WALLACE H. COULTER Foundation

FIU Engineering & Computing

Department of Biomedical Engineering

BME Undergraduate Research Day

09.29.2017 | 9-10AM

EC 2300

Join us for a special talk on

'Swept Source OCT Angiography for Macular Diseases: The Prevalence, Incidence, and Natural History of Subclinical Neovascularization in Age-Related Macular Degeneration'

featuring guest speaker Philip Rosenfeld, Ph.D.

Swept source optical coherence tomography angiography (SS-OCTA) is the only imaging modality needed for the management of most macular diseases. SS-OCTA will replace fluorescein and indocyanine green angiography because it's faster, cheaper, safer, non-invasive, and provides all the advantages of traditional OCT imaging while offering superior images of the retinal and choroidal microvasculature.

Dr. Philip Rosenfeld is a professor of Ophthalmology at the Bascom Palmer Eye Institute at the University of Miami Miller School of Medicine. He is a vitreoretinal specialist with a primary clinical research interest in age-related macular degeneration (AMD). Dr. Rosenfeld has been the principal investigator and study chairman for numerous AMD clinical trials.

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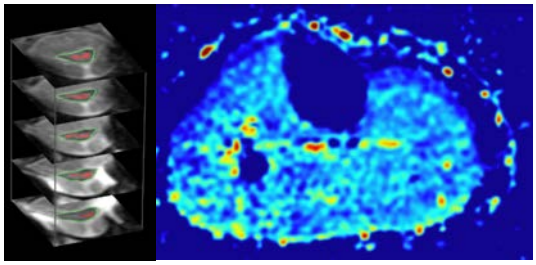
Correlation between magnetic resonance imaging-based markers of spinal cord integrity and muscle composition in individuals with chronic spinal cord injury

Authors

Kelly Nair Rojas, Dr. Jacob McPherson

Faculty Adviser Dr. Jacob McPherson



Abstract

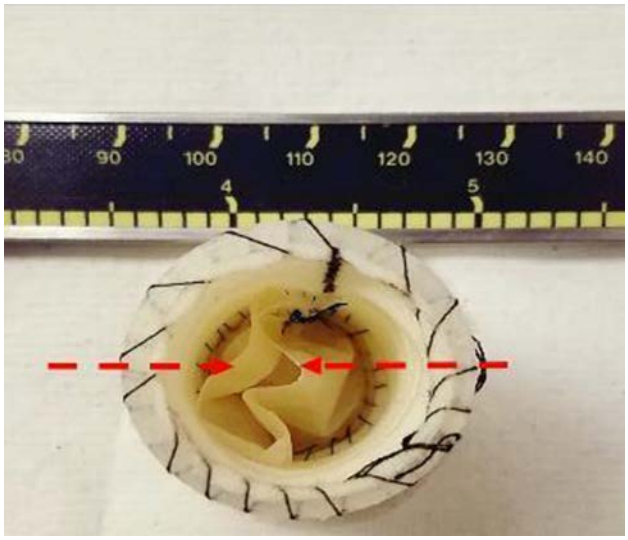
Correlation between magnetic resonance imaging-based markers of spinal cord integrity and muscle composition in individuals with chronic spinal cord injury. We investigated potential relationships between magnetic resonance imaging (MRI)-based measures of the spinal cord and MRI-based measures of muscle physiology in 14 individuals with spinal cord injury (SCI). Such relationships – or lack thereof – may hold prognostic value for determining recovery of motor function. We used simple linear regression as an initial tool to determine whether measures of damage to the spinal cord were associated with changes in muscle composition, including intramuscular fat and the diffusivity of fluid within the muscle. These metrics are potential markers of denervation, in which a muscle no longer receives neural input from the spinal cord. They may also relate to physical functions such as walking. We found a significant linear relationship between total spinal cord damage and muscle diffusion and ventral spinal cord damage and muscle diffusion. There was no relationship between dorsal spinal cord damage and muscle diffusion. We also found that individuals who retained some ability to walk after SCI exhibited higher muscle diffusion than individuals using wheelchairs for ambulation. Surprisingly, we found no correlation between muscle fat content and muscle diffusion. Future studies will extend these analyses to additional neurophysiological markers of motor impairment and performance.

Assessment of Porcine Small Intestine Mucosa Mitral Valve Replacement for the Pediatric Population

Authors

M. Hailey Hendon, Brittany Gonzalez, Dr. Sharan Ramaswamy, Omkar Mankame, Tony Cuellar, Nidhi Suthar, Dr. Krishna Rivas, Dr. Pablo Morales, Dr. Lazaro Hernandez, Dr. Steven Bibevski, Dr. Frank Scholl, Lilliam Valdes-Cruz, Sarah M. Bell, Ivan Baez

Faculty Adviser Dr. Sharan Ramaswamy



Abstract

Congenital heart defects affect 1 out of every 100 live births in the US each year (AHA, 2016). Current mechanical and bioprosthetic valves do not account for somatic growth. The purpose of this study is to assess the functionality of artificial heart valves made of porcine small intestine mucosa (PSIS) that permit valve development and somatic growth. PSIS has the advantages of being able to recruit cardiovascular cells of the proper phenotype as well as being able to degrade over time. The eventual degradation would result in a valve comprising of endogenous cells.

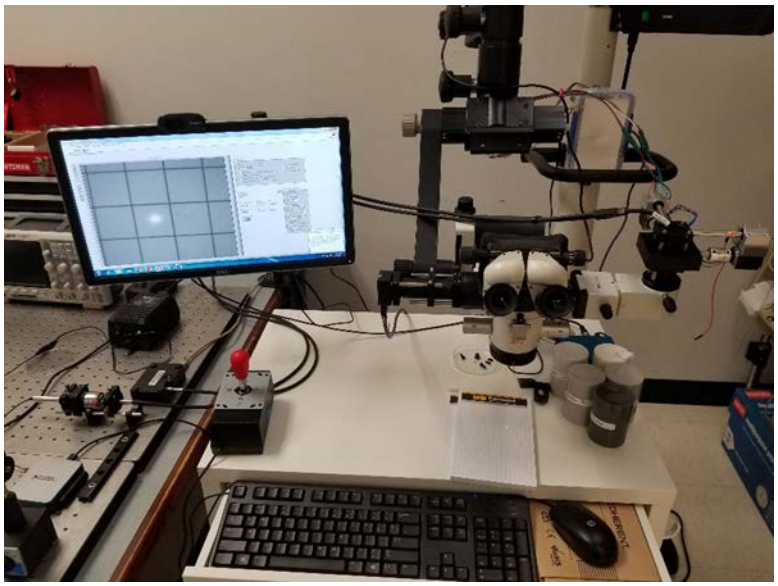
Custom made PSIS mitral valves were tested in-vitro and in-vivo. Two-ply and four-ply valves were compared in-vitro to determine their respective hemodynamic characteristics. A two-ply valve was surgically implanted in the mitral position of a baboon in order to assess function, somatic growth and immune response. In-vitro hemodynamic analysis demonstrated that the results of the two-ply valve most closely resembled that of the native valve. Preliminary in-vivo data show the valve functioning successfully with minor leakage. The animal is progressing well with no adverse effects. Further testing will continue to provide long term assessment of the PSIS valve.

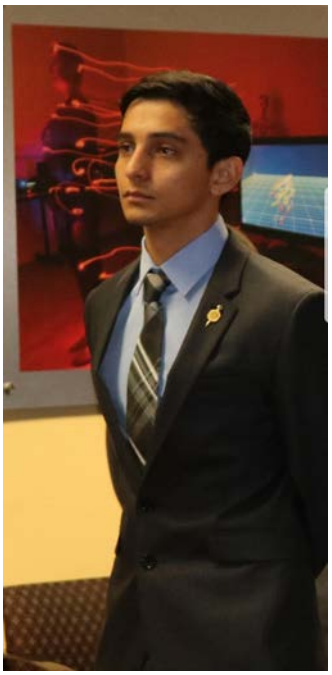
Hybrid Spectroscopy Imaging System for In Vivo Tissue Differentiation: System Development

Authors

Wei-Chiang Lin, PhD, Juan Camilo Giraldo

Faculty Adviser Wei-Chiang Lin, PhD





Abstract

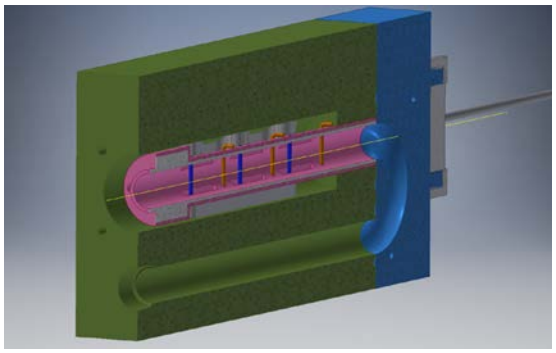
Optical properties have an intimate relationship with structure and composition of tissue, thus can provide clinical information such as functionality, injury, and pathology of tissue. Previous studies have shown that cancerous tissue possess different optical properties than healthy tissue and can be distinguished using total diffuse reflectance spectroscopy. A Hybrid Spectroscopic Imaging System capable of carrying out accurate and precise acquisition of total diffuse reflectance spectra was integrated with a Leica surgical microscope to allow for intraoperative cancer tissue identification and hence aid tumor resection. Several improvements were done to the system to improve its usability. These improvements include (1) the addition of a motorized X-Y translation stage to mobilize the site of investigation without moving the microscope, (2) a guide laser to identify the site of investigation, (3) a LabVIEW program to enable users to view and control the site of investigation remotely, and (4) a LabVIEW program to enable area investigation. In addition, the performance of the system was calibrated using tissue phantoms.

Bioreactor System Integration for Simulation of Cardiac Pulsatile Flow in Tissue Engineered Heart Valve Constructs

Authors

Andres Rodriguez, Manuel Perez-Nevarez, Omkar Mankame, Elnaz Pour Issa, Alex Williams, Alejandro Piñero and Sharan Ramaswamy

Faculty Adviser Dr. Sharan Ramaswamy



Abstract

Approximately 5 million Americans who suffer from heart valve disease are at risk of progressive deterioration in heart function, which can result in heart failure and premature death (Heart Valve Society of America, 2017). Current treatments involve repairing or replacing the valves with mechanical ones, yet these do not guarantee a permanent solution.

As a result, researchers have focused in studying the mechanical properties of tissue engineered heart valves (TEHV) as a solution to this problem. In the development of these TEHV constructs, it is generally accepted by the scientific community that mechanical forces innate to the cardiovascular system, namely flow, stretch and flex can optimize in vitro de novo tissue growth. To study the effects of these fluid dynamic forces on TEHV constructs, researchers have implemented a bioreactor system that attempts to mimic the effects of flow, flex and stretch forces on valvular tissue. Nevertheless, these conditions do not fully represent the flow and pressure profiles produced by cardiac pulses.
This study attempts to validate a bioreactor system that recreates physiologically-relevant pulsatile flow patterns that mimic the native human circulation. The overall objective of this research is to integrate a pulsed flow duplicator pump with a TEHV bioreactor system and to validate that the system in effect recreates the desired pulsatile flow waveforms found in native cardiac cycle.
We verified the flow velocity waveform within the bioreactor chamber was similar to the flow pattern produced by the pulsatile pump. However, we observed marked differences in the latter segment of the cardiac cycle. Future development work remains to improve the accuracy of the system and will be focused on determining the sources of these discrepancies.

The Role of Glucose Metabolism in Cardiovascular Calcification and Fibrosis

Authors

Daniela Medina, Jessica Molina, Joshua D. Hutcheson

Faculty Adviser Joshua D. Hutcheson

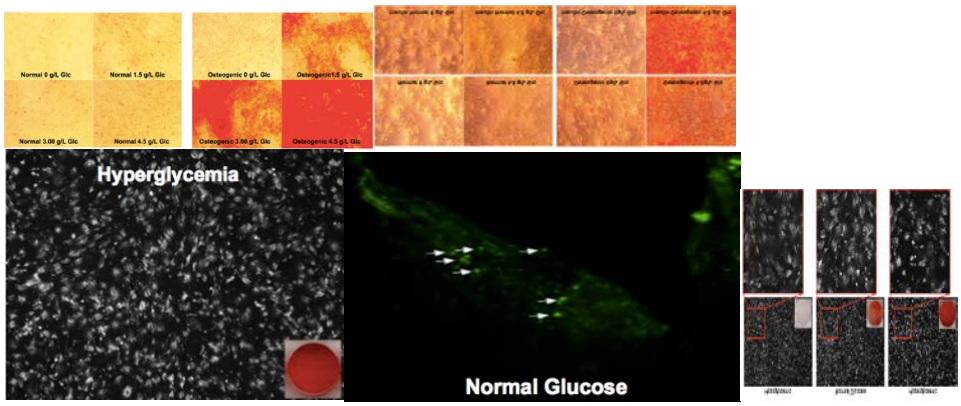


Figure 1. Alizarin Red S staining after 21 days in normal or pro-calcifying culture media representing extracellular calcifications (red).

Figure 2. Alizarin Red S staining after 16 days of treatment in normal or pro-calcifying culture media representing extracellular calcifications (red).

Figure 3. Assessment of actin cytoskeleton rearrangement in vessel wall remodeling under different glucose concentrations.

Figure 4. Assessment of actin cytoskeleton rearrangement in vessel wall remodeling under different glucose concentrations.

Figure 5. Smooth muscle cell immunofluorescence stain for caveloin-1 expression.

Daniela Medina

Jessica Molina

Abstract

The growing burden of diabetes mellitus in the population has led to higher incidence of cardiovascular diseases. The hyperglycemia associated with this disease accelerates the formation of atherosclerotic lesions, characterized by the accumulation of fibrotic collagen and deposition of calcium mineral. Fibrocalcific phenotypic changes in cardiovascular cells require actin stress fiber-induced cellular contraction. In addition, the deposition of extracellular mineral begins with caveolae domains in the cellular membrane. Caveolae are rich in caveolin-1, a scaffold structural protein required for the development of atherosclerosis. We hypothesized that hyperglycemia leads to increased expression of caveolin-1 and stabilizes the actin cytoskeleton of vascular smooth muscle cells (VSMC), leading to increased extracellular calcification. To test this, VSMCs were cultured in normal or pro-calcifying media of different glucose concentrations and changes in cell morphology were assessed. The results demonstrated that high glucose concentrations increased extracellular calcifications. We further observed that insulin in the presence of elevated glucose accelerated extracellular calcific mineral deposition. We also show that hyperglycemia-induced calcification requires actin cytoskeleton contraction. Moreover, hyperglycemia increased caveolin-1 expression. This study offers insight into cardiovascular complications associated with diabetes. Future studies may further elucidate the importance of glucose control in prevention of pathological remodeling within cardiovascular tissues.

Preliminary and Acute Histological Assessment of Elastin in a Porcine Small-Intestinal Submucosa Replacement Mitral Valve

Authors

Antonio Cuellar, Brittany Gonzalez, Omkar V. Mankame, Lazaro Hernandez, Lilliam Valdes-Cruz, Steven Bibevski, Frank Scholl, Sarah M Bell, Ivan Baez, Vincent Brehier, Michael Casares, Sharan Ramaswamy, Krishna Rivas, Pablo Morales, Jesus Lopez

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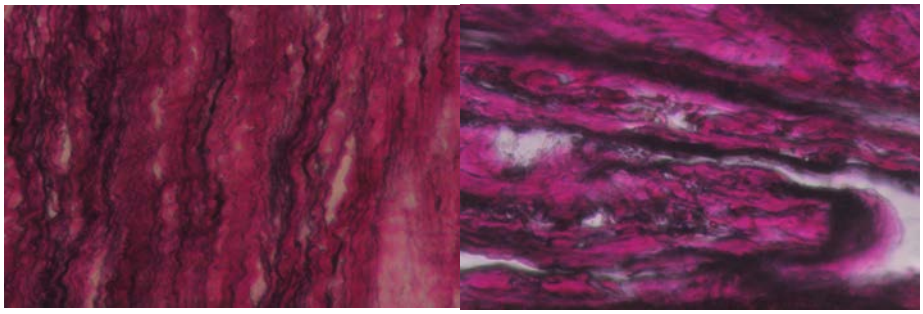


(a) *(b)*

Figure 1: **(a)** Native baboon valve with ECM components. **(b)** PSIS valves with formation of ECM components. Sections were taken from baboon mitral valve (Mannheimer Foundation). Elastin fibers are shown in black with arrows pointing to specific elastin fibers. Circumferential (1) and radial (2) of direction.

Abstract

Congenital heart valve defects are the most common birth defect affecting nearly 40,000 newborns each year in the United States (CDC, 2016). While valve replacement with a prosthetic valve is a mature technology for treatment of adult valve diseases, it is inapplicable for pediatric patients due to the continuous growth of their hearts. Tissue engineered heart valve (TEHV) approaches are ideal for valve replacement of pediatrics since it has the potential to grow with the child reducing the need for re-operations.

In the current study, a porcine small intestinal submucosa (PSIS) valve was implanted in the mitral position of a non-human primate model to assess acute tissue response and remodeling characteristics of elastin, a primary extracellular matrix (ECM) component of heart valves.

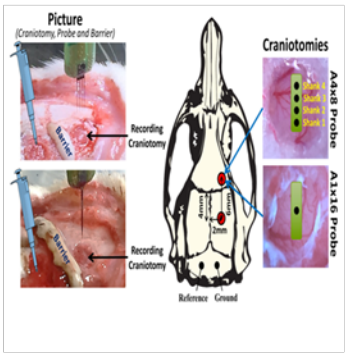
Normal valves have elastin fibers oriented radially, which is apparent in the native baboon valve (**Figure 1a**). Preliminary results of *de novo* elastin formation show that elastin fibers are present on the PSIS valve surface only 3 days after implantation; this early formation provides confidence that other key ECM components will also deposit (**Figure 1b**). However, the elastin fibers appeared less defined and oriented in the PSIS valve. Therefore, further longitudinal assessment is necessary to provide conclusive results.

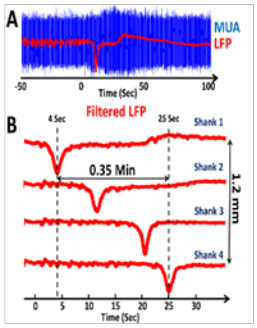
Revisiting CSD propagation characteristics with microelectrode arrays: from field potentials to spiking

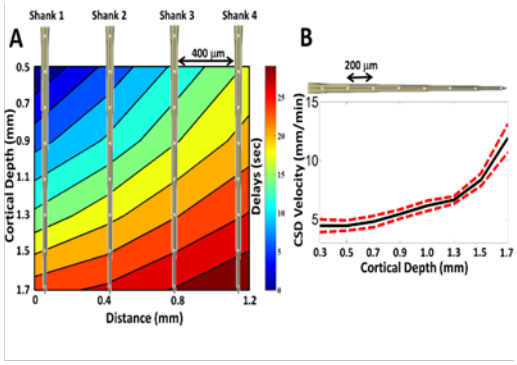
Authors

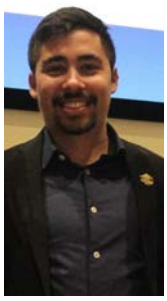
Daniel E. Rivera, Arash Moshkforoush, Darlene Ramos, Yoichiro Mori, Jorge Riera

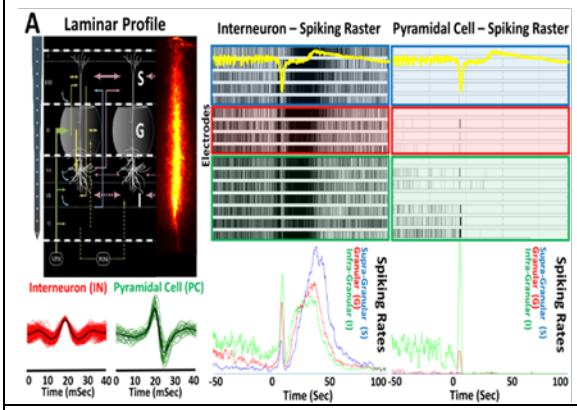
Faculty Adviser Dr. Jorge Riera Diaz

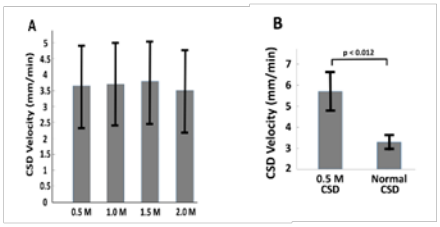


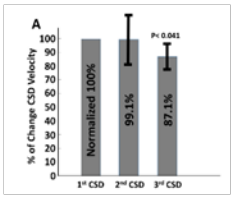












Abstract

Cortical spreading depression (CSD) is a wave of neuronal depolarization that leads to a silencing of spontaneous neuronal activity. The underlying mechanisms behind CSD genesis/propagation, yet to be fully understood, have been investigated using two electrophysiological recording techniques: I) intracranial potentials with single/multiple electrodes, and II) membrane potentials with whole-cell/patch approaches. Technological advances in intracranial recording with microelectrode arrays (MEA), however, have still not been used for the analysis of CSD events propagating along the neocortex in vivo. In this study, we obtained CSD-related intracranial potentials from the neocortex of rats using high-resolution MEAs. Firstly, we confirmed the existence of facilitation/adaptation mechanisms in the CSD propagation, potentially related to cell swelling and dendritic beading. Secondly, we found an intriguing cortical-depth dependency in the propagation velocity of the CSD. Lastly, laminar spiking in different neuronal populations suggests a short-term sequencing profile in the neuronal silencing. These spiking patterns might result from local exhibitory/inhibitory interactions ruled by the cortical microcircuit architecture, as well as from electro-diffusive phenomena during CSD events. We conclude that MEAs offer a unique framework for characterization of spatiotemporal profiles of neuronal depolarization, relevant network connections, and associated differences in putative neuronal firing rates during CSD events.

Oscillating flow conditions in marrow stem cell-derived engineered heart valve tissues

Authors

Maria Montesinos, Alex Pinero

Faculty Adviser Dr. Sharan Ramaswamy

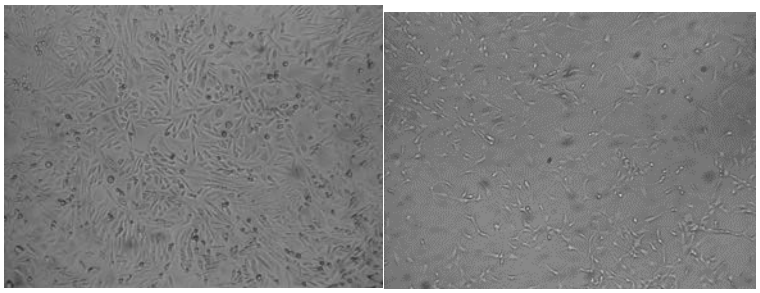


Figure 1: *In vitro* Rat Valvular Endothelial Cells
Figure 2: *In vitro* Rat Bone Marrow Stem Cells

Abstract

Congenital heart defects (CHDs) are the most common types of birth defects according to CDC. About 40,000 births per year in U.S. are associated to critical congenital heart defects. These infants generally need surgery or other procedures in their first year of life. Treatment is critical for a better quality of the patient's life. However, in pediatric patients, somatic growth is not feasible with currently available heart valve prosthetic implants. In best case scenario, replacement of valves would need to be performed several times, but in most cases, treatment is not even feasible. Tissue engineered heart valves (TEHV) offer a tremendous opportunity to promote direct integration with the native tissue accommodating somatic growth. In addition, TEHV has the ability to adapt and continuously grow with the potential host. This opens an alternative solution for heart valve replacement. However, controlled growth of heart valve tissue requires better understanding of bone marrow stem cells (BMSCs). This study demonstrates in vitro that BMSCs are able to grow and differentiate into robust engineered heart valve tissue cells, with the formation of both endothelial surface cells and activated interstitial cells under cyclic flexure and steady flow conditions. Under these mechanical conditions BMSCs displayed evidence of collagen and glycosaminoglycans (GAGs) formation, which may indicate a sign of integration between native and BMSCs derived engineered heart valve tissues.

Chemotherapy Cytotoxicity on Cancer Cells determined via SRB assay

Authors

Zoë Bernard

Faculty Adviser Dr. Anthony McGoron

Abstract

The objective of my project is the development of a protocol using the Sulforhodamine B (SRB) colorimetric assay for cytotoxicity screening of conjugated nanoparticles that target folate receptors. The effects of numerous chemotherapy drugs at different concentrations on SKOV-3 ovarian carcinoma cells was obtained. This was achieved by the growth of the adherent SKOV-3 cell line, and cytotoxicity screening. When the cells are confluent, they are seeded in a 96-well plate and exposed to media with or without the drug. Media was treated with Cisplatin or Doxorubicin. A linear trend is expected when comparing the death rate of cells for the Cisplatin or Doxorubicin.
Different concentrations of Cisplatin or Doxorubicin (10μM, 5μM, 2.5μM, 1μM, and a control) were added to the SKOV-3 seeded well plates. In the future folic acid conjugated nanoparticles produced in our Theranostics laboratory will be tested using the optimized SRB assay protocol.

Estimating Post-Void Residiual Volume in Long-Term Urodynamic Studies

Authors

Chazman Childers

Faculty Adviser Dr. Zachary Danziger

Abstract

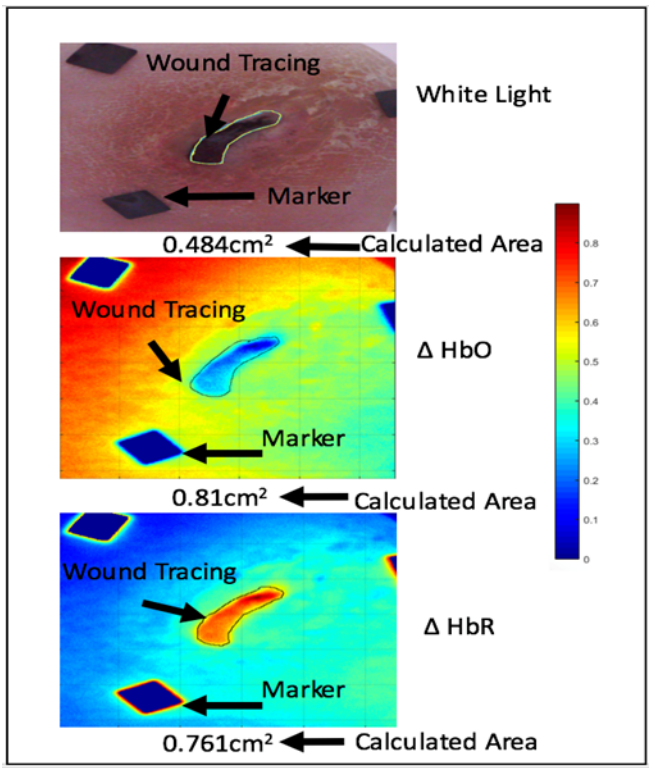
Within the arena of bladder research, animals are used in many experiments to model various pathologies. Diseases, such as urinary retention and urinary tract infections, can be modeled utilizing animals and the urodynamics can be observed to formulate better medical solutions for these diseases. In urodynamic studies, the volume retained after voiding, or post-void residual, is a strong indicator of various pathologies. Unfortunately, there are no methods for long-term urodynamic studies in which the post-void residual can be measured, despite there being a clinical need. The goal of our research is to develop a computational model which can accurately estimate post-void residual volume in the bladder over the course of long-term urodynamic studies. Currently, there is a computational model developed by Danziger and Grill to estimate post-void residual volume in animal models, under laboratory specific conditions. Building on this work, we are improving this model to allow for the inclusion of multiple ureter flow rates – a normal physiological phenomenon. With this improved model, our aim is to develop better solutions for common urinary system diseases.

Comparison of Hemodynamic Changes and Wound Area in Diabetic Foot Ulcers

Authors

Cristianne Fernandez, Rebecca Kwasinski, Kevin Leiva, Richard Schutzman, Edwin Robledo, Penelope Kallis, Francisco Perez-Clavijo, Robert Kirsner, E.A. Pretto, Anuradha Godavarty

Faculty Adviser Dr. Anuradha Godavarty



Sample data plots showing white light image, ΔHbO and ΔHbR plots with the wound area traces and calculated area.

Abstract

Diabetic foot ulcers (DFUs) affect approximately 25% of the estimated 29.1 million people diagnosed with diabetes. For clinicians treating patients with these ulcers, it is important to evaluate the area of the wound as well as the blood oxygenation in the wound and peri-wound regions, as oxygen is vital for wound healing. DFUs were imaged using a Near InfraRed Optical Scanner (NIROS) that utilizes near infrared light at different wavelengths to obtain 2-D maps of the changes in oxy- (ΔHbO) and deoxy- hemoglobin (ΔHbR) concentrations. The changes in ΔHbO and ΔHbR were observed over weeks and the area of the visible wound site was calculated. Regions of changed oxygenation were estimated and correlated with the visible wound size across weeks of healing. Long term weekly data analysis and visible wound size measurement can be used to determine if a wound is healing outside in or inside out.

Measuring retinal temperature changes noninvasively using a laser speckle imaging system

Authors

Nicole Sevilla, Ilyas Saytashev, Pedro Lopez, Herbert Wertheim, Jessica C. Ramella-Roman

Faculty Adviser Dr. Jessica Ramella-Roman

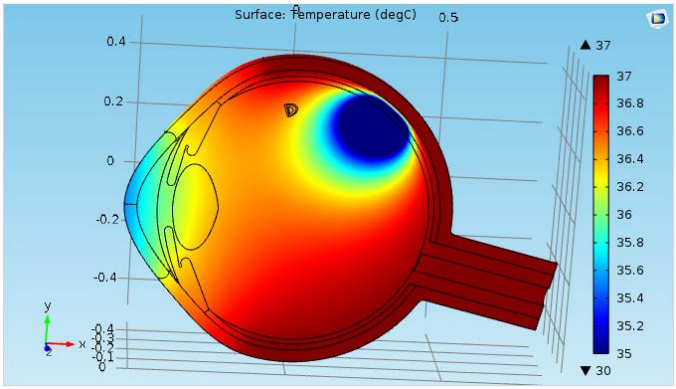


Fig. 1. Change in temperature at the cornea is related to local change in temperature at the retina

Abstract

The human retina can suffer irreversible damages if exposed to sources of heat out of physiological range. Some familiar sources include the sun or lasers utilized in routine eye surgery procedures. To avoid and monitor possible detrimental effects in the eye due to heat, retinal temperature measurements are necessary. However, the eye's anatomy makes the retina inaccessible for contact temperature measurement techniques. Inverse thermal models, depicting the thermal distribution of the eye, suggest that local retinal temperature cannot be extrapolated using standard corneal surface temperature measurements. Furthermore, non-contact thermal imaging technologies such as FLIR are restricted to cumulative heat emission measurements from a single surface and have low-resolution. Therefore, a novel approach is necessary to measure temperature at the retina. Here we propose the use of a laser speckle imaging system (LSI) to measure the micro changes in index of refraction resulting from an increase of local temperature. Speckle cross-correlation models are used to highlight changes in speckle patterns as the temperature changes. Here we will describe a newly developed a LSI system consisting of a 12-bit monochrome camera, a 50mm focal length F# 1.3 lens, a diode laser centered at 640 nm, and a polarized single mode fiber and preliminary studies relating temperature to speckle cross-correlation.

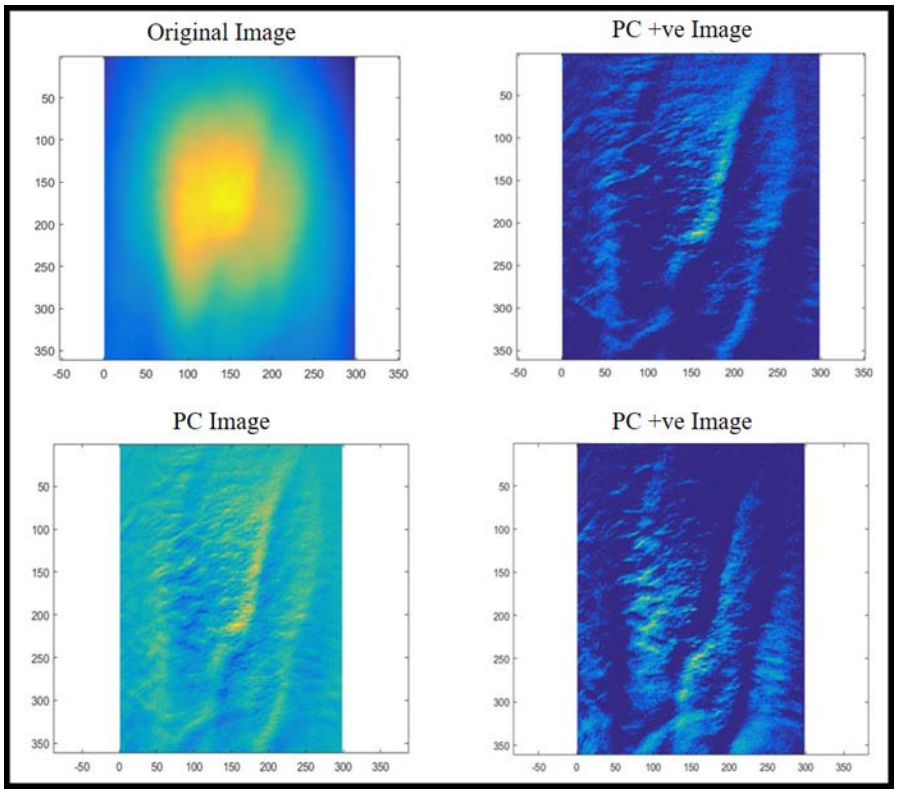
Further investigation and improvements to this system could yield a non-contact imaging system for clinical use and retinal disease prevention.

Spatial Information of Blood Vessels from NIR Imaging of Venous Occlusion

Authors

Edwin A. Robledo, Yoany Rodriguez, Anuradha Godavarty

Faculty Adviser Anuradha Godavarty



Abstract

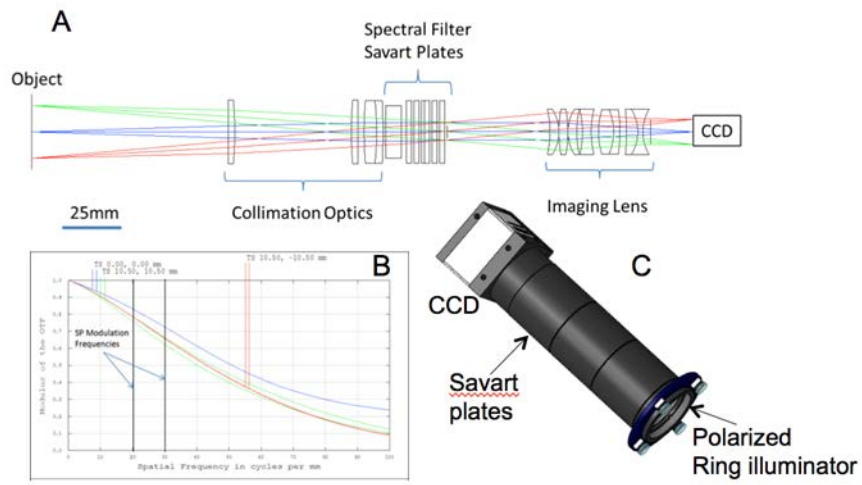
Noncontact-based near-infrared (NIR) optical imaging have been developed in the Optical Imaging Laboratory (OIL) for the use of wound imaging. At OIL, we use a Near Infrared Optical Scanner (NIROS) to capture a diffuse reflectance signal that changes with physiological changes in the blood flow. In the current work, we are implementing a noise-reduction technique, principle component analysis (PCA), such that you can extract the spatial information of the blood vessels, apart from the physiological changes in the blood flow from NIR images. Venous occlusion based experimental studies were performed on the dorsum of the hand and around the median nerve below the wrist of 2 subjects. It was observed that the vessel within the area of interest could be demarcated by applying PCA to the diffuse reflected signals from NIROS. Future work involves coregistration of hemodynamic changes in blood flow to the spatial-temporal maps of the respective blood vessels.

A low cost, portable Mueller Matrix polarimeter for low resource settings

Authors

Jessica C. Ramella-Roman, Karla Montejo, Karl Krup, Vijaya Srinivas, Edward DeHoog, Joseph Chue-Sang, Nicole Sevilla, Purnima Madhivanan

Faculty Adviser Dr. Jessica Ramella-Roman



Abstract

Cervical cancer is the fourth most common cancer in women worldwide, with developing countries suffering about 80% of mortalities due to lack of effective screening programs. It has been shown that the collagenous cervical ultrastructure becomes disrupted during onset of precancerous lesions. Mobile colposcopes on the market for examining the cervix are limited in that they capture images of surface color and texture which require expert review. With the incorporation of Mueller Matrix Imaging, a modality capable of characterizing collagen, subtle changes in tissue alteration can be detected using visible light, with accuracy comparable to tomographic techniques. Here we present a cost-effective, hand-held portable Mueller Matrix polarimeter based on the single snapshot Savart plate approach. We show that our system is capable of nominal Mueller Matrix imagery in under a second with errors below 5%. Feasibility of this novel system was tested in a rural Indian health camp.

Neurovalvular Physiology

Authors

Aaron Armbrister

Faculty Adviser Dr. Joshua Hutcheson

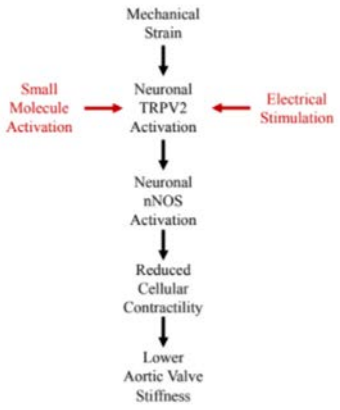


Figure 1: Projected Pathway

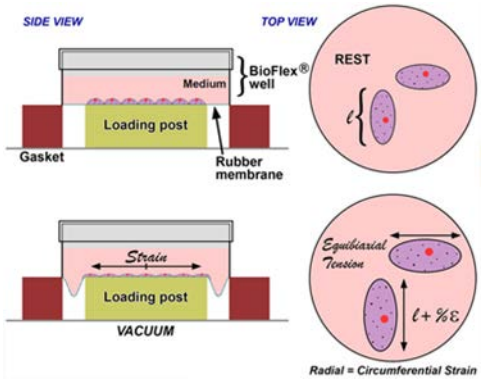
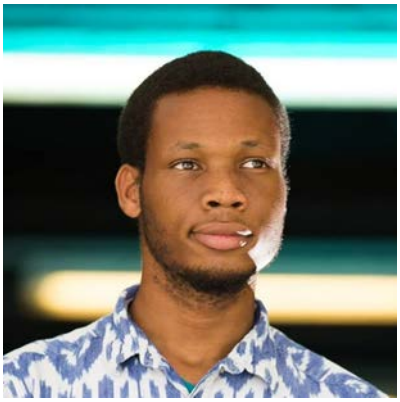


Figure 2: In Vivo apparatus for applying strain with the Flexcell5000



Abstract

Aortic valve stenosis has a prognosis worse than most metastatic cancers with a mortality rate of over 50% in under 2 years for inoperable patients. The only treatment currently available is a complete valve replacement. The lack of treatment options is due to the lack of understanding the physiological pathways that leads to the calcification of this tissue. Increased mechanical strain contributes to calcification of the aortic valve; however, the underlying mechanisms remain unknown. We recently identified a mechanically activated calcium channel, TRPV2, in aortic valve interstitial cells. This channel is also found in the gastrointestinal tract, in which it is known to activate neuronal nitric oxide synthase and cause the muscles to relax. We hypothesize that TRPV2 plays a similar role in aortic valve tissues, and can modulate valve biomechanical properties. We will begin by placing valve cells in a mechanical strain regimen in vitro under different pathological conditions and measuring TRPV2-mediated calcium influx. TRPV2 agonists and antagonists will be added to assess changes in aortic valve cell contraction and the resultant effects on aortic valve biomechanics. The outcomes of this study may lead to new insight into aortic valve physiology and therapeutic targets for aortic valve disease.

Manipulating Nanoparticles for Bio-distribution Analysis and Blood-Brain Barrier Perforation

Authors

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Abstract

Nanoparticles (NP) and their cell uptake have become a significant area of study for possible treatment of cancer. The success of NPs for drug delivery is based on their effective size and interaction with live cells. Silver is important because it can be used for both chemotherapy delivery, production of free radicals for photodynamic therapy and imaging using Surface Enhanced Raman Spectroscopy. Silica NPs are desirable for being porous that enable them to carry a greater payload of chemotherapy drug, and carry multiple drugs (i.e. chemotherapy, fluorescent imaging, and photothermal therapy). They tend to be inherently less toxic than silver Nps. This project will explore the ability of silver and silica NPs as drug delivery platforms like therapeutic agents through biodistribution analysis carried out using TOF-SIMS.

On the other hand, a study on the blood-brain barrier (BBB) is nominated. BBB is a barrier formed by the brain endothelial cells lining the cerebral microvasculature that protects the brain from fluctuations in plasma composition, neurotransmitters and xenobiotics. Treatment of brain tumor is a concern since therapeutics get obstructed by the BBB. Strategies that are employed to cross the barrier need to make sure the barrier is not damaged. Among the various approaches available, nanobiotechnology based delivery methods tend to bring out more success. NPs open the tight junctions between endothelial cells. They may be transcytosed or endocytosed through the endothelial cell layer, and coated to ease transaction. Thus, a thesis is proposed that will synthesize silica NPs and/or PGXD and investigate the size, coating agents, and surface charge optimal for crossing the BBB without damaging it. The synthesized NP will be injected in healthy mice to check the BBB permeability via receptor-mediated transcytosis, passive diffusion or active transport through the endothelial cells. Surface modification of the NPs with surfactants and polymers will be investigated to check efficiency of the strategy. It is hypothesized that if the NPs are able to cross the BBB in a healthy mice, then they will be able to cross the BBB of a brain with tumor as pathogenesis tends to increase permeability of BBB.

A Study on Somatosenation: the Effect of Proprioception on Touch Perception

Authors

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Abstract

Somatosensation is a multifaceted property that confers the senses of touch, temperature, pain, and bodily position to a person. The combination of the component senses allow for interaction with the world. This is exemplified in object identification tasks, like reaching in a bag to grab a pen, which frequent everyday life—especially when referring to sensations that originate in the hands.

This study aims to obtain a quantifiable relationship between touch and proprioception in the perception of object compliance; that is, to examine the effect of proprioceptive changes on touch perception.

In order to conclude this relationship, an experiment was developed that allows for the calculation of the point of subjective equality (PSE) and the just-noticeable difference (JND) for object compliance at various hand-opening positions. The process by which the experiment was designed is detailed in this poster.

The results of this study will bestow a more comprehensive understanding of somatosensation that has a myriad of applications. Whilst neural prostheses have been significantly improved with regard to motor control technology that utilizes afferent neural pathways, which transport somatosensory information, is comparatively underdeveloped. Improving our understanding of these properties in the body is integral to their development.

Hemodynamic Imaging of Venous Leg Ulcers using a Near Infrared Optical Scanner (NIROS)

Authors

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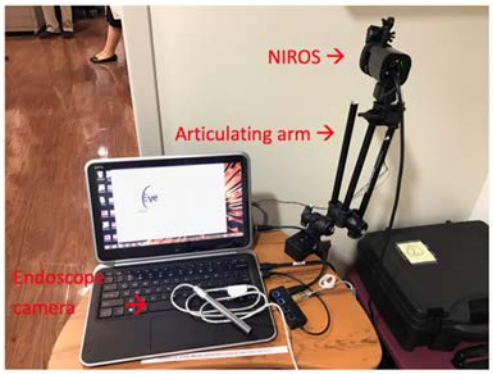
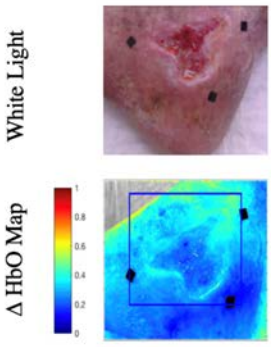


NIROS and endoscope camera set up in clinic on an articulation arm



White light image and oxygenated hemoglobin map of wound and surrounding tissue

Abstract

Venous leg ulcers (VLUs) are the most common type of leg ulcer, accounting for over 90% of all ulcer cases. Clinicians currently employ visual inspection of the wound: observing the surface granulation and wound size. There is a need to develop a physiological approach that differentiates tissue oxygenation in and around the wound site. Herein, the Optical Imaging Laboratory (OIL) developed a portable, non-contact near-infrared optical scanner (NIROS) for sub surface imaging of wounds. The near infrared images were used to evaluate the oxygenated and deoxygenated hemoglobin maps of the wound and the surrounding tissue. The oxygenated hemoglobin maps of healing wounds indicated an insignificant oxygenation contrast between wound and surrounding tissue across weeks of treatment. On the contrary, the maps of non-healing wounds indicated low oxygenation levels compared to the surroundings across weeks of treatment.

The Synthesis of Gold Nanoparticles

Authors

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Abstract

Nanoparticles are particles that are less than about 100 nanometers in size. These particles have recently become the focus of scientific research as they have many potential applications in medicine. For one, they can improve the accuracy of the medicine administered by targeting only the virus/tumor and leaving healthy tissue untouched. Gold nanoparticles also help in the diagnosis of certain diseases such as cancer as they attach to the antibodies of these cells and heat up when exposed to infrared light. Other nanoparticles require a chemical to be added so that they can heat up when exposed to near-infrared light. The objective of this study was to create nanoparticles that were both stable and small enough to use in the areas of cancer therapy. In the lab, trisodium citrate dihydrate (Na3C6H5O7 2H2O) was added to a heated gold chloride trihydrate solution (HAuCl4 3H2O) in an attempt to create these nanoparticles. To create the optimal particle, the amount of time and temperature at which the solution was kept, as well as the concentration of the trisodium citrate were manipulated. The time ranged from 5 minutes to 60 minutes, the temperature from 50 to 100 degrees Celsius, and the concentration from 1% to 10%. To find the absorbance spectra and monitor the stability of the solution we used a UV-Visible Spectrophotometer. The absorbance spectra is used to determine how many nanoparticles are produced. Additionally, to measure particle size we used Dynamic Light Scattering (DLS). It was found that higher temperatures led to larger particles, longer periods of time led to larger particles, and higher concentrations of the trisodium citrate led to small particles. However, throughout the trials, it was observed that there is a peak in which these factors provide the best yield of nanoparticles. The data has presented us with a parabolic trend in terms of yield depending on the convictions of the ranging times, temperatures, and trisodium citrate concentrations. With these findings, the ideal conditions for synthesizing nanoparticles can be reached.

Histological Assessment of Elastin Fiber Orientation in Non-Human Primate Aortic Valves After Flex-Flow Treatment

Authors

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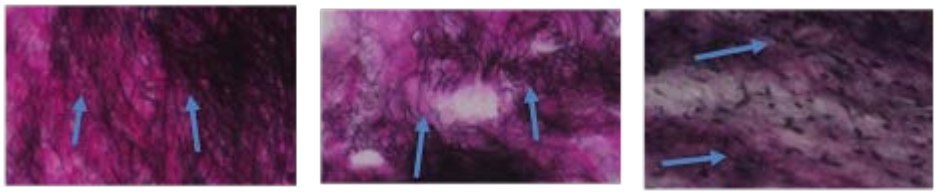

Figure 1: Orientation of elastin fibers in a Baboonheart. Elastin on the ventricularis side of the leaflets at **(a)** static group day 0 **(b)** bioreactor group day 7 **(c)** static group day 7. After 7 days, the bioreactor group was able to better maintain the radial orientation of fibers of elastin. Circumferential (1) and radial (2) of direction.

Abstract

Heart valves have the ability to open and close continuously while maintaining the phenotypes of valvular cells due to the composition and orientation of the extracellular matrix (ECM) (Wiltz, 2013). The aortic valve has three layers: ventricularis, spongiosa and fibrosa that contain elastin, glycosaminoglycans (GAGs) and collagen, respectively. A major component of heart valves is elastin, which provides extensibility of the heart valve leaflets and helps the valve to return to its position while maintaining the collagen network. The ECM and its components are critical in the biomechanical and mechanobiological role of the valve, but the mechanical role, particularly that of the elastin fibers is poorly understood.

In the current study, explanted nonhuman primate (Hamadryas Baboons) aortic valve leaflets were longitudinally assessed for their elastin fiber network histologically for their elastin fiber network. Histological differences of elastin from static and bioreactor culture (Flex-Flow) conditions were compared.

Our preliminary results provide insight that Flex-Flow conditions yield an altered elastin network compared to static controls. This finding suggests that a combination of Flex-Flow transfers mechanical stresses onto the leaflet that lead to elastin adaptation which in turn maintains valve homeostasis.

Theranostics: The Development of Novel Polymers for Tumor Targeted Nanomedicine

Authors

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Abstract

The goal is to develop a tumor-targeted drug delivery system utilizing biocompatible nanoparticles that will enable personalized treatment for cancer patients. The first step in synthesizing this system is the development of biocompatible, tumor-targeting polymers based on tumor receptors found in popular cancer cell lines, such as SKOV-3 in ovarian cancer. These novel polymers were synthesized utilizing a “one-pot” method, combining the biocompatible agents: glycerol, dodecanoic acid, and a variable acid. The variable acids were selected specifically to act as a ligand on the tumors of interest; these include malic acid, maleic acid, succinic acid, and fumaric acid. Characterization of the polymers was accomplished through FTIR analysis, Differential Scanning Calorimetry (DSC), solubility testing, High-Pressure Liquid Chromatography (HPLC), pH testing, and Zeta potential. This study into the polymer assembly and characteristics will provide the basis for a nanoparticle based drug delivery system that will incorporate both adjuvant hyperthermia and chemotherapy treatments advancing the field of theranostics.

Computational Fluid Dynamic Analysis of Neonatal Aortic Valve Post Balloon Valvuloplasty

Authors

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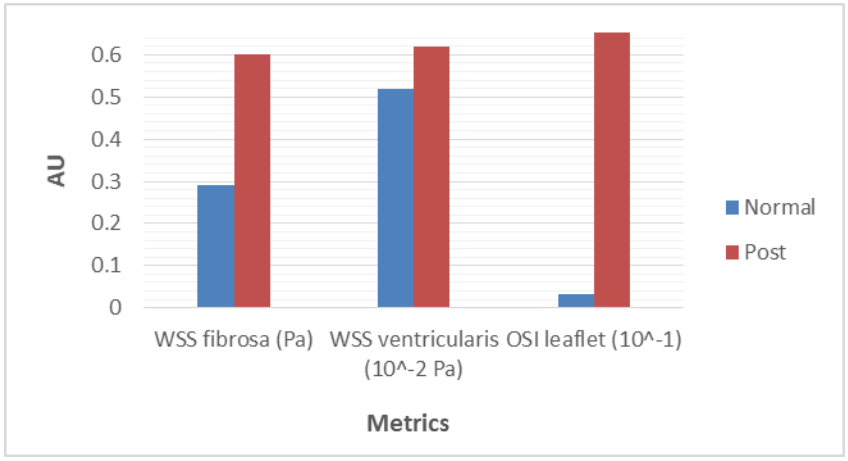

Figure 1: Comparison of TAWSS and OSI for Normal and Post Balloon Valvuloplasty, in the fibrosa and ventricularis sides of the valve leaflet.

Abstract

Congenital pathophysiological alterations in heart valves can lead to stress-induced changes in cellular function and tissue adaption. In this study, the flow patterns of aortic valves were studied, comparing normal flow of an aortic valve with a stenotic valve, after it underwent balloon valvuloplasty. Different parameters of flow were compared, including wall shear stress (WSS), oscillatory shear index (OSI) and time average wall shear stress (TAWSS). To extract the shear stress waveforms, a Computational Fluid Dynamics simulation was conducted. There was a distinct difference in the TAWSS (axial) between the two patients on the fibrosa side of the valve leaflets. Peak shear stresses of 2.9 dynes/cm2 on the normal patient were observed. However, the value of peak wall shear stress was more than twice this value (6 dynes/cm2) for the congenital valve. Furthermore, a clear difference in the velocity profiles upstream of the aortic valve was observed. Shear stress profiles were substantially different between the ventricularis and the fibrosa supporting that there is side-specific responses to fluid-induced shear stress environments. Moreover, post-balloon flow is sensed differently by VECs given their differences from normal flow patterns. Although the anomaly of stenosis is temporarily resolved; this flow difference can trigger subsequent restenosis.

Mathematical Model of Plasma Membrane Electrophysiology in a Single Pericyte Cell

Authors

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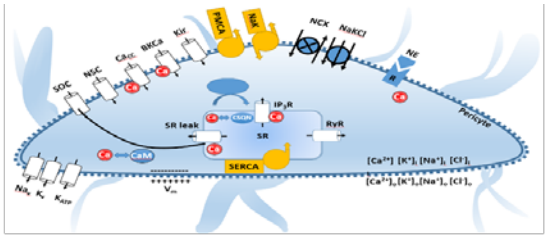

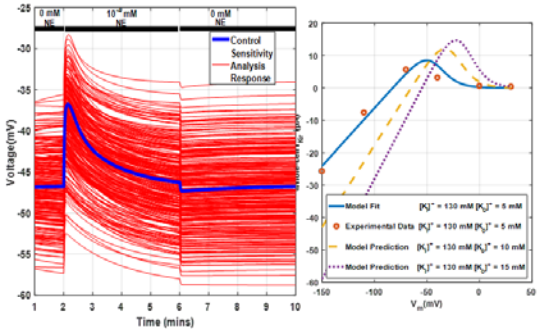

Abstract

A mathematical model of a single pericyte cell was developed based on data available in literature. The model incorporates the dynamic behavior of 1) plasma membrane currents; 2) release and uptake of Ca2+ by the sarcoplasmic reticulum; 3) tracking of cytosolic Ca2+, K+, Na+, and Cl-; and 4) electrophysiological response due to norepinephrine (NE) stimulus. Current and voltage data attained from literature review was fitted to known equations for these channels. Coupled differential equations were then used along with these parameters to show the dynamic change of ion concentrations, membrane voltage, and gating variables. Validation was done using available literature data on NE and K+ stimulation. The proposed model predicted the depolarization and repolarization effects of NE and the increasing depolarization effects of increasing external K+ levels as reported in the literature. Further research for this model will aid in elucidating the underlying role of pericytes on arterial constriction/dilation, vasomotion, and in understanding their roles in disease states.

3-D Bioprinting and Tissue Engineering of Heart Valves Using Alginate/Gelatin Hydrogels

Authors

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Fig.1 BioBot, Polar coordinate-based benchtop bioprinter. 3-axis automated system that can incorporate up to 5 materials per experiment.

Abstract

Heart valve diseases lead to substantial mortality and morbidity globally. The prevalence of these diseases is projected to increase globally from almost 300,000 cases in 2003 to roughly over 850,000 by 2050. Currently, surgical replacement of diseased heart valves is the most common treatment for end-stage valve disease (Yaqoub et al, 2005).

Developing heart valve tissue engineered (HVTE) constructs using 3-D bioprinting techniques has become a focus of new research studies as it may offer solutions for the current limitations of today's surgical methods. A number of different materials are currently used as scaffolds in HVTE constructs, such as decellularized valvular matrices as well as synthetic and natural polymers. Of these, biocompatible natural hydrogels show favorable bioactivity characteristics of high absorbance of water, transport of fluids and homeostatic characteristics like temperature and Ph. (Hikmet et al, 2010).

This study will evaluate recent 3-D bioprinting techniques for HVTE constructs with a focus on the applications of alginate/gelatin natural hydrogel. The in-vitro performance of hydrogel will be assessed to examine the compatibility of valvular interstitial cells to native heart valve culture. The overarching goal is to inform on the ideal hydrogel composition that best replicates native mechanical and biological functions of natural heart valves.

Fragile Object Simulator Design and Development

Authors

Daniella Rojas

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Abstract

Currently, upper limb prostheses lack the ability to provide sensory feedback about the objects handled by the user. An amputee can control the movement of the prosthetic hand but the hand provides no sensation over the aperture or forces applied to the object. Regaining the ability to coordinate hand aperture with the force applied would help an upper-limb amputee to manipulate fragile objects. In order to conduct studies towards sensory feedback systems it is important to design an instrument that can simulate a fragile object. There are different objects found in daily life that could serve as fragile objects for these studies, such as an egg. However, using fragile daily life objects would be wasteful, messy, expensive, and nonreplicable. The Fragile Object Simulator is a device that can be broken during the experiment, reassembled, reused providing replicable results, and without being damaged or producing waste. As we continue to develop the Fragile Object Simulator, tasks such as project planning, CAD design, and manufacturing have been fundamental for the project and my trainee experience. Further work on the project includes validation and testing. Finalizing the Fragile Object Simulator will allow us to record data from experimental research on sensory feedback systems developed by the Adaptive Neural Systems Laboratory.

Executive functioning in bilinguals, monolinguals and heritage language speakers with limited proficiency: An fNIRS study

Authors

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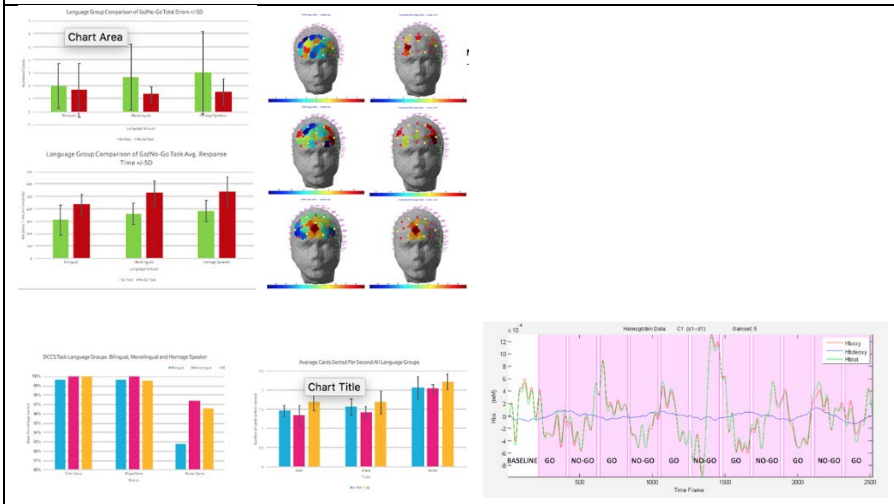

Abstract

The bilingual advantage in executive functioning has been studied extensively. However, to date, no research has focused on heritage speakers, who may have limited proficiency in their second language but understand it. The present study aims to contribute to this need by comparing the executive functioning of monolingual, fully bilingual, and heritage speakers. The study did so with two validated behavioral measures (Dimensional Card Change Sort Task (DCCS) and Go/No-Go task) and with brain imagining (Functional Near-Infrared Spectroscopy, fNIRS). 45 undergraduate students from FIU participated in the study and performed the two tasks while simultaneously undergoing fNIRS. Results indicated that for the DCCS tasks, heritage speakers took the longest time to sort cards in all the different dimensions and had the slowest reaction times for the Go/No-Go task. Preliminary fNIRS data revealed that monolinguals and bilinguals shared some areas of neural recruitment while performing the tasks, whereas heritage speakers did not. While not significant now, the data reveal that the benefits in executive functioning from bilingualism comes from being able to be fully productive at both languages. This means that bilingualism can lead to enhanced executive function, but that daily oral use is required to reap the benefits of bilingualism.

Brain Computer Interfaces

Authors

Morits Luik, Dr. Zachary Danziger

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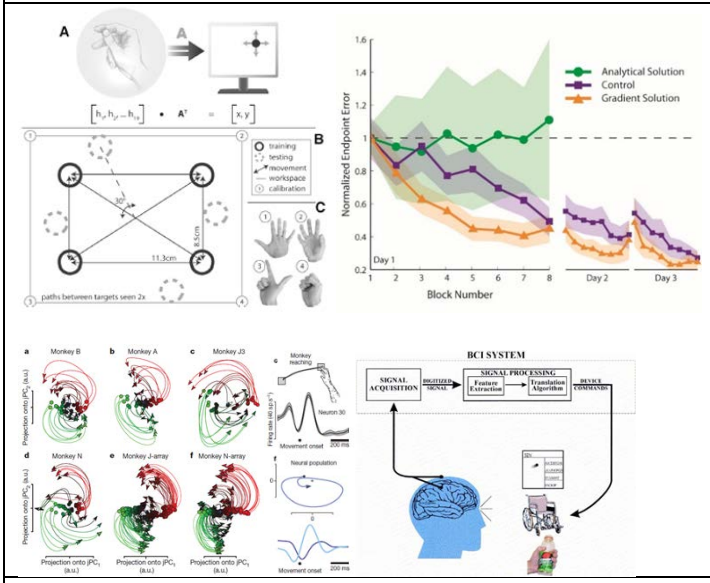

Abstract

A Brain-Computer Interface (BCI) allows for communication between the brain and an external device without the use of the body's nerves or muscles. This system records signals from the brain, interprets them, and uses them to control an external device, such as a wheelchair or a cursor on a screen. While a BCI does propose a solution for communication between the brain and the outside world, the procedure and setup is often invasive and bulky. For this reason, experimental setups are limited by the invasive procedures and the availability of volunteers for this procedure. However, by using a model system of the human hand to mimic signals recorded from the brain, the procedure can be tested using non-invasive methods that do not require volunteers with disabilities. The human hand can provide 19 degrees of freedom to use as experimental data points. By using instrumented data gloves to record the motion of the hand and fingers, the data can be interpreted as if the recordings were taken from the brain. Using this data, this study examines the intent of the user and how this correlates to moving a 2D cursor to a set point on a computer screen. The focus of this study is to generate an algorithm that is able to decipher each user's intent, and adapt to the user learning to use the BCI. By creating an adaptable algorithm that is able to decipher the users intent, the functionality of the BCI as well as the speed at which the user develops the skills to use it will increase.

WALLACE H. COULTER Foundation

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Department of Biomedical Engineering

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Join us for a special talk on 'Engineering's Commitment to Humanity: What is Your Role' featuring guest speaker Herbert F. Voigt, Ph.D.

The role of engineers in increasing life's quality and duration is undeniable. This talk will take stock of the human condition and focus on issues that are not particularly concerning to those living in western civilization. These issues are huge in scale and mighty daunting, and yet humans muddle on. In the end, you need to consider what role you might play in the future to ameliorate the current situation.

What capacity do you have now? What is your role?

Herbert Frederick Voigt, a Fulbright Scholar, is a Professor of Biomedical Engineering and an Associate Research Professor of Otolaryngology at Boston University. He was past-president of of the Biomedical Engineering Society (BMES, 1999). Dr. Voigt's research interests include the auditory neurophysiology and is also deeply involved in biomedical engineering issues and education throughout the world