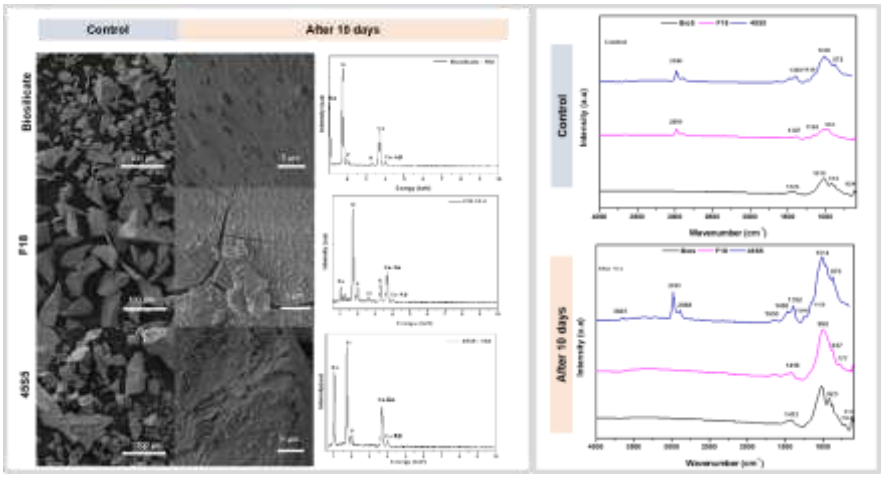
Biosilicate and 45S5 materials have SiO_2-Na_2O-CaO-P_2O_5 as their base composition while the F18 glass is covered by the patent BR10INPI 20130209619. The samples were conditioned in a non-supplemented DMEM culture medium (*Dulbecco's Modified Eagle's Medium*) for 10 days at a temperature of 37°C by shaking at 80 rpm. The samples were characterized before and after conditioning by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), Fourier Transform Infrared Spectroscopy (FTIR), and Cytotoxicity Assay.

Results and Discussion

Figure 1 indicated that storage the biomaterials for 10 days in DMEM resulted in a slight change in the topography. The literature suggests that bioactive materials, when

exposed to aqueous media, have the ability to perform ionic exchanges with a culture medium, especially sodium and calcium present on the surface. This way, resulting in the possible formation of a layer of calcium phosphate on the surface [3]. As a complementary analysis, the EDS spectrum indicates the presence of phosphorus and calcium characteristic peaks of apatites. The spectrum the sample shows an absorption band 1400-1580 cm-1 attributed to phosphate group and 866 - 877 cm^{-1} correspond to carbonate both can be associated with apatites. However, cytotoxicity assays showed cell viability around 30% after conditioning suggesting protocol changes.

Figure 1 - Samples before and after immersion in non-supplemented culture medium for 10 days -



Conclusions

This study aims to perform surface treatment of bioactive materials to improve their biocompatibility. Initial results indicate that immersion in a culture medium for 10 days led to the formation of an apatite structures. *In vitro* tests and chemical characterizations were carried out indicating a slight improvement.

Acknowledgment

The authors thank Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support, and Vetra for donating the biomaterials.

References

1 Hench L, Wilson J. Surface-active biomaterials. Science, v. 226, n. 4675, p. 630–636, 1984
2 Jeong J et al. Bioactive calcium phosphate materials and applications in bone regeneration. Biomaterials research, v. 23, n. 1, p. 1-11, 2019.
3 Lópes - Cuevas J et al. In vitro bioactivity of a glass-ceramic biomaterial with near-eutectic composition of the pseudo-binary system diopside-tricalcium phosphate. Boletin de la Sociedad Espanola de Ceramica y Vidrio, v. 60, n. 2, p. 83–92, 1 mar. 2021

Light-tissue interaction of laser with neonatal rat brains

FABRETTI LT[1*], SILVA DFT[2], RAELE MP[2], KATO IT[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Nuclear and Energy Research Institute (IPEN-CNEN), São Paulo/ SP, Brazil

*leonardo.fabretti@aluno.ufabc.edu.br

Keywords: Photobiomodulation, Neonatal Anoxia, light-tissue interaction, Biomedical Engineering, Neuroscience.

Introduction

Neonatal anoxia is a major causa of neonatal deaths worldwide. The oxygen deprivation during birth can lead to incapacitating sequelae to surviving newborns, like the impairment of motor and cognitive functions [1]. The hippocampus is particularly sensible to such insults. The prefrontal cortex when hit by this insult, leads to disorders of attention-deficit/hyperactivity and learning disorders. Currently, the only available therapeutic solution for such insult is submitting neonates to hypothermia therapy [2].

Photobiomodulation therapy (PBM) consists of the application of light in a target injured tissue with the objective of promoting wound healing and reducing pain, inflammation and swelling [3]. Recent studies have shown its capabilities of reducing inflammation and having neuroprotective effects on the central nervous system, while also displaying promising results in the treatment of Parkinson, Alzheimer, stroke and traumatic brain injury [4].

Given the context, our research group aimed to investigate the light-tissue interaction using an animal model of neonate rat brains, by evaluating the light distribution, propagation and attenuation throughout the brain and also quantifying the amount of light that reaches the hippocampus and the pre-frontal cortex.

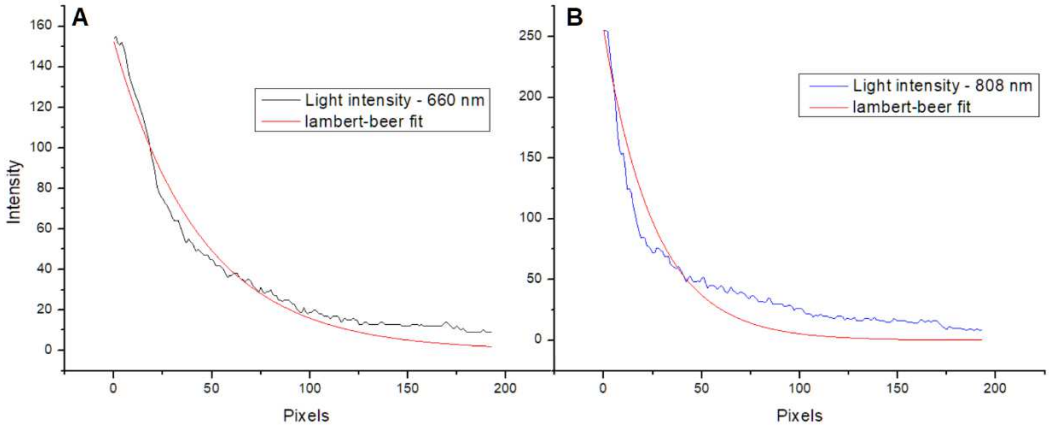
Materials and Methods

Neonate Wistar rat brains will be used to evaluate light distribution, being irradiated with a laser of 808 nm and 660 nm of wavelength in the bregma region. Images will be acquired perpendicular in relation to the target surface using an infrared sensible camera (Luca®, Andor Technology, North Ireland), later to be transformed into intensity matrices and the value of attenuation will be analyzed using a lambert-beer curve fitting. The tissue absorbance/ transmittance and reflectance will also be analyzed using a spectrophotometer (Cary 5000, Agilent Technologies, USA). The spectroscopic data will be collected for different regions of the brain. Preliminary test results for light attenuation were already obtained using adult Wistar rat brains. (CEUA: 8852240517).

Results and Discussion

Preliminary test images of irradiated adult rat brains at 808 and 660 nm were obtained and the 8-bit grayscale data were extracted using Python as intensity matrices. The following graphs were obtained in a straight line with the laser header direction, from the surface of the brain in the bregma region (dorsal) till the end of the tissue (ventral):

Figure 1: Plot of light intensity of different wavelengths of irradiation of an adult rat brain. The data was also fit into a lambert-beer function. Source: own work.



It is noticeable that the 808 nm wavelength (B) has a steeper curve, which may indicate a higher value of light attenuation. Further calculations with a more robust model of lambert-beer curve fitting will be added later on.

The spectroscopy data will be collected for different regions of the brain in transversal slices, following the same dorsal-ventral way of the light attenuation analysis. Despite having differences in grey and white matter concentrations, it is expected that the different regions don't deviate too much from one another in terms of light absorbance and reflectance.

Conclusions

Our study aims to help define an adequate methodology of light irradiation for future applications of photobiomodulation therapy in the brain.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

References

1 Takazono PS, Golin MO; Asfixia Perinatal: Repercussões Neurológicas e Detecção Precoce. Revista Neurociências 21:761-10p. 2013.

2 Miguel PM, Deniz BF, Deckmann I, Confortim HD, Diaz R, Laureno DP, Silveira PP, Pereira LO; Prefrontal cortex dysfunction in hypoxic-ischaemic encephalopathy contributes to executive function impairments in rats: Potential contribution for attention-deficit/hyperactivity disorder. The World Journal of Biological Psychiatry 19(7): 547-560. 2017.

3 Chung H, Dai T, Sharma SK, Huang YY, Carrol JD, Hamblin M; The Nuts and Bolts of Low-level Laser (Light) Therapy. Annals of Biomedical Engineering 40(2): 516–533. 2012,

4 Salehpour F, Mahmoudi J, Kamari F, Sadigh-Eteghad S, Rasta SH, Hamblin MR; Brain Photobiomodulation Therapy: a Narrative Review. Mol Neurobiol 55(8):6601-6636. 2018.

Design and simulation of a quadrature hybrid T/R switch for 7T MRI

SANTOS, L.G.C. [1]*, PAPOTI D.[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo, SP, Brazil

*e-mail: luiz.gcsantos1@gmail.com

Key words: Magnetic Resonance Imaging, Birdcage Resonator, Ultrahigh Field MRI, Quadrature Polarization, T/R Switch.

Introduction

One of the most efficient geometries in terms of homogeneous RF field production is the birdcage coil or birdcage resonator [1]. To enable the circular polarization of the RF field generated by a birdcage coil, it is necessary to feed the RF power into the two ports 90º geometrically apart, as well as 90º of phase difference. In addition, if the same RF coil is used for transmitting and receiving the RF, it is necessary a dedicated circuit to guide the RF power from the amplifiers to the coil and a different path to transmit the induced signal to the low noise preamplifiers. The work reported here describes the design of a quadrature hybrid T/R switch RF circuit operating at 7 Tesla (i.e. 297 MHz) MRI scanner. This T/R switch will be used to provide quadrature excitation and detection in a transceiver birdcage resonator for knee MRI at 7 Tesla [2].

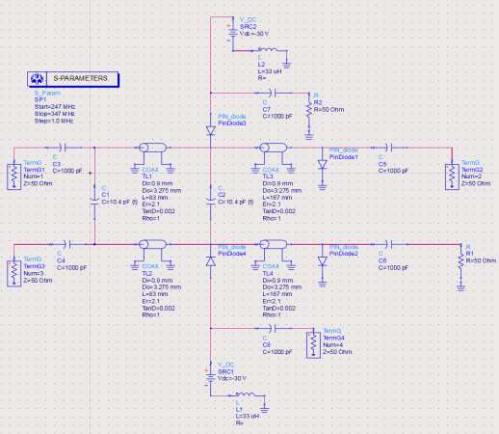
Materials and Methods

The designed quadrature/hybrid (Figure 1) has 4 inputs and is composed of λ/8 = 83 mm long 50 Ω coaxial cables (considering the speed of light $c = 3*10^8$ and coaxial cable speed factor v = 0.66) with 10.4 pF high power capacitors. The circuit maintains maximum isolation between the ports on the same side and causes a 0° and 90° phase shift [3]. The T/R Switch consists of 50 Ω coaxial cables with a length of λ/4 = 167 mm with PIN diodes connected at the output directly to ground and when semiconductors are fed by a Bias-T type circuits, the output impedance tends to increase [4]. Capacitors of 1000 pF were used as DC current isolators and inductors of 33 μH as RF isolators. The combination of the both circuits was tested in the Advanced Design System (ADS, Keysight) and the transmission (S_{21}) coefficients between the ports during transmission of the RF signal were evaluated. 50 Ω loads were added to the circuit to dissipate the reflected RF power if the coil is not matched to 50 Ω. Ports 1 and 3 are considered the outputs for powering the RF coil, port 2 a preamplifier and port 4 the input for the RF transmit signal.

Results and Discussion

During RF power transmission, an isolation of -25.52 dB between ports 1 and 3, -3.10 dB between ports 1 and 4, and -3.08 dB between ports 3 and 4 could be measured. This means that there is good isolation between the ports feeding the RF coil during transmission and half the power is applied to each transducer port. The transmission coefficients related to port 2 remained below -70 dB while the PIN diodes were on. Therefore, the port destined for the RF preamplifier is completely isolated. During reception the isolation between ports 1 and 3 was -24.80 dB, -3.12 dB between ports 2 and 3, and -3.11 dB between ports 1 and 2. The transmission coefficients related to port four remained below -80 dB while the PIN diodes were off.

Figure 1. Quad/Hybrid T/R switch schematic



Font: Author.

Conclusions

This work described the design and simulation of a quad/hybrid T/R switch circuit operating at 297 MHz whose application is to allow quadrature excitation and reception with a transceiver birdcage resonator for knee MRI at 7T. This T/R switch will enable the RF power to be decreased by a factor of 2 compared to the current linear polarized birdcage coil. In addition, the SNR should increase by a factor of $\sqrt{2}$. The results obtained through the ADS simulations were satisfactory and the next step is the prototyping of the circuit and workbench testing, before performing imaging tests in the 7T MRI scanner.

References

1 Hayes, Cecil E. et al. An efficient, highly homogeneous radiofrequency coil for whole-body NMR imaging at 1.5 T. Journal of Magnetic Resonance (1969), v. 63, n. 3, p. 622-628, 1985.

2 Santos LGC, Chaim KT, Vidoto ELG, Tannús A and Papoti D. Development and characterization of a transmitter/receiver volume Birdcage Coil for knee MRI at 7T. In: IX Congresso Latino-Americano de Engenharia Biomédica e XXVIII Congresso Brasileiro de Engenharia de Engenharia Biomédica, October 24–28, 2022, Florianópolis, Brazil.

3 Mispelter J, Lupu M, Briguet A. Quadrature Driving. In: Mispelter J, Lupu M, Briguet A. NMR probeheads for biophysical and biomedical experiments: theoretical principles and practical guidelines. World Scientific Publishing Company, p.295-344, 2015.

4 Yang X, Zheng T and Fujita H. T/R switches, baluns, and detuning elements in MRI RF coils. In ISMRM Fourteenth Scientific Meeting Weekend Syllabus, May, 2006.

A model for lung ventilation, gas exchange and the respiratory system's self-regulation

TEMPLE MV[1], NISHITANI WS[1*]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*wagner.nishitani@ufabc.edu.br

Keywords: Biomedical Engineering, Modeling of Dynamic System, Lung Mechanics, Gas Exchange, Numerical Methods.

Introduction

Pulmonary mechanics can be divided into two processes: inspiration, which is an active phenomenon where the volume of the thorax increases, creating a negative pressure in relation to the exterior (atmospheric) that allows the inflow of air; and expiration , a passive process that occurs as a result of the elastic properties of the lungs, generating a positive pressure that allows air to escape [1].

The gas exchange between the air and the blood of the pulmonary capillaries in the respiratory system occurs in the alveoli, which are structures that extend from the bronchioles. The basis of this process is the passive diffusion along the respiratory membrane. Thus, the oxygen from the atmospheric air in the alveoli flows into the blood and the carbon dioxide goes the opposite way [1,2].

The pressure that a specific gas exerts in a mixture is defined as its partial pressure. The partial pressures of gases determine their movement between the lungs and the blood, which will diffuse through the permeable membrane from the region where the partial pressure is highest to lowest [2].

The respiratory system is regulated with the goal of maintaining adequate levels of oxygen and carbon dioxide in the blood, which can lead to an increase or decrease in respiratory rate and pressures amplitude in order to normalize the partial pressures of these gases [2,3].

In this work, a concentrated model for lung mechanics and one for gas exchange will be developed, as well as an integrated model with these two components. The main goal is the reproduction of the physiology of the respiratory system through a simplified model that covers the pulmonary mechanics, the gas exchange and the control of the pulmonary mechanics in response to the concentrations of carbon dioxide and oxygen in the blood.

Materials and Methods

The methodology for developing the models is based on the theory of modeling dynamic systems, in which systems of ordinary differential equations are developed and numerical integration methods are applied to solve them, such as second-order

Runge-Kutta. This integration method will be applied computationally through software developed in Python.

The pulmonary mechanics model was based on the model proposed by Albanese et al. [3], without significant changes, while the gas exchange model was adapted from the model proposed by Albuquerque Neto [4], using fewer compartments and adapting the premises and equation of each compartiment.

Finally, an integration between the models will be developed, with a control component of pulmonary mechanics based on the blood gases partial pressures, obtained through gas exchange.

To validate the models, tests will be conducted in order to compare the model results with data from the cited literature, considering simulated and experimental results.

Results and Discussion

Preliminarily, the pulmonary mechanics model was implemented and the air flow obtained was used as an input of the gas exchange model which was developed separately.

With the systems implemented separately, it was possible to reproduce the results obtained by Albanese [3], regarding air flow and alveolar pressure. Similar results were observed for oxygen and carbon dioxide partial pressures when compared with the data obtained by Albuquerque [4].

After the models validation, the next step is their integration, with the main goal of implementing a control component, which aims to change the respiratory rate and pressure amplitude so that the partial pressures at abnormal levels are regulated over time.

Conclusions

The models were implemented and validated considering the literature on this topic, leaving their integration as the next step.

The contribution of this project is to reproduce the respiratory system's physiology by modeling the mechanics, transport and exchange of gases in a simplified way, so that it serves as a learning tool in the field of biomedical engineering.

References

1 BRASIL. Ministério da Saúde. Secretaria de Gestão de Investimentos em Saúde, Projeto REFORSUS. Equipamentos Médico-Hospitalares e o Gerenciamento da Manutenção: Capacitação à Distância. Brasília, DF, pp. 684-720. 2002.

2 TORTORA, G.J., DERRICKSON, B. Princípios de anatomia e fisiologia. 14a Edição, Rio de Janeiro: Guanabara Koogan, pp. 1144-1206. 2016.

3 Albanese A, Cheng L, Ursino M, Chbat NW. An integrated mathematical model of the human cardiopulmonary system: model development. Am J Physiol Heart Circ Physiol, 310(7):H899-921. 2016. doi: 10.1152/ajpheart.00230.2014. Epub 2015 Dec 18. PMID: 26683899.

4 ALBUQUERQUE-NETO, C. Um modelo do transporte de monóxido de carbono no sistema respiratório do corpo humano. Dissertação (Mestrado) - Escola Politécnica, Universidade de São Paulo, São Paulo, 2005.

Development of modular multifrequency TIE hardware architecture using STM32

TOMAZINI MO[1]*, CAMARGO EDLB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*mirela.tomazini@ufabc.edu.br

Keywords: Bioimpedance, EIT, Multifrequency measurement channel, Electrical impedance tomography.

Introduction

Electrical impedance tomography (EIT) is a technique for acquiring tomographic images by applying electrical currents or voltages to a given structure. Since each body has a particular anatomy, physiology, and possible specific pathologies, using the EIT method is possible to obtain information on the distribution of bioimpedance presented internally to the body [1,2].

The previously mentioned technique presents itself as a non-invasive, low-cost, and portable alternative for the generation of medical images through the mapping of body impedances, becoming a possible alternative in terms of diagnostic and monitoring methods [3,4].

The EIT technique can be explored in terms of time and frequency differentials, requiring a multifrequency electrical impedance tomography device to perform the second type of analysis. In addition, there are studies that suggest that for the detection of certain pathologies, such as malignant tumors, it is necessary to apply currents with more than one frequency [1,3,4].

This project is proposed in this context, which objective is the development of a modular and low-cost multifrequency EIT hardware architecture based on a previously developed EIT multifrequency channel using STM32, with a view to using this technology for medical applications.

Materials and Methods

Among the needed material to carry out this project, there are oscilloscope, signal generator, multimeter, soldering iron, and computer electronics materials such as microcontrollers (STM32), operational amplifiers, resistors, and capacitors are inexpensive and relatively easily available on the market.

The first part of the research consists of carrying out a bibliographical review of the different techniques for acquiring EIT signals using multiple frequencies.

Next, the optimization of the multi-frequency impedance measurement channel previously developed will be performed, which currently consists of an electrical circuit with the following parts: input operational amplifier, signal DC adjustment, low pass filter, signal generator, and current source.

After optimization, the channels will be replicated and integrated using a microprocessor. Then the measured signals will be processed through free software, such as EIDORS (http://eidors3d.sourceforge.net/), on a Raspberry Pi.

Results and Discussion

By the end of the research, it is expected to obtain a hardware with a similar architecture as the one presented in Figure 1, which has modularity as one of the important characteristics allowing improvements to be developed and applied to isolated sections of the equipment.

Figure 1. Block diagram of the proposed architecture (The blocks painted orange will be built, while those painted blue will be purchased ready-made).

Font: Tomazini MO, Camargo EDLB.

Conclusions

Nowadays, there is no available commercial multifrequency electrical impedance tomography. Although some research groups are developing their equipment for specific purposes such as brain and breast imaging, an optimized way of doing so has not been consolidated. This is the perspective from which this project arose, showing itself as a relevant topic in the field of Biomedical Engineering to contribute to the EIT development [6][7].

Acknowledgment

This work was carried out with the support of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Financing Code 001.

References

1 Bera TK. Bioelectrical impedance methods for noninvasive health monitoring: A review. Journal Of Medical Engineering, 1(1-28):e1010525. 2014.
2 Jagadale A, Kakade S, Paril S. Development of Eletronic system for Bioimpedance Analysis. 1. ed. Saarbrucken: LAP Lambert Academic Publishing. 2016.
3 Noor J. Electrical Impedance Tomography - A Low Frequency Approach. 1. ed. Saarbrucken: LAP Lambert Academic Publishing. 2010.
4 Khalil S, Mohktar M, Ibrahim F. . The theory and fundamentals of bioimpedance analysis in clinical status monitoring and diagnosis of diseases. Sensors, 14(6):10895-10928. 2014.
5 Ke XY, Hou W, Huang Q, et al. Advances in electrical impedance tomography-based brain imaging. Military Medical Research. 9(10): 1-22.2022.
6 Ain K, Kurniadi D, Ulum M F, et al. Development of multi frequency electrical impedance tomography for rectangular geometry by finite volume methods. Jurnal Teknologi. 84(2):9-15.2022

Compositional changes on dentin due to IR and UV high-intensity *Q-switched* lasers

RODRIGUES M*, ANA PA

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

monique.rodrigues@ufabc.edu.br

Keywords: Fourier transformed infrared spectroscopy, high power lasers, caries, laser radiation.

Introduction

High intensity lasers are used for alteration in dental hard tissues, and such modifications may increase the resistance of these tissues to demineralization. These changes are due to the increase in surface temperature during irradiations, which should exceed 100° C and can reach up to 1200° C. However, to avoid damage to adjacent tissues, such as pulp or periodontal tissue, pulsed lasers are recommended as they allow sufficient thermal relaxation time to prevent excessive heat accumulation into the irradiated hard tissues.

Commercially available lasers for this purpose have a pulse duration of the microsecond order. Considering that root dentin is a tissue of small thickness and very close to soft tissues such as gum and periodontal ligament, the use of *Q-switched* lasers can be more suitable. These lasers have a nanosecond pulse duration; thus, the time between pulses is much longer, which allows extended thermal relaxation time of tissue. In this way, it is possible to adjust higher peak powers, ensuring elevated temperatures during irradiations and thus greater microstructural changes on the radiated surface, which therefore leads to better resistance to demineralization. Prior studies have shown that the radiation with Nd:YAG laser (1064 nm) of 5 ns pulse duration can promote surface melting and recrystallization, suggesting that temperatures above 1000° C have been reached [1]. Considering the composition of the dentin, with higher water content and organic matrix compared to enamel, emitting lasers in the ultraviolet region has also been proposed for caries prevention [2].

However, no studies reported compositional changes arising from partially demineralized dentin by these two *Q-Switched* lasers. This study evaluated the chemical modifications to the demineralized root dentin after Nd:YAG laser irradiation with two distinct wavelengths, aiming to determine which one could be investigated in a future clinical application.

Materials and Methods

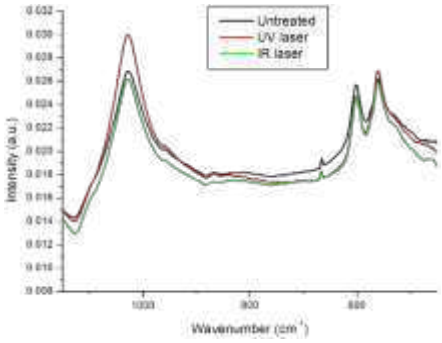
Thirty samples of bovine root dentin were demineralized for 32h to simulate an incipient caries lesion. Then, samples were randomly distributed in three experimental groups (n = 10): untreated samples, samples treated with *Q-switched* Nd:YAG laser at 1064 nm (IR laser) and samples treated with *Q-switched* Nd:YAG laser at 355 nm (UV laser).

After treatments, the compositional changes were evaluated by Fourier transform infrared spectroscopy (FTIR), using the diffuse reflectance method. The spectra were collected with a resolution of 4 cm^{-1} and 60 scans in the region of 4000 to 450 cm^{-1}. For the comparative semi-quantitative analysis, the vectorial normalization of the spectra was performed.

Results and Discussion

The irradiation of dentin with IR laser promoted minor changes in dentin composition, with a small reduction in the intensity of the peaks corresponding to the phosphate vibrations. Also, laser irradiation decreased the intensity of bands of the amides I, II and III, corresponding to the organic content of the dentin, which consist with literature [2]. The UV laser decreased the intensity of the 1021 cm^{-1} peak (corresponding to the ν_3 asymmetric vibration of phosphate), which may be due to the increase in local temperature, promoting a structural rearrangement in hydroxyapatite [3].

Figure 1. Average infrared absorption spectrum of demineralized root untreated dentin and after treatment with IR laser and UV laser in the region between 1150 - 450 cm^{-1}.



Font: The authors.

Conclusions

High-intensity *Q-switched* Nd:YAG laser irradiation can change the microstructure of demineralized dentin, and the effects promoted by 1064 nm laser irradiation are most evident, which suggests that this is best wavelength for the prevention of root caries.

Acknowledgment

The authors would like to thank to CAPES, National Institute of Photonics (CNPq/INCT 465763/2014-6) and Multiuser Experimental Center of UFABC (CEM-UFABC).

References

1. Antunes A, Vianna SS, Gomes ASL, de Rossi W, Zezell DM. Surface morphology, elemental distribution, and spectroscopic changes subsequent the application of nanosecond pulsed Nd:YAG laser on dental enamel surface. Laser Phys Letters 2: 141-147.2005.
2. Wheeler CR, Fried D, Featherstone JD, Watanabe LG, Le CQ. Irradiation of dental enamel with Q-switched lambda = 355-nm laser pulses: surface morphology, fluoride adsorption, and adhesion to composite resin. Lasers Surg Med. 32:310-317.2003.

Use of PDT therapy for symptom reduction in patients who are or have had COVID-19

PINHEIRO RS*, ANA PA[1], RIBEIRO MS[2], TANAKA H[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil, Center for Lasers and aplications, ²IPEN-CNEN/SP

*renato.pinheiro@ufabc.edu.br

Keywords: PDT Therapy, Viral load, Laser, Covid-19.

Introduction

The pandemic spread of the novel coronavirus disease (COVID-19), caused by the SARS-CoV-2 virus, is a global health threat. After 15 months of the appearance of the first case in China, more than 674,229,072 people were diagnosed with COVID-19 with approximately 6,864,006 deaths. Light-based technologies emerge in this scenario as concrete options to combat COVID-19. Currently, photodynamic therapy (PDT) has been successfully used in infectious diseases for microbial inactivation, including viruses (4-7). PDT makes use of an endogenous or exogenous photosensitizer (PS), oxygen and light irradiation at the site to be treated. When the FS absorbs light, it goes into an excited state. Upon returning to the ground state, the PS can pass through its triplet state, reacting with the substrate (type I reaction) or with molecular oxygen (type II reaction).

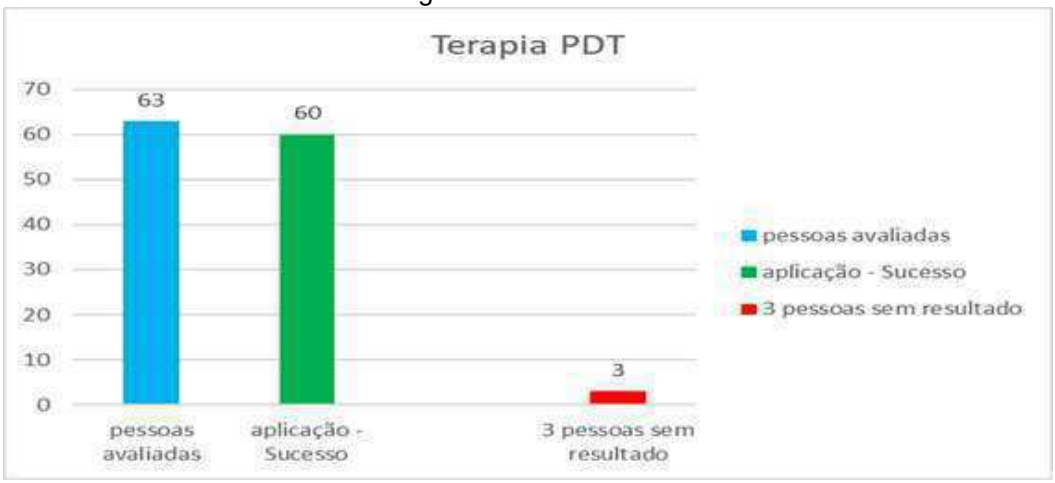
Materials and Methods

We selected 63 patients who agreed to participate in the therapy and were evaluated to verify data related to their health history and tests related to COVID-19, such as imaging tests and history of symptom progression. For the PDT group, we used a 100 μM aqueous AM solution (Sigma-Aldrich) prepared from a 1mM stock solution. MB was applied in the oral cavity with the aid of an irrigation syringe (5 ml) and the patient received 5 ml of the solution, gargling for 5 minutes. After that, we performed the irradiation with LED equipment emitting at λ = 660 nm and power of 100mW for 5 min, following the protocol presented by Schikora et al. (38). This procedure resulted in the delivery of 24 J of energy into the oral cavity. The nasal cavity was irradiated in two stages, one in the right nostril and another in the left, totaling 5 min per nostril.

Results and Discussion

Therapy success percentage (reduction of covid-19 symptoms and treatment of sequelae): 95.23%. Fig 1.

Figure 1. Results PDT



Font: Personal archive

Conclusions

The therapy applied in the research allowed significant improvements in the symptoms of patients with covid-19, non-invasiveness and speed of recovery were important points observed in the therapy.

Acknowledgment

The authors would like to thank to National Institute of Photonics (INCT-INFO) for giving suport for this investigation.

References

1 COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU). Disponível em: https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b4 8e9ecf62020. Acesso: 17/12/2020.
2 Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA. 2020.
3 Epstein D, Miller A, Ben-Avi R, Matan M. High-flow tracheal oxygen in tracheostomised COVID-19 patients. J Crit Care, 59:35-6. 2020.

Study and Application of Machine Learning Models in Activated Clotting Time Data

PIRES PH[1]*, SANTIAGO AG[1], ALMEIDA FN[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*phpsilva@ufabc.aluno.edu.br

Keywords: Machine Learning, Dimensionality Reduction, Learning Supervised, Activated Coagulation Measurement, Activated Clotting Time.

Introduction

The current development of new technologies, especially in the field of data analysis, is enabling a revolution in various areas of society, especially in health care [1], contributing to the development of both hardware and software. These technologies are used to monitor and analyze biological signals and link large amounts of data. This enables physicians to diagnose diseases faster and more accurately, develop new treatments, and detect things in the development of diseases that were previously unknown.

In the context of hardware development, the Active Coagulation Monitor (ACM) developed by the Instituto Dante Pazzanese de Cardiologia (IDPC) allows analogous determination of the timing of clot formation during the performance of surgeries and procedures that require the use of cardiopulmonary bypass, such as cardiac surgery, hemodialysis, hemodynamics, and therapies for thromboembolic disease and thrombolysis [2]. Measurement of Activated Coagulation Time (ACT) is performed by taking a blood sample from the patient (volume of 1 mL) to control the dosage of the anticoagulant heparin or to control the dosage of protamine to reverse the clotting effect [2].

It is important to emphasize that this test is considered the gold standard in these procedures and that "point-of-care" tests have a shorter interval between sample collection and test result, as well as a lower associated error, compared to tests ACT laboratory tests. Activators such as celite, kaolin and glass beads are commonly used to perform these tests [2].

Machine learning models consist of applying multiple algorithms to a large amount of data to find consistent patterns that describe the analyzed phenomenon and can lead to the optimization or automation of certain procedures. Their data to be analyzed by Machine Learning (ML) models must be stored in a structured way to allow the application of the algorithms and the interpretation of the results. It is worth noting that there are differences between the algorithms of ML and their forms of application: Supervised learning (SL) models are used in classification problems where there is a predetermined number of classes and each sample of database data is labeled, and in regression problems to predict numerical results.

This project aims to apply machine learning models to data collected in studies using ACM from the IDPC Adib Jatene Foundation. In a first study, data from studies

with an animal model will be used, as is common in this type of approach [3]. Then, these models will be used to validate the most appropriate algorithms and their limitations. The application of these models to human data is expected after the project is approved by the IDPC Human Research Ethics Committee. The aim of the study is to look at machine learning algorithms and their potential applications to determine the importance of active clotting time parameters and their prediction, analyze and apply unsupervised learning algorithms for aggregation of data and dimensionality reduction, analyze the impact of each acquired parameter on active clotting time (ACT), and apply supervised learning algorithms for regression and providing models for prediction of ACT.

Materials and Methods

The first phase of this project consists of a review of the Unsupervised Dimensionality Reduction and Parameter Analysis learning models that are most relevant in the ACM tests. In these algorithms, labels are not considered, i.e., there are no objective values or predetermined classes for each sample, but only a set of *N* independent classes that are predetermined and to which each sample in the database is assigned based on its similarity with the others. At the end of the analysis, the reduced database is used as input for supervised learning algorithms, i.e., there is a label or objective value that the model should reach, defined by an expert - in the case of classification models - or the result of an analysis - for regression models.

Results and Discussion

First, these models are applied to data obtained from animal experiments. This will be data that has already been digitized and contains the same information input as tests performed on humans, but in a controlled environment designed to study ACM hardware. It is then expected that the application of these models, already validated on data obtained in a surgical environment, will verify their suitability as an investigative and support system for ACT testing.

Conclusions

It is anticipated that the proposed project will produce a robust study that will allow for the review of parameters of greater relevance in coagulation outcomes and potential ACM test failures, as well as a reliable predictive model to support hardware ACM.

References

1 Camila Takemoto Bertolini, Saul de Castro Leite, and Fernanda Nascimento Almeida. Predicting cancer patients' survival using random forests. In Luis Kowada and Daniel de Oliveira, editors, Advances in Bioinformatics and Computational Biology, pages 96–106, Cham, 2020. Springer International Publishing.
2 Stephen Horton and Simon Augustin. Activated Clotting Time (ACT), pages 155–167. Humana Press, Totowa, NJ, 2013.
3 Yamashita K., Saito T., Tanaka K., Makino T., Takahashi T., Kurokawa Y., Yamasaki M., Eguchi H., Doki Y., Nakajima K., Kubo Y. Heparinized swine models for better surgical/endoscopic training. DEN open, 2: e64, 1 2021.

Project and analysis of a dual band CPW-fed antenna for WBAN applications

QUADROS ADS[1*], NETO MCA[1], OLIVEIRA KS[1]

[1] Federal University of Pará (UFPA), Computer and Telecommunications Laboratory (LCT), Belém/PA, Brazil.

*angelica.quadros@itec.ufpa.br

Keywords: WBAN, Dual-Band Antenna, CPW, 5.8 GHz, 3.5 GHz.

Introduction

The growth in the research and development of flexible and wearable devices and sensors has led to the foundation of wireless body area network (WBAN) [1] and the antenna plays a crucial role in ensuring the operation of a WBAN system [2].

Relevant works used Rogers 5880 as substrate to provide flexibility in WBAN applications antennas [3]. Some authors have developed wearable antennas with two main resonances: the 3.5 GHz (WiMAX communication standard) and 5.8 GHz (ISM-band), such as [4]. In WBAN projects as [3], numerous researchers have decided to feed their antennas with coplanar waveguide (CPW).

This work proposes a compact low profile dual-band antenna with operation at 3.5 GHz, for data transmission over WiMAX wireless communication standard, and 5.8 GHz for targeting the WBAN application.

Materials and Methods

The antenna was designed and simulated using CST Microwave Studio 2020 software [5], which is based on FIT (Finite Integration Technique) [5]. Is composed of a ground plane below, followed by the substrate and, above, the radiating element. The single layer semi-flexible Rogers Duroid 5880 substrate, with thickness=1.6 mm, has dielectric constant of 2.2 and tangent loss of 0.0009. Is fed with a 50 Ω CPW and its geometry consists of an "x" shape with circles at the ends, a curve in the center and a feed line. The radiating element and the feed line are PEC (Perfect Electric Conductor) 0.035 mm thick.

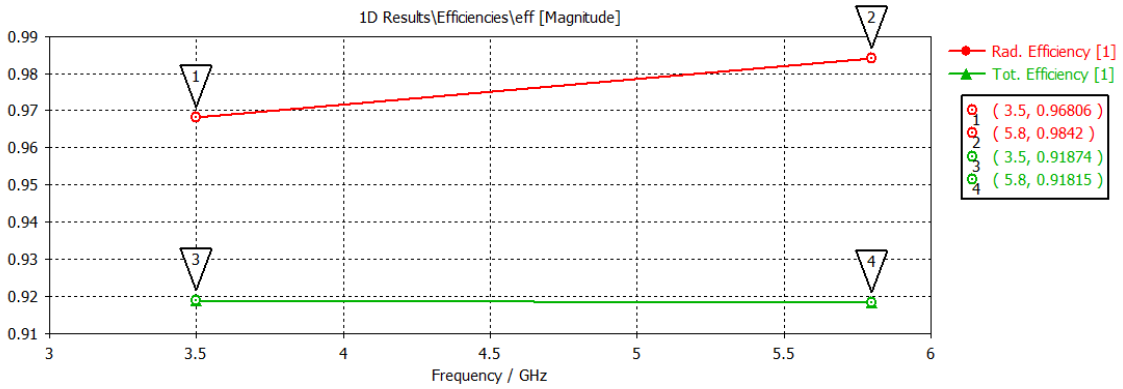
Results and Discussion

Seven parameters were analyzed: return loss, gain, current distribution, electric field, impedance, radiation pattern and efficiency.

Efficiency is measured by the ratio between radiated power and input power. It indicates how much power is transmitted, given the power received. The total efficiency of an antenna takes into account the losses at the input terminals and inside the antenna structure [6]. Figure 1 shows both radiation e total efficiencies. The graph

indicates a total efficiency of over 91% at both target frequencies. The radiation frequency shows even higher values, with efficiency of more than 96% at 3.5Ghz and more than 98% at 5.8GHz.

Figure 1. Simulated Radiation efficiency and total efficiency.



Font: The authors.

Conclusions

This project aimed the design and analysis of a dual band antenna for WBAN applications, operating at 3.5 GHz and 5.8 GHz. The proposed design achieved acceptable high gain and radiation efficiency levels at both resonant frequencies. But the analysis of the impedance and the surface current diagram suggest that energy is being wasted or not being distributed properly. The evaluations allowed a better comprehension of the antenna operation and the conclusion that the proposed antenna fits perfectly for WBAN applications, as the calculated parameters demonstrate this.

In the future, the authors intend to implement impedance matching techniques, more than one simulation environment for comparisons, add SAR analysis, use human models simulations and, from then on, enable real measurements on people.

Acknowledgment

The authors would like to thank the LCT team for their encouragement and support.

References

1 P. S. Hall and Y. Hao, Antennas and propagation for body-centric wireless communications. Boston, Mass: Artech House, 2012.

2 Yang,Deqiang., Hu,Jianzhong and L,Sihao. ,2018. A Low Profile UWB Antenna for WBAN Applications. IEEE Journals & Magazine. [online] Ieeexplore.ieee.org. Available at: <https://ieeexplore.ieee.org/document/8330748> [Accessed 30 Mar. 2019].

3 Dey, AB, Mitra, D, Arif, W. Design of CPW fed multiband antenna for wearable wireless body area network applications. Int J RF Microw Comput Aided Eng. 2020; 30:e22459. https://doi.org/10.1002/mmce.22459.

4 El Atrash, M., Abdalla, M., & Elhennawy, H. (2021). A fully-textile wideband AMC-backed antenna for wristband WiMAX and medical applications. International Journal of Microwave and Wireless Technologies, 13(6), 624-633. doi:10.1017/S1759078720001397

5 “CST Studio Suite Help,” Mit.edu, 2022. https://space.mit.edu/RADIO/CST_online/cst_studio_suite_help.htm (accessed Dec. 16, 2022).

6 C. Sun, Z. Wu e B. Bai, “A Novel Compact Wideband Patch Antenna,” IEEE transactions on antennas and propagation, pp. 7334-7339, 12 2017 Dezembro.

Evaluation of the antioxidant potential of aqueous and organic extracts of *Gustavia augusta* in cell lines

REZENDE LR[1*], LOMBELLO CB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

[*]laurent.r@aluno.ufabc.edu.br

Keywords: Antioxidant Activity, Tissue Regeneration, Tissue Engineering, Cytotoxicity.

Introduction

Tissue Engineering is an interdisciplinary area that uses knowledge in Engineering and Life Sciences to develop techniques that enable or induce the regeneration of biological tissues. The application of techniques and biomaterials aimed at tissue regeneration is complex and needs to consider several factors, such as biocompatibility, cell-matrix interactions, regulation of redox balance, among others [1]. *Gustavia augusta (Figure 01) is* a representative of richness of Brazilian biodiversity in pharmacological application [2,3]: the scientific literature presents characteristics of regenerative interest, such as anti-inflammatory, antioxidant and antitumor potential

Figure 01. *Gustavia augusta*, stem and flower.

Font: Tarcísio Leão (stem) e Dick Culbert (flower).

Thus, in order to verify potential future application use in tissue regeneration we propose to verify the antioxidant and cytoprotective action of the extracts of *G. augusta* against the oxidative stress induced by hydrogen peroxide and sodium glutamate in cell lines, observing the induction of antioxidant response, the analysis of ROS (reactive oxygen species) and the patterns of viability against oxidative stress,.

Materials and Methods

Cellular cytotoxicity will be performed with fibroblast cell lines that will be exposed to oxidative stress induced by peroxide and glutamate in three situations: in the absence of *G. augusta* extracts, in the previous incubation for 24h with the extracts, and in the previous incubation for 48h with the extracts. In all cases, the culture medium will be changed, and washed with PBS. Qualitative, morphological, and quantitative assays (MTT, trypan blue and crystal violet) will be performed as described previously [4]. The cytoprotective/antioxidant potential of the extracts will be verified, inducing stress via

peroxide in the presence of the *G. augusta* extracts, following the determination of reduced glutathione (GSH) and the oxidation of thiol groups of mitochondrial proteins [5-6]. The experiments will be performed in triplicate, with ANOVA One/ TwoWay and Tukey-Krammer test. The significance level adopted will be 5%.

Results and Discussion

It is known that the maintenance of redox balance is essential for tissue regeneration processes [1]. Thus, the evaluation of an antioxidant potential of extracts of *Gustavia* is important to highlight the applicability of the species to the area. Qualitative, morphological and quantitative assays (MTT, trypan blue and crystal violet) have already been performed for aqueous and organic extracts of stem and leaves [4].

Table 01. IC_{50} of *Gustavia augusta extracts in Vero cell lines.*

IC50 (ug/mL)					
Extract	Trypan Blue	Violet Crystal	MTT	**Mean**	SD
Aqueous	40,3	52,4	53,4	**48,7**	+/- 7,3
Methanolic	38,9	42,2	45,1	**42,1**	+/- 3,1
Ethanolic	32,1	36,2	38,1	**35,5**	+/- 3,0

Font: Author [4]

With the antioxidant and cytoprotective tests, the authors will include new data on the patterns of cell viability. *G. augusta* extracts are expected to demonstrate antioxidant activity in the treated strains reducing the formation of ROS and increasing cell viability, what would allow future applications in tissue regeneration.

Conclusions

Brazil, as holder of the largest share of the world's biodiversity [9], has an enormous natural potential for the selection and development of new drugs and herbal medicines. The evaluation of the antioxidant potential of a Brazilian plant is an important study to apply our biodiversity, enabling the creation of mechanisms to enhance tissue regeneration, as a controlled release agent in use with scaffolds or in dressings.

Acknowledgment

The authors would like to acknowledge CAPES for financial support.

References

1 Lanier R., Langer R, Vacanti JP. Principles of Tissue Engineering. 5. ed. Academic Press. 2020.
2 Lorenzi H, Matos FJA. Plantas Medicinais no Brasil. 2. ed. Instituto Plantarum, Nova Odessa. 2008.
3 Garcia TDE. Actividad antioxidante de los extractos del chopé (Gustavia augusta L.). Revista de la Sociedad Química del Perú, v. 75, n. 3, 2009
4 Rezende LR. Ensaios de viabilidade celular: um estudo comparativo de metodologias quantitativas. 2019. 30f. Trabalho de Iniciação Científica – Universidade Federal do ABC, 2019.
5 Rigoulet, M, Yoboue ED, Devin A. Mitochondrial ROS generation and its regulation: Mechanisms involved in H_2O_2 signaling. Antioxid. Redox Signal. v.14, p. 459-468, 2011
6 Kowaltowski, AJ, Souza PNC, Castilho RF, Vercesi, AE. Mitochondria and reactive oxygen species. Free Radic Biol Med. 47:333–343; 2009.
7 Santos ACB. Uso popular de espécies medicinais da família Verbenaceae no Brasil. Revista Brasileira de Plantas Medicinais. V. 17, n.4,p. 980-991, 2015.

Fluorescence detection based point-of-care diagnostic device for clinical applications

MARANHO JG[1]*, ANA PA[2]

[1, 2] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*Julio.gallinaro@aluno.ufabc.edu.br

Keywords: Point-of-care, Fluorescence, Molecular Diagnostics, Biomarker Identification.

Introduction

Point-of-care diagnostic devices have shown promise for timely and accurate diagnosis of various diseases, especially in resource-limited settings where access to laboratory facilities is limited. These devices offer the advantage of rapid diagnosis, allowing medical personnel to make informed treatment decisions quickly [1]. In this paper, we present the development of a fluorescence detection-based point-of-care diagnostic device for clinical applications. The device is user-friendly and portable, and uses a set of sensors to detect and analyze fluorescence signals from a variety of samples. I will describe the hardware and software components of the device as well as its testing and validation procedures. I will also discuss the potential applications of this device in the clinical setting and its impact on patient care. The goal of this work is to provide healthcare professionals with a reliable, easy-to-use tool that can aid in the diagnosis and treatment of a variety of diseases.

Materials and Methods

The point-of-care diagnostics device will be developed using the SparkFun Triad Spectroscopy Sensor[2] distributed by SparkFun Electronics, which uses three spectral sensors (AS72651, AS72652, and AS72653)[3] from the manufacturer AMS that allow analysis of 18 wavelengths in the range of 410 nm to 940 nm with a resolution of 20 nm (FWHM). The sensors will be positioned below the sample port that will receive a cartridge where the sample will be deposited, and above the cartridge, an excitation LED will be inserted. The cartridges have microfluidic channels to deliver the sample to 3 wells positioned over the sensors.

The excitation source is modular and will be composed of LEDs that are allocated on metal core printed circuit boards (MCPCB), which provide the electrical connections of the LED with the device and also act as heat sinks. The selection of the excitation LED depends on the Fluorescent Probe used. The excitation source LEDs are characterized to determine the wavelengths available for excitation and the power levels achievable at each wavelength.

The excitation source accommodates only one LED for each sample testing cycle. To use different excitation wavelengths, it will be necessary to perform different measurement cycles, changing the excitation LED for each cycle. The excitation

source control system will be composed of a driver circuit that will be controlled by a PWM signal provided by the microcontroller.

The device has a user interface based on the ITEAD HMI Nextion NX4832t035 to control the operation parameters and export the results of the tests performed on the samples.

The Arduino Uno microcontroller board based on the ATmega328P will be used to control all device systems (User interface, excitation source control, and sensor data acquisition).

The firmware of the device will be written in C++ language using Arduino IDE and will control all functions of the device. It will receive the measurement parameters (integration time, LED power, calibration parameters, etc.) through the user interface, perform the tests and display the test result on the interface. It will also be possible to export data to a computer via a SD card.

A software with a graphical interface will be programmed to read the results of the SD card on a computer, which will facilitate sharing and printing of the tests. This software will be programmed in Python 3.

Once the device is fully assembled, validation tests can be performed to determine the detection limits and the accuracy and specificity of the instrument. For this purpose, different fluorescent probes are used in conjunction with their target molecules at different concentrations and in the presence or absence of impurities.

Results and Discussion

So far, the excitation source LEDs have been characterized in terms of their wavelength. Once the construction of the device is complete, tests will be performed to determine the detection limit, specificity, and precision.

Conclusions

The development of a fluorescence detection-based point-of-care diagnostic device represents a significant advance in the field of biomedical engineering. This device provides a rapid, accurate, and reliable method for diagnosing and monitoring various clinical conditions without the need for complex laboratory equipment or specialized personnel.

In addition to clinical applications, the development of this device demonstrates the importance of interdisciplinary collaboration between engineers, scientists, and medical professionals.

Acknowledgment

Thanks to the Lab of Biophotonic and Biomedical Optics at UFABC for generously providing access to their instruments and facilities.

References

1 Nayak S, et al. Point-of-care diagnostics: recent developments in a connected age. Analytical chemistry 89.1: 102-123. 2017.

2 SPARFUN ELECTRONICS. Spectral Triad (AS7265x) Hookup Guide. [S. l.], 8 Nov. 2018. Available at: https://learn.sparkfun.com/tutorials/spectral-triad-as7265x-hookup-guide. Accessed on: 15 Feb. 2023.

3 AMS AG. AS7265x Smart 18-Channel VIS to NIR Spectral_ ID 3-Sensor Chipset with Electronic Shutter. [S. l.: s. n.], 2018. Available at: https://ams.com/documents/20143/36005/AS7265x_DS000612_1-00.pdf/08051c8a-a7f6-6231-7993-2d3fe0bf38b8. Accessed on: 15 Feb. 2023. Page: 13

Antimicrobial properties of polymers impregnated with clove extract Via supercritical CO_2

PARRA, K.C*, JORDÃO, A.M [2], CHAMPEAU, M [2], KATO, I.T [1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), Biomedical Engineering, São Bernardo do Campo/SP, Brazil
[2] Federal University of ABC, Center of Engineering, Modelling and Applied Social Sciences, Materials Engineering, Santo André/SP, Brazil

Corresponding author: * karem.parra@ufabc.edu.br

Keywords: antimicrobial, Clove oil, PLLA

Introduction

The production of clove oil has been increasing, with applications in the food, cosmetic, and pharmaceutical industries. The incorporation of essential oil can develop bioplastics with antimicrobial and antioxidant effects that prolong the shelf life of food and drinks. There is a growing interest in developing food packaging with a more sustainable process to reduce environmental impact. Similarly, active packaging with antimicrobial properties receives considerable consumer attention [6,7]. Clove essential oil (CEO) is extracted from the dried stem, leaves, and flower buds of Eugenia aromaticum and Eugenia caryophyllata (Western Hemisphere) or Syzygium aromaticum (Eastern Hemisphere). Eugenol ($C_{10}H_{12}O_2$, phenylpropanoid) is a volatile terpene with low solubility in water, a strong odor, and a fiery flavor. The high levels of eugenol contained in CEO are responsible for its strong biological and antimicrobial activities [5,8]. CEO can inhibit both Gram-negative bacteria and Gram-positive bacteria. Similarly, food-related pathogens have shown greater sensitivity to CEO than probiotics and fungi [4]. In the food industry, clove is often used in the form of ground or extracted essential oil, but always in small amounts due to its intense aroma and flavor. The distinct properties of the fluid CO_2, such as nonflammability, nontoxicity, environmental friendliness, and its ability to solubilize lipophilic substance led to the wide of the $scCO_2$ in various applications [9].

The objective of this study is to evaluate antibacterial activity and release profile of clove extract compounds impregnated into polycarbonate (PC) and poly (L-lactic acid) (PLLA) via supercritical CO_2 assisted impregnation.

Materials and Methods

The antimicrobial properties of impregnated polymers will be evaluated against *Escherichia coli* (ATCC 33694) and *Staphylococcus aureus* (ATCC 29213) using the disc-diffusion method [1]. The bacterial inoculum will be prepared in saline solution from an overnight growth in a non-selective medium. The suspension's absorbance at

625 nm will be adjusted to a value between 0.08 and 0.13 (0.5 on the McFarland scale), corresponding to a cell concentration of 1 - 2 x 10^8 CFU/mL. BHI agar plates [3] will be inoculated with 0.1 mL of bacterial suspensions, and 6 mm discs of impregnated samples will be placed in the Petri dishes. Clove extract, pure PC and pure PLLA samples will also be used as controls. The diameter of inhibition zone will be evaluated after 24 h and every three days for 27 days [2].

To evaluated the release profile of clove extract compounds, samples of 6 mm of diameter were placed in 10 mL of 95% ethanol and stored at 4 ^{o}C. At each time of analysis (1 h, 3 h, 5 h, 8 h, 12 h, 24 h, 48 h, 4 days, 7 days, every 4 days for 3 weeks and once a week until complete 3 months), 1 mL of the stored solution were obtained to evaluate the release CEO, and 1 mL of fresh ethanol was added. CEO content will be determined using a UV-vis spectrometer [10].

Acknowledgment

This work is supported by FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo), process number 2018/23902-3.

References

1 Brazilian Committee on Antimicrobial Susceptibility Testing. Disk-Diffusion Method for Antimicrobial Susceptibility Testing, January 2021 of EUCAST.

2 Wang L, Jiang Y, Chai Z, Li P, Cheng Y, Jing H, Leng X. Synergistic Antimicrobial Activities of Natural Essential Oils with Chitosan Films. J. Agric. Food Chem, 59(12410): e 12419. 2011.

3 Yabalak Erdal, Elif Ayşe Erdoğan Eliuz, M Dilek Nazlı. Evaluation of Citrus reticulata essential oil: Chemical composition and antibacterial effectiveness incorporated gelatin on E. coli and S. aureus.International Journal of Environmental Health Research. 32(6):1261-1270. 2021.

4 Shahbazi Y. Antioxidant, antibacterial, and antifungal properties of nanoemulsion of clove essential oil. Nanomedicine Res, 4(204) :e 208. 2019.

5 Alvarez MV, Moreira MR, Roura SI, Ayala-Zavala JF, González-Aguilar GA . Using natural antimicrobials to enhance the safety and quality of fresh and processed fruits and vegetables: Application techniques and quality issues. Handbook of natural antimicrobials for food safety and quality, 315 : e 325. 2014.

6 El-Shafei AM, Adel,AM, Ibrahim AA, Al-Shemy MM . Dual functional jute fabric biocomposite with chitosan and phosphorylated nano-cellulose (antimicrobial and thermal stability). International Journal of Biological Macromolecules, 124 (733) : e 741. 2019.

7 Fang Y, Tung M, Britt I, Yada S, & Dalgleish D. Tensile and barrier properties of edible films made from whey proteins. Journal of Food Science, 67(188):e 193.2002.)

8 Alvarez MV, Moreira M, del R, Roura SI, Ayala-Zavala J F, González-Aguilar GA. Using natural antimicrobials to enhance the safety and quality of fresh and processed fruits and vegetables: Application techniques and quality issues. Handbook of natural antimicrobials for food safety and quality, (315) : e 325. 2014.

9 Mohd Omar AK ,Tengku Norsalwani T, Abdul Khalil HPS, Nagao H, Zuknik MV, Hossain HV, Norulaini NAN. Waterless sterilization of oil palm fruitlets using supercritical carbon dioxide. The Journal of Supercritical Fluids, 126(65): e 71. 2017.

10 Lu H, Jieying D, Zhaoming WYW, Bo Chen,YMXL, Baocai X. International Journal of Biological Macromolecules.Improving the functionality of chitosan-based packaging films by crosslinking with nanoencapsulated clove essential oil,09(197) :e 205. 2021.

Characterization of new titanium alloys for use in tissue engineering

MARTINS AF[1*], PLAINE AH[2], BUENO CO[1], MENDES FILHO A[1], LOMBELLO CB[1]

[1] Center for Engineering, Modeling and Applied Social Sciences (CECS), Federal University of ABC (UFABC), São Bernardo do Campo, Brazil.
[2] Mechanical Engineering Department (CCT), University of the state of Santa Catarina (UDESC), Joinville, Brazil.

**andressa.francine@aluno.ufabc.edu.br*

Keywords: Biomedical Engineering, Medical Devices, Biomaterials, Titanium Alloys.

Introduction

Bone tissue is a type of specialized connective tissue contained by cells and a calcified extracellular matrix [1]. The tissue presents high rigidity and low flexibility, characteristic of human bones and which assist in soft tissue support functions, protection of vital organs, and skeletal support [1, 2]. In addition, the tissue has intrinsic regenerative capacity. In case of injury or pathology, replacement is done by scar tissue and subsequent bone remodeling may occur, with filling of the area by neoformed tissue [1-3]. However, in specific cases or with the involvement of extensive areas, it may be necessary to use biomaterials that favor bone protection and that also maintain the functional structure that can be associated with metallic structures, such as plates and pins, for the stabilization of the bones affected. Thus, this work seeks to study the biological interaction of some titanium (Ti) alloys for application in bone tissues [3].

Materials and Methods

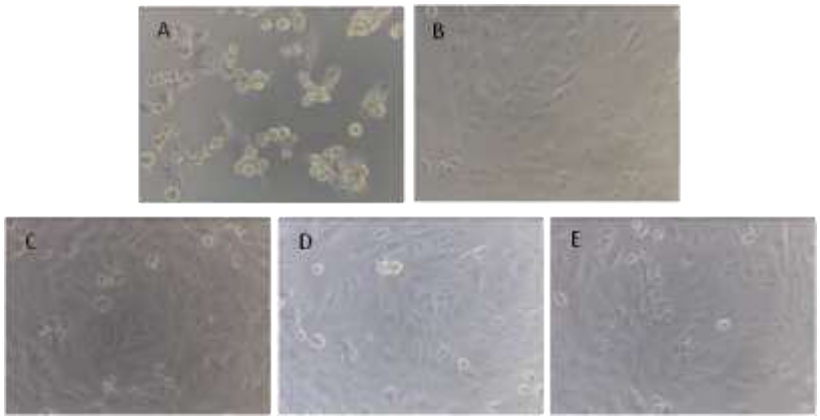
According to the proposed tests, samples of Ti64 (Ti-6Al-4V alpha-beta titanium alloy), TNHF (Ti-16Nb-10Hf metastable beta alloy) and TNTM (Ti-29Nb-13Ta-4Mo alloy) were prepared and sterilized in an autoclave for the cell interaction test. Cells of the Vero lineage were used, cultivated with HAM-F10 culture medium, supplemented with 10% fetal bovine serum (FBS) and antibiotics. A total of 93.9% cell viability was achieved,and 10.000 cells were inoculated in culture plates, on the Ti samples. The cells were maintained in culture for 24 hours to evaluate the initial cellular interaction of the cells with the titanium samples. Also, cytotoxic positive (latex) and negative (ideal culture conditions) controls were used. After this period, the cells in contact with the Ti64, TNHF and TNTM samples were observed, using light microscopy with phase contrast to characterize the cytotoxicity of the samples.

Results and Discussion

Vero cells are anchorage-dependent cells and highly recommended for *in vitro* cytotoxicity testing. Under ideal conditions for culture, these cells show an elongated or

polygonal-type morphology, forming a cellular monolayer [4, 5]. In the qualitative analysis of cytotoxicity, inverted light microscopy with phase contrast was used, in order to identify, in general, changes in morphology or also the incidence of cell lysis or although cytoplasmic vacuolation. In this case, it was possible to observe that Vero cells did not show signs of cytotoxicity in the presence of Ti64, TNHF and TNTM samples (Figure 1), indicating a good interaction of the cells with the samples. Therefore, the results obtained from this experiment show potential for the use of these alloys as an alternative in biomedical applications.

Figure 1. Micrographs of Vero cell morphology after interaction with titanium alloys samples. A = Positive control, B = Negative control, C = Ti64, D = TNHF, E = TNTM.



Font: authors

Conclusions

This work aimed to understand the use of titanium alloys in simulated biological conditions, as an alternative to other metallic biomaterials that have been used for the treatment of bone tissue injuries. So far, a good cellular response has been observed, without signs of cytotoxicity, demonstrating them as biologically compatible.

Acknowledgment

The authors would like to thank the researcher-students for Laboratory O-L104 (UFABC), and the UFABC for the experimental support.

References

1 Junqueira, L. C.; Carneiro, J. Histologia básica. 13.ed. Rio de Janeiro: Guanabara Koogan, 2018.
2 Souza, D S; Medrado, L; Gitirana, L B. Histologia. Capítulo 2 - Histologia. Conceitos e métodos para a formação de profissionais em laboratórios de saúde. v.2. Rio de Janeiro, 2010.
3 Mitsuo, M M. Biomateriais e regeneração óssea: conceitos e perspectivas. Revista De Ciências Médicas E Biológicas, 21(1), 3–4, 2022.
4 Guimarães, Z A S. Compósitos titânio-diamante para uso como biomateriais. Universidade Estadual do Norte Fluminense Darcy Ribeiro - UENF. Campos dos Goytacazes, RJ, 2012.
5 Nascimento, M H M, *et. al.*. Evaluation of cell interaction with polymeric biomaterials based on hyaluronic acid and chitosan. J Mater Sci Mater Med, v.28, n.5, p.68, 2017.

Signal generation module for bioimpedance equipment

FERREIRA SL[1*], CAMARGO EDLB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

[*]silvio.ferreira@ufabc.edu.br

Keywords: Bioimpedance, Signal Generation, ICL8038, XR2206, AD9850.

Introduction

The signal generation module is responsible for generating a reference signal for the operation of bioimpedance equipment, such as electrical impedance tomography equipment.

The quality and precision oh the signal produced by the signal generator directly interfere with the operation of the equipment where it is used, and may cause instability and errors in the final result.

For the study of the signal generation module, Integrated Circuits (ICs) capable of generating frequency signals with stability and reliability were used in this research. Thus, the following ICs were selected for analysis: ICL8038, XR2206 and AD9850.

Materials and methodology

The Integrated Circuit (IC) ICL8038 is capable of generating three different waveforms: sinusoidal, square and triangular [1]. The ICL8038, despite having its manufacture discontinued by the manufacturer *Intersil*, continues to be widely used in circuits and wave generation applications.

The XR2206 IC - like the ICL8038 - also has the possibility of generating three types of waves [2]; however, it has a wider variety of kits and circuits that are based on it.

The AD9850 has its frequency generated by a DDS (Direct Digital Synthesizer) [3], this frequency being defined by the controller and with the possibility of being changed at any time during its use. It also has two counter-phase sinusoidal outputs, suitable for bipolar current sources.

Results and Discussion

The tests carried out with the signal generators showed the need to use a passive high-pass filter to remove the offset present in the generated signal. The designed passive high-pass filter uses a 100 nF capacitor and a 1 KΩ resistor, resulting in a cutoff frequency of approximately 1.60 KΩ.

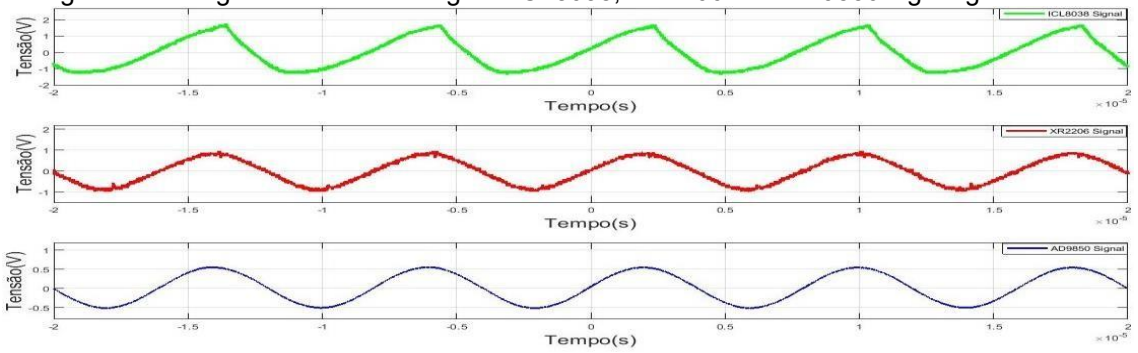
The ICL8038 IC had its tests following the guidelines contained in its datasheet. During tests with the aid of an oscilloscope, the IC presented a noisy signal that was

difficult to adjust for the desired frequency, even using the suggested circuit for noise reduction.

To test the XR2206 IC, a kit with an already manufactured printed circuit was used. This option proved to be more advantageous, both for economic issue and for the quality of the printed plate produced. In oscilloscope tests, this kit presented a stable signal that was easy to adjust to the desired frequency.

The test carried out with the AD9850 was aided by a STM32 microcontroller, responsible for controlling the desired frequency to be adjusted on the generator. The AD9850 generated a noise-free signal, with the possibility of a simplier and more precise adjustment at the stipulated working frequency — compared to the other tested options. It also presented the possibility of changing the frequency programmatically at any time during the operation — an important differential in the use of this IC. Figure 1 shows the result of the signals obtained using the ICL8038, XR2206 and AD9850 signal generators.

Figure 1.The signals obtained using the ICL8038, XR2206 and AD9850 signal generators.



Font: FERREIRA SL, CAMARGO EDLB.

Conclusions

The tests carried out with the three generators showed that, although all the ICs tested fulfilled the signal generation function, the AD9850 IC proved to be a safer option for use in bioimpedance equipment, both due to the quality of the generated signal and the possibility of changing the desired frequency during equipment operation.

Acknowledgment

This work was carried out with the support of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Financing Code 001.

References

1 INTERSIL. ICL8038 Precision Waveform Generator/Voltage Controlled Oscillator datasheet, 2001.
2 EXAR-CORPORATION. XR-2206 Monolithic Function Generator datasheet. [S.l.]:EXAR Corporation, 2008.
3 DEVICES, A. Ad9850 cmos 125mhz complete dds synthesizer. Analog Devices, One Technology Way, PO Box, v. 9106, 2004.

Collagen crosslinking with methylene blue: a photodynamic therapy approach

SOUZA P.S.[1*], MALMONGE, S.M. [1], SANTOS-JR, A. S. [1], DAGHASTANLI N. A.[1], ANA, P.A.[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

**patricia.souza@aluno.ufabc.edu.br*

Keywords: Hydrogel, Photosensitizer, Irradiation, Tissue Engineering, Biomaterials.

Introduction

Collagen is a structural protein formed by a triple helix, present in the extracellular matrix of animal cells. Known as a natural biopolymer, collagen has a low durability due to external factors and a poor mechanical strength [1]. To increase collagen strength, a reticulation process forming a three-dimensional polymeric network, known as crosslinking, is used. Reticulation allows the increasing cross-links between the collagen intermolecular covalent bonds structures and extracellular matrix proteoglycans, using photochemical reactions [2]. The induction of biomechanical rigidity of collagen is commonly explored in clinical practice in cases of progressive corneal ectasia as a therapeutic option, using ultraviolet radiation and photoinitiators [3], since they produce reactive oxygen species that increase the connection of one polymer chain to another. The reticulation changes the physical properties of collagen, such as the decrease in its flexibility and an increase in its rigidity and melting temperature.

Several reticulation methods are reported in the literature, such as the use of EDC (1-ethyl-3-(3-dimethyl aminopropyl) carbodiimide), glutaraldehyde, dehydrothermal reticulation (DHT) etc. However, it is still necessary to develop one that can be used during a clinical procedure. In this way, the purpose of this project is to induce a new method of collagen crosslinking through the use of a red light emitting diode (LED) and Methylene Blue as a photosensitizing molecule to increase the elastic modulus of collagen from the Photodynamic Therapy (PDT). Photodynamic Therapy is defined by the combination of the application of a photosensitizer (PS - Photosensitizer) and a light source in the presence of molecular oxygen. Specificity and selectivity, combined with minimal tissue toxicity and reduced systemic effects, make PDT an alternative of low-cost as therapeutic modality with high potential in multiple health areas [4]. As a photosensitizer, Methylene Blue is a non-toxic dye containing a phenothiazinium chromophore that allows the absorption of light and the origin a photochemical reaction that produces reactive oxygen species (ROS) or singlet oxygen that are highly cytotoxic in the PDT [5].

Materials and Methods

Samples of collagen hydrogels will be prepared using the technique of dissolving gelatin in the 2,2,2 trifluoroethanol 5% (w/v). After a dense polymeric membrane is formed, it will be submitted to an electrospinning process.

The following reticulation processes will be tested in this study: no reticulation (negative control); reticulation by EDC (positive control); reticulation using a combination of riboflavin 0,1% and UV-A light (370 nm), and reticulation using a combination by methylene blue + red light (660 nm). The most adequate parameters of photosensitizer concentration and light dosimetry will be soon determined.

The physio-chemical properties of the reticulated hydrogels will be addressed by SEM (scanning electron microscopy), swelling, density and porosity, Fourier-Transform Infrared Spectroscopy (ATR-FTIR) and TG-DSC (Thermogravimetry–Differential Scanning Calorimetry). The mechanical characterization of the scaffolds will be performed with a compression test to determine their modulus of elasticity. For this, the compression curves will be obtained from the Universal Testing Machine (MTS) and the Poisson Coefficient measured to verify the cell viability for the strength purpose.

The direct and indirect cytotoxicity and biocompatibility of the scaffold will be also evaluated using cell cultures of Vero cell line, proliferated using the following culture conditions: Eagle's Minimum Essential Medium (EMEM), Fetal Bovine Serum (FBS) and Dimethylsulfoxide (DMSO) maintained at 37°C.

Conclusions

The knowledge resulting from this project will contribute to the establishment of new perspectives on the use of collagen scaffolds for biomedical materials in tissue engineering and treatments in clinical practice.

Acknowledgment

The authors would like to thank to CAPES, National Institute of Photonics (CNPq/INCT 465763/2014-6), Multiuser Experimental Center of UFABC (CEM-UFABC) and UFPE.

References

1 Adamiak K, Sionkowska A. Current methods of collagen cross-linking: review. International Journal of Biological Macromolecules. https://doi.org/10.1016/j.ijbiomac.2020.06.075. 2020.
2 Lamy R, et al. Reticulação do colágeno corneano com radiação ultravioleta e riboflavina para tratamento do ceratocone: resultados preliminares de um estudo brasileiro. Rev.bras.oftalmol. https://doi.org/10.1590/S0034-72802008000500006. 2008.
3 Saad S, et al. Corneal crosslinking in keratoconus management. Journal Français d'Ophtalmologie, (1078- 1095). doi:10.1016/j.jfo.2020.07.002. 2020.
4 Kwiatkowskia S, et al. Photodynamic therapy - mechanisms, photosensitizers and combinations. Biomedicine & Pharmacotherapy, (1098–1107). doi: 10.1016/j.biopha.2018.07.049. 2018.
5 Lim DJ. Methylene blue-based nano and microparticles: fabrication and applications in photodynamic therapy. Polymers. https://doi.org/10.3390/polym13223955. 2021.

Development of a methylene blue-based hydrogel for treatment of oral contaminations

RODRIGUES FM[1*], MALMONGE SM[1], ANA PA[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*fabrizio.rodrigues@ufabc.edu.br

Keywords: Photodynamic Therapy, Antibiotic Resistance, Photosensitizer, Hydrogel.

Introduction

Infectious complications impair bone regeneration and, therefore, the success of bone grafts and transplants, which compromises the prognosis of dental implants. Depending on the bacterial species present, aspects of osteogenesis (differentiation, matrix production and mineralization) are significantly impaired [1].

Depending on the patient's oral and systemic health conditions, the use of antimicrobials may be contraindicated, mainly due to the risk of developing the phenomenon of resistance, associated with the different side effects that can be developed in immunosuppressed patients. In this way, the photodynamic therapy is a promissory alternative considering its antimicrobial effect.

The objective of this work is to develop a gelatin hydrogel doped with methylene blue (MB) for treatment of contaminated surgical areas using photodynamic therapy.

Materials and Methods

For the development of the dense hydrogel membrane, the gelatin was dissolved in 5% 2,2,2 trifluoroethanol. The solution was poured in Petri dishes for solvent evaporation. At the end, a dense polymeric membrane was formed. After, the membranes were immersed in an aqueous solution of N,N-(3-(dimethylamino)propyl)-N′-ethyl carbodiimide (EDC), using the molar proportion gelatin-COOH:EDC of 1:1 and kept in the solution for 24 hours. After the crosslinking process, the membranes undergo a washing process to remove the crosslinking agent excess [2]. The incorporation of MB occurred by dripping a 0.005% solution [3], following the values obtained in the swelling test for its percentage of absorption.

It was evaluated the swelling degree (SD) and water absorption capacity (WAC) of the gelatin hydrogel, as well as the chemical characterization by Fourier transformed infrared spectroscopy (FTIR). The swelling test was performed using dehydrated hydrogel samples that were submerged in distilled water and weighted along 2, 4, 6, 8, 10, 15, 20, 25 and 30 minutes. The SD calculation was performed according to the equation 1 and WAC was determined by equation 2:

$$SD\ (\%) = \frac{MS-M0}{M0} \times 100 \text{ - considering dry base} \quad (1)$$

$$WAC\ (\%) = \frac{MS-M0}{MS} \times 100 \text{ – considering wet base} \quad (2)$$

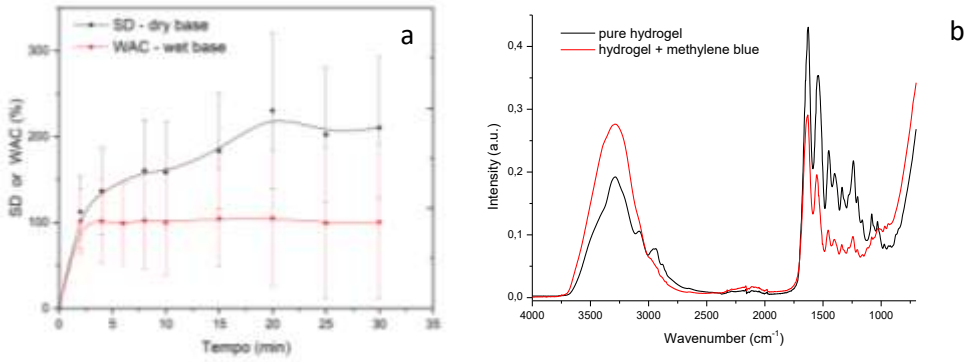
where MS is the mass of swelled sample and M0 is the mass of dried sample.

Results and Discussion

Figure 1a shows the SD and WAC of the gelatin membrane along the time. It was verified that the dense gelatin membrane undergoes WAC in a value superior to 90% and SD value near around 200. The result of WAC obtained was used to calculating the mass of photosensitizer solution to be incorporated in the membrane, and methylene blue dripping. The SD and WAC values obtained are similar to results showed in the literature. Parente & Malmonge performed a study with gelatin hydrogel that presented similar result of water WAC [4] and Kuijpers *et al.*[5] obtained gelatin membranes that presented SD values ranging from 200 to 300%.

Figure 1b shows the average infrared spectra of the gelatin membrane and the gelatin membrane with MB. It is noticed typical infrared bands of amides I, II and III, with similar characteristics of a collagen structure. It is not evidenced the formation of new peaks due to MB incorporation, but the decrease in the mean intensity of collagen peaks.

Figure 1. (a) Water SD and WAC of gelatin membranes (n=3); (b) FTIR spectra pure hydrogel and hydrogel with MB.



source: author

Conclusions

The development of a gelatin hydrogel, with the ability to be doped with methylene blue, shows promise as a treatment of surgical areas in the oral cavity.

Acknowledgment

The authors would like to thank to National Institute of Photonics (CNPq/INCT 465763/2014-6) and Multiuser Experimental Center of UFABC (CEM-UFABC)

References

1 Wainwright M, Maisch T, Nonell S, Plaetzer K, Almeida A, Tegos GP, Hamblin MR. Photoantimicrobials-are we afraid of the light? Lancet Infect Dis. 17:e49–e55. 2017

2 Barnes CP, Pemble CW, Brand DD, Simpson DG, Bowlin GL. Cross-linking electrospun type II collagen tissue engineering scaffolds with carbodiimide in ethanol. Tissue Eng. Jul;13(7):1593-605. 2007

3 Ambrósio JAR, Pinto BCS, Marmo VLM, Santos KWD, Junior MB, Pinto JG, Ferreira-Strixino J, Raniero LJ, Simioni AR. Synthesis and characterization of photosensitive gelatin-based hydrogels for photodynamic therapy in HeLa-CCL2 cell line. Photodiagnosis Photodyn Ther. 2022.

4 Parente C and Malmonge SM. Development of a gelatin based hydrogel to be used as a fibrous scaffold in myocardial tissue engeneering In: Congresso Brasileiro de Engenharia Biomédica, 2020, Vitoria, ES. Anais do CBEB 2020, 1:1878. 2020.

5 Kuijpes AJ, Engbersi GHM, Krijgsveld J, Zaat SAJ, Dankert J and Feijen J. Cross-linking and characterisation of gelatin matrices for biomedical applications. J. Biomater. Sci. Polymer Edn, 11(3):225–243. 2000.

Observational and cross-sectional study of conditions caused by the use of Covid-19 protective masks

LIMA GL[1*], LOMBELLO CB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

* gisely.lima@ufabc.edu.br

Keywords: Clinical research; COVID-19; Coronavirus; Dermatitis; Mask.

Introduction

COVID-19 represented the most significant global health crisis and is regarded as one of the greatest public health challenges of all time. The lack of scientific knowledge about the disease when the pandemic started, its rapid transmissibility and dissemination promoted difficulties in establishing contention strategies [1,2].

The use of Personal Protective Equipment (PPEs) and hand hygiene were adopted by the World Health Organization and ANVISA to prevent Covid-19 transmission, and protect health professionals since the beginning of the pandemic, even along with the social distancing recommendations [5,6]. ANVISA established that when caring for suspected or confirmed patients, the PPEs required by health professionals include: cap, goggles or face shield, mask (surgical or respiratory protection mask), gown and procedure gloves [2,5,6]. The type of mask indicated may vary, and the most common types recommended for health professionals are N95 masks, or the corresponding FFP2 (Filtering Face Parts 2) in Brazil. These masks show a with a minimum efficiency of 95% in filtering particles up to 0.3 μm [2]. Although the use of N95 masks cans prevent transmission and protect from contamination, the prolonged use and the masks reuse can led to adverse skin reactions. The increased prevalence of skin disorders due to mask use is evident in dermatological practice [7,8,9,10].

Although the Covid-19 transmission is under better control, the end of the pandemic is in sight, but not here yet, and other respiratory diseases may led to the same precautions, such as intense mask use. Considering these facts, this project has the general objective of collecting and analyzing data about the skin disorders conditions possibly related to the prolonged use of masks by health professionals, in addition to proposing measures to prevent the occurrence of such illnesses.

Materials and Methods

This project is based on a literature review and an observational study applied virtually. This consisted of a questionnaire with 18 questions through the Google Forms platform. The general objective of the questionnaire was to collect and analyze population data and the involvement of skin conditions due to the use of masks. All study

participants should have at least18 years old, be clearly informed about the study, and if they agree to participate, they must sign the Informed Consent Form. This study was approved by Research Ethics Committee (CAAE: 62401822.4.0000.5594).

Results and Discussion

The questionnaire was applied to the general public. Within 115 responses, 44 were obtained from health care professionals (38,26%), and 71 (61,74%) form general public, moreover 86,96% were women. We observed that from the health professionals response 14 (31,82%) generally uses N95 masks, and most of them (78,57%) related some skin alteration due to the use of masks. On the other hand the general public only 16 (22,53%) uses N95 masks, and among them only 25% related skin alterations. The use of surgical masks was mentioned by 52,27% of the health professionals, and 38,03% of general public. Skin affections were mentioned by 52,17% of the health professionals and 33,33% of general public using surgical masks. As for fabric masks, 15,91% of the health professionals used this type of masks, and 39,44% of the general public, affections were cited by 28,71% and 21,43%, respectively to health professionals and general public. This difference in skin affections related probably is resultant from the period and frequency of mask use, more intense for the heaths care professionals, mainly considering more protective masks, such as N95 and surgical.

Conclusions

The authors concludes that prolonged use of masks skin can lead to skin affections, and the health professionals are more suitable to these consequences.

Acknowledgment

The authors acknowledge UFABC for the financial support.

References

1 Werneck GL, Carvalho MS. A pandemia de COVID-19 no Brasil: Crônica de uma crise sanitária anunciada. Cadernos de Saude Publica, 36(5):e00068820, 2020.
2 World Health Organization. Mask use in the context of COVID-19. Interim guidance., 22p. 2020.
3 Buonanno G, Stabile L, Morawska L. Estimation of airborne viral emission: Quanta emission rate of SARS-CoV-2 for infection risk assessment. Environment international, 141:105794. 2020.
4 Duval D, Palmer J C, Tudge I et al. Long distance airborne transmission of SARS-CoV-2: rapid systematic review. BMJ, 377:e068743. 2022.
5 BRASIL. Ministério da Saúde. Recomendações de proteção aos trabalhadores dos serviços de saúde no atendimento de COVID-19 e outras síndromes gripais, 370. 2020.
6 ANVISA. Nota Técnica GVIMS/GGTES/ANVISA Nº 04/2020 - revisada em 25/02/2021. Medidas de prevenção e controle que devem ser adotadas durante a assistência aos casos suspeitos ou confirmados de infecção pelo novo coronavírus (SARS-CoV-2), 118p. 2020.
7 Cribier B, Taieb C, Saint Aroman M,et al. SARS-CoV-2: skin diseases, mask wearing and unpleasant sensations. J Eur Acad Dermatol Venereol, 35(9):e558-e560. 2021.
8 İnan Doğan E, Kaya F. Dermatological findings in patients admitting to dermatology clinic after using face masks during Covid-19 pandemia: A new health problem. Dermatol Ther, 34(3):e14934. 2020.
9 Techasatian L, Lebsing S, Uppala R, et al. The effects of the face mask on the skin underneath: a prospective survey during the COVID-19 Pandemic. J Prim Care Community Health. E:11:2150132720966167. 2020.
10 Liu N, Ye M, Zhu Q, Chen D, Xu M, He J, Li Q, Li J. Adverse reactions to facemasks in health-care workers: a cross-sectional survey. Clin Cosmet Investig Dermatol, 15:947-954. 2022.

Development of modular and gain-variable Electrical Impedance Tomography architecture

PINHEIRO G[1*], CAMARGO EDLB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil

*gustavo.pinheiro@ufabc.edu.br

Keywords: Electrical Impedance Tomography, Instruments, Variable Gain.

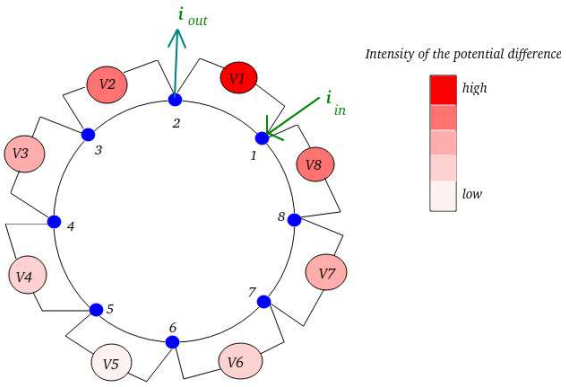
Introduction

It is characteristic of biological tissues to oppose electrical currents based on their passive electrical properties. The studies that explore this behavior and the resulting techniques make up the research field of Electrical Bioimpedance. The project presented here seeks to explore part of the instrumentation involving the electronic devices of Electrical Impedance Tomography (EIT), an image reconstruction technique based on the electrical properties of a conductive domain through current and potential measurement channels by means of electrodes fixed on a surface [1]. In this project, we are interested in the clinical applications of these devices, such as lung monitoring [2], and in the instrumental challenges inherent to this area of knowledge. Thus, the objective is to develop the architecture of a modular electrical impedance tomography, composed of excitation and acquisition systems for electrical biopotentials [3]. The specific objective is to contribute to improvements in the measurement channel, with electronic instrumentation that allows adjustable gains in signal processing to increase the spatial resolution of the acquired images. In the end a scalable tomograph with initially 8 channels with adjustable gains is expected.

Materials and Methods

Figure 1 shows a conductive domain model bounded by eight electrodes, with current injection in 1 and removal in 2. We seek a variable gain in the measurements of lower electrical potentials in order to recover the signal captured in these regions. To obtain the desired gain, Inverting amplifier and Non-inverting amplifier applications will be tested, using different commercial amplifiers.. The microcontroller employed will be the 32-bit Arm Cortex-based STM32F103C, which has two analog-to-digital converters and UART, SPI, and I²C communications.

Figure 1. Electrode distribution and electric potentials around a conductive domain, electrodes in blue.



Font: authors.

Results and Discussion

At the end of the project, it is expected that the control of the individual gain of each measurement channel will increase the resolution of the system, with an increase in its full scale and signal-to-noise ratio, compatible with what is observed in other existing systems [3]. We also seek to explore the number of channels the developed set can reach while maintaining its functionality, initially operating with 8 channels and reaching up to 32, evaluating the contribution of the adjustable gain circuit in relation to the existing conditioning circuits.

Conclusions

The EIT technique is being applied in different medical diagnostic specialties, so many biomedical engineering research groups are dedicated to develop different architectures to obtain more valid clinical instruments for clinical application. The development of a variable gain channel circuit can contribute to reducing one of the limitations of this technology, which is the low spatial resolution of the images obtained.

Acknowledgment

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

References

1 Heikkinen L, et al. Real time three-dimensional electrical impedance tomography applied in multiphase flow imaging. Measurement Science and Technology, v. 540, 08 2006.
2 Morais CCA, et al. Monitoring of pneumothorax appearance with electrical impedance tomography during recruitment maneuvers. Am. J. Respir. Crit. Care Med., American Thoracic Society, v. 195, n. 8, p.1070–1073, abr. 2017.
3 Santos AL. Arquitetura de Aquisição de Sinais para Tomografia por Impedância Elétrica – São Paulo, 2016. 72 p.

Chondrogenic differentiation of mesenchymal stem cells from primary tooth pulp

KATAYOSE JS[1,2]*, FERRARAZ DC[2], LOMBELLO CB[1].

[1]Center for Engineering, Modeling and Applied Social Sciences (CECS), Federal University of ABC (UFABC), São Bernardo do Campo/SP, Brazil
[2]Criogênesis, Brazil
*jackeline.s@ufabc.edu.br
Keywords: Biomedical Engineering, Mesenchymal Stem Cells, Tooth Pulp.

Introduction

The concept of tissue engineering, as proposed by Langer and Vacanti in 1993, is based on three factors, such as cell regeneration, the use of scaffolds and bioactive substances [1]. The advances in Regenerative Medicine have shown a promising perspective in the use of mesenchymal-plus cells in the treatment of various diseases and other conditions in orthopedics [2]. Mesenchymal stem cells are undifferentiated cells, with high proliferative capacity and differentiation in other cell lines, which, when manipulated *in vitro*, can undergo several passages without losing their characteristic. Among the various sources of obtaining this cell type, the tooth pulp has shown to be more promising, due to its easy obtainment and isolation, in addition to being less invasive than other sources. To be considered as such, the cells must present some characteristics, such as adhesion to the plastic, the possibility of multiplying and differentiation [3,4]. The aim of the present study is to differentiate the mesenchymal stem cells obtained from tooth pulp into chondrocytes, after thawing, according to the parameters described above. The results indicated the ability to adhere to the plastic, changing its conformation in terms of its shape and differentiation into chondrocytes after culture with differentiation medium.

Materials and Methods

A. Cell Culture. The Mesenchymal Stem Cells used in the experiments were isolated from tooth pulp (CAAE 80572417.0.0000.5594) digested with collagenase type IV and cultivated in culture medium containing DMEM low glucose, 10% fetal bovine serum (FBS) and 1% antibiotic/antimycotic, and kept in an incubator at 37 °C with 5% CO2. After 80% confluence, cells were frozen with 10% DMSO with controlled temperature drawdown, for the tests described later, the cells were thawed in a bain-marie at 37°C.

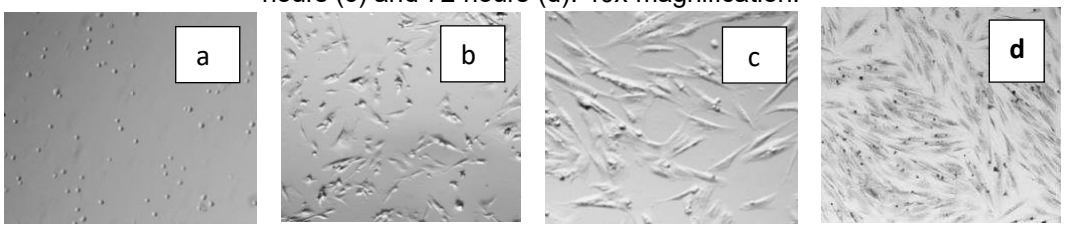
B. Cell Morphology. The morphological analysis of the cells was evaluated under an inverted microscope, without phase contrast, after 24 hours, 48 hours and 72 hours.

C. Chondrogenic Differentiation. After 3 days of cell growth, the culture medium was replaced by the cell differentiation medium, renewed every 3 days, for 20 days period.

Results and Discussion

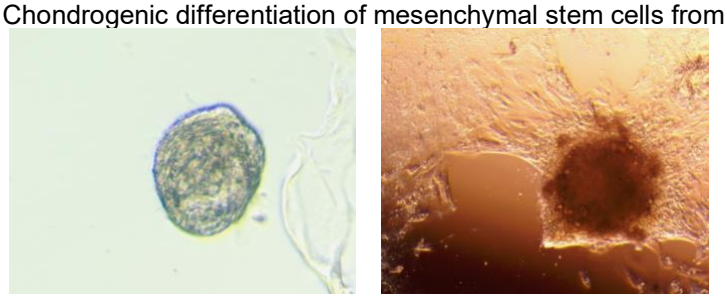
The cells saw a variation in their morphology, presenting a more rounded conformation in the plate and up to 24 hours and later assuming a more elongated format, fibroblast-like (figure 1). It was observed that after 20 days of culture with chondrogenic differentiation medium, there was cell growth in the scaffold (figure 2).

Figure 1. Proliferation of mesenchymal stem cells from dental pulp: 0 hour (a), 24 hours (b), 48 hours (c) and 72 hours (d). 40x magnification.



Font: From the author

Figure 2. Chondrogenic differentiation of mesenchymal stem cells from dental pulp.



Font: From the author.

Conclusions

One of the main applications of MSCs in regenerative medicine for damaged tissues is their use in cases of bone repair, epithelial healing process in cases of burns, for example, and in the degeneration of articular cartilage, a tissue that has a limited ability to intrinsic repair requiring cell-based strategies such as restoration of cartilaginous tissue with the application of autologous chondrocytes cultured in vitro.

Acknowledgment

We thank the Federal University of ABC (UFABC) and Criogênesis for all the support in its infrastructure, in carrying out this work under CAAE 80572417.0.0000.5594.

References

1 Langer R, Vacanti JP. Tissue Engineering: the union of biology and engineering. Tissue engineering. Science, 260(98):920-926. 1993.
2 Peng L, Ye L, Zhou X-D. Mesenchymal stem cells and tooth engineering. Int J Oral Sci, 1(1):6-12. 2009.
3 Caseiro, AR., et al. Mesenchymal Stem/ Stromal Cells metabolomic and bioactive factors profiles: A comparative analysis on the umbilical cord and dental pulp derived Stem/ Stromal Cells secretome. 2019.
4 Park JW, Fu S, Huang B, et al. Alternative splicing in mesenchymal stem cell differentiation. Stem Cells: 1-13. 2020.

Phytochemical profile and cell migration effect of extracts from leaves of *Lafoensia glyptocarpa* Koehne (Lythraceae)

FARIA JT[1]*, AMBROSIO FN[2], TOTINI CH[2], LAGO JHG[2], LOMBELLO RA[2], LOMBELLO CB[1]

[1] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil
[2] Federal University of ABC (UFABC), Center for Natural and Human Sciences (CCNH), São Bernardo do Campo/ SP, Brazil

*juliana.toledo@outlook.com.br

Keywords*: Lafoensia glyptocarpa*, Phytochemical Profile, *In Vitro*, Cell Migration.

Introduction

Specialized metabolites are organic compounds produced by plants that perform adaptive functions, such as responses to environmental stress and defense against pathogens and herbivory [1]. Phenolic, aliphatic and nitrogenous compounds, for example, are widely studied for their medicinal potential (antioxidant, antibiotic, antiviral effects) [2]. The plant of interest in this work, *Lafoensia glyptocarpa* Koehne (Lythraceae), popularly known as mirindiba-rosa, is a Brazilian native tree species from the Atlantic Forest [3]. There are still no studies related to its medicinal potential, only reports of the presence of flavonoids in the leaves [4], but there are scientific data that indicate this clinical potential for other species of the genus *Lafoensia* [5].

Bearing in mind the importance of studies aimed at expanding the scientific knowledge of brazilian native flora species and possible applications to improve human and animal health, this work determines the phytochemical profile and effect on animal cell migration of extracts from leaves of *Lafoensia glyptocarpa*.

Materials and Methods

Leaves of *Lafoensia glyptocarpa*, collected in Campinas - SP (RAL85, 22°52'32.8"S/47°03'36.4"W, SisGen A8A3C26) were used to prepare crude aqueous and ethanolic extracts [6,7].

The phytochemical profile of the *L. glyptocarpa* extracts were analyzed by 1H nuclear magnetic resonance (1H NMR) spectra, acquired by Varian INOVA 500 spectrometer operating at 500 MHz at the Multiuser Experimental Center of UFABC-Santo André. The solvents DMSO-d6 and methanol-d4, were used for aqueous and ethanolic extract, respectively.

For cell migration assays, Vero cells were inoculated in 96-well plates in the presence of extracts (filtered and then diluted in distilled water at concentrations of 25, 50, 100 and 250 µg/mL) and the centers of the wells were scraped, removing part of the cell monolayer. The observations were made at 0h and 24h to observe the migratory capacity of the cells using the ImageJ program to analyze the spaces re-occupied by the cells.

Results and Discussion

The 1H NMR spectrum of the extracts of *L. glyptocarpa* revealed signs indicative of the presence of aliphatic hydrogens (0.5 - 2.0 ppm) [8]. It was possible to observe characteristic signals of hydrogens in oxygenated carbons (3.0 - 4.5 ppm) and the presence of phenolic compounds evidenced by singals in 6,5 – 8,0 ppm [9]. The alcoholic extract was able to obtain greater extraction of compounds, mainly due to the polarity and viscosity of the solvents. These results are corroborated by studies with subfractions of ethanolic extract of *Lafoensia pacari* [10], which indicates an improvement in the quality of spectra by separating the compounds from the extracts into less complex fractions.

The results of cell migration assay obtained in 24h, despite the standard deviation of the data, were similar to those observed with extracts from stem bark of *L. pacari*, that were able to inhibit the proliferation of leukemic and tumor cell lines [11]. The extracts, at the different concentrations tested, do not stimulate the migratory potential of Vero cells and this result may be associated with the presence of phenolic compounds, such as some classes of flavonoids capable of inhibiting cell proliferation and migration [12].

Conclusions

Despite not inducing cell migration, the extracts of *Lafoensia glyptocarpa* leaves have potential for future investigations with tumor cells, aiming to verify their anticancer therapeutic effects. These results may be related to the presence of phenolic compounds, which were observed in accentuated signs in the phytochemical profile of the species.

This work reinforces the importance of research on the therapeutic application of medicinal plants, mainly from native flora, aiming to use them as medical devices.

Acknowledgment

We thank the Federal University of ABC and CAPES for the structure and funding; to the SA/SBC Multiuser Center and all the collaborators of this project.

References

1 Weng JK, Lynch JH *et al*. Adaptive mechanisms of plant specialized metabolism connecting chemistry to function. Nat Chem Biol 17, 1037–1045. 2021.
2 Builders P (Ed.). Herbal Medicine. BoD–Books on Demand. 2019.
3 Carvalho PER. Espécies Arbóreas Brasileiras: Merindiba-Rosa: *Lafoensia glyptocarpa*. Embrapa, 5. 2014.
4 Santos DYAC, Salatino LFM, Salatino A. Foliar flavonoids of *Lafoensia* (Lythraceae). Biochem Syst Ecol. 28(5):487–488. 2000.
5 Ávila RID, Ferreira CC, Alvarenga CBM *et al.* Toxicological evaluation of *Lafoensia pacari* A. St.-Hil. (Lythraceae) stem bark extract: Acute and subchronic studies in mice. Braz. J. Pharm. Sci. 55:e17289. 2019.
6 Fonsêca SGDaC. Farmacotécnica de Fitoterápicos access at: <https://farmacotecnica.ufc.br/wp-content/uploads/2019/11/farmacot-fitoterapicos.pdf>.
7 Milhem MM, Al-Hiyasat AS, Darmani H. Toxicity testing of restorative dental materials using brine shrimp larvae (*Artemia salina*). J Appl Oral Sci, 16(4):297–301. 2008.
8 Pavia DL *et al.* Introdução à Espectroscopia. 4ed. São Paulo: Cengage Learning. 2010.
9 Silverstein RM, Webster FX. Identificação Espectrométrica de Compostos Orgânicos, 6ª. ed. LTC Livros Técnicos e Científicos, Rio de Janeiro, 2000.
10 Fonseca AS, Cunha AL, Lima FCA *et al.* Molecular docking studies and evaluation of the antiretroviral activity and cytotoxicity of the species *Lafoensia pacari* Saint-Hilaire. Braz. J. Biol, 82:e256261. 2022.
11 Da Silva Marcondes DB, Reichert CL, De Andrade LF *et al.* Cytotoxicity and apoptogenic effects of *Lafoensia pacari*. J Ethnopharmacol, 157:243–250. 2014.
12 Raffa D, Maggio B, Raimondi MV *et al.* Recent discoveries of anticancer flavonoids. Eur. J. Med. Chem., 142:213–228. 2017.

Study of the influence of different divalent ions on the crosslinking of alginate as gel-matrix for bioprinting applications

FERREIRA NK[1], GIRON J[1], MENDES OM[2], ROMEU A[1], da SILVA JVL[1], SABINO GMA[1, 3], DAGUANO JKMB[1, 2*]

[1] Center for Information Technology Renato Archer, Campinas/SP, Brazil; [2] Federal University of ABC (UFABC), Center for Engineering, Modeling and Applied Social Sciences (CECS), São Bernardo do Campo/ SP, Brazil. [3] Simón Bolívar University, Caracas, Venezuela

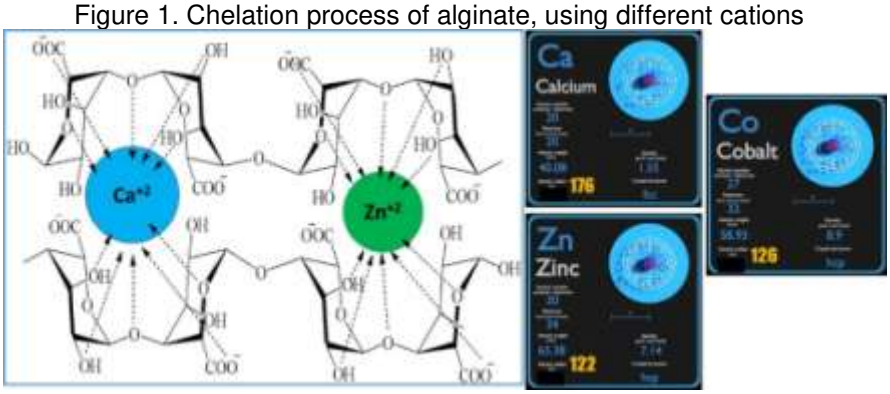
*e-mail: *juliana.daguano@ufabc.edu.br, [1] knferreira@cti.gov.br*

Keywords: Alginate, Divalent Cations, Chelation, Bioinks, Bioprinting.

Introduction

Hydrogels have been widely used in tissue engineering because biomimic the extracellular matrix. Lately, the focus has been on the development of so-called bioinks (hydrogels loaded with cells) [1]. However, the lack of mechanical resistance and angiogenesis, between others may limit its applications [2]. That is why the development of formulations for the generation of gels has become a challenge [3]. In this study, preliminary results are present in the development of an alginate-based formulation that will be later mix with smart polymers (thermosensitive). The first steps of this project is to see how the process of ionic crosslinking of alginate (which will be the matrix of these gels), occur using mixtures between various divalent cations (cobalt, zinc and calcium). These cross-linked gels will be well characterized and subjected to bioprinting processes. For now, the preliminary results present here are using the ions Ca^{+2} and Zn^{+2} (molar rate 1:1), as highlighted in Figure 1. There seems to be an ionic competition between them to chelate the polysaccharide, which ti is evidence in the rheological results performed and in the infrared study.

Figure 1. Chelation process of alginate, using different cations



Materials and Methods

Alginate, calcium chloride ($CaCl_2$) and zinc chloride ($ZnCl_2$) were obtain from Dinâmica (São Paulo, Brazil). The gels were prepared with the aid of a mechanical

stirrer Fisatom-711(São Paulo, Brazil) for 20 min at ~25ºC, in the proportions of 4% (w/v) of alginate and 4.5% (w/w) of cations. For FTIR analyses, samples were lyophilized.

Results and Discussion

Rheological behavior of the alginate matrix (Figure 2) and infrared spectroscopy date (Figure 3) can validate the chelation process. In the case of rheological behavior, it can be seen how the alginate behaves as a newtonian material, while being ionically crosslinked it adopts a shear-thinning characteristic. It can be seen that when Ca^{+2}/Zn^{+2} (1:1) are combined, there is an intermediate behavior between that of Ca^{+2} and Zn^{+2}, which can benefit the gel properties at the time of bioprinting. FTIR-ATR results show how the vibration of the carboxylate group -COO- changes depending on the presence of the cation and the combination of both, an increase in the intensity of the signal between 1600-1700 cm^{-1} is observed, which is attributed to the chelation between the group $-COO^{-}(^{+2}M)$.

Figure 2. Rheological behavior of alginate gels

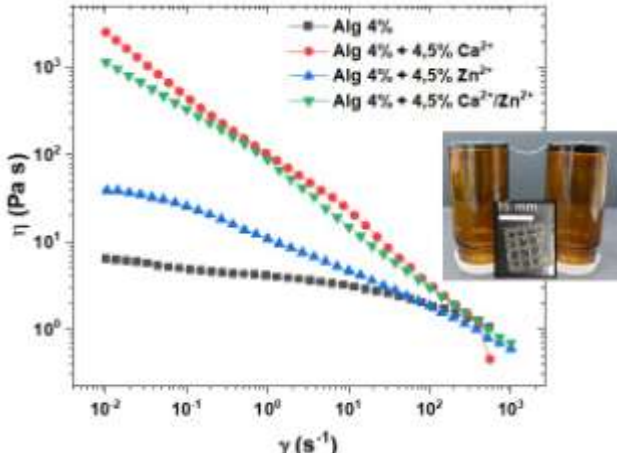
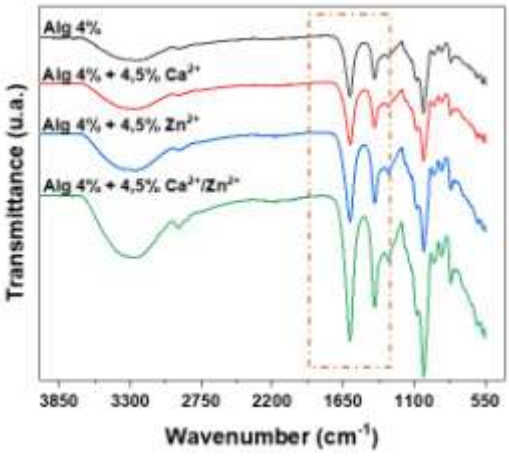


Figure 3. FTIR-ATR spectra of alginate gels



Conclusions

There is a good correlation between the affinity of alginate for Ca^{+2} and Zn^{+2} cations and its mixture Ca^{+2}/Zn^{+2} (1:1), given the evident change in rheological behavior, coupled with the evidence appreciated by FTIR spectroscopy. These results are promising in terms of the potential for use as gels (bioinks) and for bioprinting.

Acknowledgment

M.A.Sabino thanks FAPESP for the grant (2021/13949-5) as visitor research at CTI. K. Ferreira and J. Giron want to thanks for the grant PCI (CNPq 444303/2018-9) at CTI. A. Romeu thanks PIBIC (CNPq 164363/2021-1) at CTI.

References

1 Montero FE, Rezende RA, da Silva JVL and Sabino MA. Development of a Smart Bioink for Bioprinting Applications. Front. Mech. Eng. 5:56. doi: 10.3389/fmech.2019.00056. 2019.
2 Liu Y, Hu Q, Dong W, et al. Alginate/Gelatin-Based Hydrogel with Soy Protein/Peptide Powder for 3D Printing TSE Scaffolds to Promote Angiogenesis. *Macromolecular Bioscience*, *22*(4), 2100413. 2022.
3 Morgan FL, Moroni L, Baker MB. Dynamic bioinks to advance bioprinting. *Advanced healthcare materials*, *9*(15), 1901798. 2020.

I Workshop on

Biomedical Engineering

UFABC

2023