College of Engineering Biomedical Research Day

ORAL PRESENTATION

Abstract Title:	**Noncontact 3-dimensional Speckle Contrast Diffuse Correlation Tomography of Tissue Blood Flow Distribution**
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Abstract: Recent advancements in optical diffuse correlation techniques and instrumentation have opened the path for versatile deep tissue microvasculature blood flow imaging systems. Despite this progress there remains a need for a completely noncontact, noninvasive device with high translatability from small/testing (animal) to large/target (human) subjects with trivial application on both. Accordingly, we discuss our newly developed setup which meets this demand, termed noncontact speckle contrast diffuse correlation tomography (nc_scDCT). The nc_scDCT provides fast, continuous, portable, noninvasive, and inexpensive acquisition of three dimensional tomographic deep tissue (up to 1 cm) blood flow distributions with straightforward design and customization. The features presented include a finite element method implementation for incorporating complex tissue boundaries, rapid data collection with a diffuse speckle contrast method, reflectance-based design promoting experimental translation, robust adjustable source and detector pattern and density for high resolution measurement of unique application-specific regions of interest, extensibility to related techniques, and fully noncontact hardware for avoiding tissue compression and interactions. Validation was shown in the detection and characterization of both high and low contrasts in flow relative to the background using tissue phantoms with a pump-connected tube (high) and phantom spheres (low). Furthermore, in vivo validation of extracting spatiotemporal three dimensional blood flow distributions and hyperemic response during forearm cuff occlusion was demonstrated. Finally, the success of instrument feasibility in clinical use was examined through intraoperative imaging of mastectomy skin flap.

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College of Engineering Biomedical Research Day

ORAL PRESENTATION

Abstract Title: **Biomechanics of Surgical Breast Reconstruction**

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Abstract: Controversy exists regarding the relationship between breast size and upper back pain. This controversy highlights the lack of objective standards for determining the effects of breast shape and size, which patients are candidates for therapeutic surgical breast reduction, and the criterion for discriminating therapeutically necessity vs. cosmetic. Economics also plays a role because only the former is covered by healthcare insurance. Few publications address the biomechanics of breast reconstruction and only one known work attempts to quantify the relationship between breast shape/size and back pain. The purpose of the present work is to develop a model of the upper back that incorporates the biomechanical contribution of the breasts and thus enables objective quantification of the effects of pre and post- surgical reconstruction breast size and shape on the biomechanics of the upper back. Various models for the upper thorax of the adult human female were created to quantify the biomechanical effect of breast shape, size, and position on the forces generated in the thoracic spinal column. Models used were those adapted from classical teaching models of the human spine, which were modified by inclusion of pertinent pre and postoperative breast biomechanical contributions. The following variables were considered: body weight, height, breast and nipple-areola complex size/shape/angle pre and post-surgery. Differences in thoracic vertebral forces were calculated based on both continuous breast shape and sizes, and categorical, i.e., cup size, variables. Assumptions made include erect posture, normal vertebral structure and composition, and head/neck/arm/chest shape and size conforming to the 50th percentile adult human female. Using the models developed, the magnitude of compressive forces on the various levels of the thoracic vertebrae will be shown as functions of breast weight, cup size, and breast shape. These results will be compared with clinical findings pertaining to shoulder deformation and other symptoms associated with various pre-surgical breast sizes as well as patient reported levels of post-surgical pain relief. The results will also be compared with existing healthcare insurance industry standards defining “medically necessary” surgical breast reconstruction to determine if revision of these standards is warranted.

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12th Annual CCTS Spring Conference
Thursday, March 30, 2017 Lexington Convention Center

College of Engineering Biomedical Research Day

ORAL PRESENTATION

Abstract Title:	**Mechanical Demands Imposed on the Lower Back by Manual Material Handling Tasks in Patients with Acute Low Back Pain**
Author(s):	I. Shojaei, Department of Biomedical Engineering, U of Kentucky Q. Hooker, Department of Kinesiology and Health Promotion, U of Kentucky E.G. Salt, College of Nursing, U of Kentucky B. Bazrgari, Department of Biomedical Engineering, U of Kentucky

Abstract: Understanding changes in the lower back biomechanics with progression from an acute episode to chronic and/or recurrent low back pain (LBP) can inform early management before transition to a disabling disorder. The objective of this study was set to investigate differences in mechanical demand of lowering and lifting a load in the sagittal plane on the lower back between individuals with and without acute LBP. Participants included a group of 19 females with health-care provider diagnosed acute LBP and a group of 19 asymptomatic female controls. Kinematics and kinetics data were respectively collected using accelerometers and a force platform during a task involving lowering a 4.5 kg load from upright standing posture to the knee height and then lifting back to the initial upright posture. Mechanical demands of the task on the lower back were estimated using measured kinematics and kinetics along with an inverse dynamic procedure involving a rigid multi-segment model of the lower extremities and pelvis. Peak values of thoracic rotation, lumbar flexion, velocity, acceleration, and deceleration were all smaller ($F>6.82$, $p<0.015$) in patients compared to controls. However, there was no difference in max and mean values of the mechanical demands of the task on the lower back ($F<2.96$, $p>0.097$) between the groups. Similar mechanical demands for both groups suggest a comparable total internal tissue responses for offsetting the task demand. However, smaller lumbar flexion in patients suggests a smaller passive contribution to the task demand which should be compensated by larger active control.

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College of Engineering Biomedical Research Day

ORAL PRESENTATION

Abstract Title:	**Modeling the Oxidative Consumption of Curcumin from Controlled Released Poly(beta amino ester) Microparticles in the Presence of a Free Radical Generating System**
Author(s):	C.T. Jordan, Department of Chemical and Materials Engineering, U of Kentucky J.Z. Hilt, Department of Chemical and Materials Engineering, U of Kentucky T.D. Dziubla, Department of Chemical and Materials Engineering, U of Kentucky

Abstract: Under a variety of pathophysiological conditions (e.g., radiation injury, inflammation, acute lung injury), cells are no longer able to maintain a balance between antioxidants and exogenous or endogenous radical generation, resulting in free radical overproduction and oxidative stress. Curcumin, a potent antioxidant, has three potential sites of oxidation in the presence of free radicals, but due to its hydrophobicity, poor solubility and bioavailability, it has possessed a low therapeutic effect in vivo. To overcome these limitations, our group has previously synthesized a covalently crosslinked poly(curcumin beta amino ester), poly(curcumin), film, where the hydrolytically degradable backbone of the polymer network increases curcumin's bioavailability, utilizing a controlled release mechanism, which gives great potential to show positive efficacy on oxidative stress treatment and cellular protection. The oxidative consumption of curcumin released from poly(curcumin) microparticles has yet to be studied in the presence of a free radical generator, such as AAPH. The kinetics of curcumin release and consumption can be used to model poly(curcumin) as a compartmental based system to verify the contributing factors to microparticle degradation with and without the presence of AAPH. Increased swelling and degradation of bulk films reported in the presence of AAPH suggest accelerated degradation of the polymer, which releases curcumin in the environment at a faster rate, changing the kinetics of delivery. The kinetics of curcumin release in the presence of free radicals is important in the development of delivery systems to allow for successful translation to in vivo studies.

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College of Engineering Biomedical Research Day

ORAL PRESENTATION

Abstract Title:	**A Brain-Machine Interface for Closed-Loop Peripheral Nerve Stimulation to Improve Hand Function in Spinal Cord Injury Patients**
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Abstract: Afferent electrical stimulation is known to augment the effect of rehabilitative therapy through use-dependent cortical plasticity. Experiments pairing transcranial magnetic stimulation (TMS) with peripheral nerve stimulation (PNS) have shown a timing-dependent effect on motor evoked potential (MEP) amplitude. This suggests that PNS applied in a closed-loop manner could improve motor function through positive reinforcement. A brain-machine interface (BMI) was developed to apply PNS in response to specific changes in electroencephalogram (EEG) signals with the intention of delivering sensory feedback to the brain as confirmation of volitional motor effort. In this ongoing study conducted with IRB approval, seven of eight subjects with incomplete cervical spinal cord injury (SCI) each received twelve sessions of BMI-driven closed-loop PNS applied while engaged in an interactive cue-driven hand grip task with one subject dropping out after seven sessions. Functional outcomes were assessed over the intervention and correlated with timing of stimulation relative to movement. Subjects with PNS occurring before force onset (n=4) had a mean change in maximum voluntary contraction force (MVC), measured using a hand dynamometer, of 27±21% for the left hand and 35±20% for the right hand. Subjects with PNS occurring after force onset (n=4) had a mean MVC change of -0.35±8.6% for the left hand and 4.7±18% for the right hand. Corresponding motor cortical remapping was observed in five out of eight subjects. While these results come from a small sample in an ongoing study, they suggest that closed-loop protocols with fine control of PNS timing could be a valuable adjunct to physiotherapy in the rehabilitation of patients with SCI.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #149

Abstract Title: **Effect of Temperature on Sleep Regulation in an Animal Epilepsy Model**

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Abstract: Sleep and seizures interact in a complex manner: while seizures disrupt sleep, poor sleep can lead to seizures. The thermoregulatory response to ambient temperature (Ta) change affects vigilance dynamics. Thus, it seems plausible that Ta could be manipulated to improve sleep quality and thereby reduce seizures in epilepsy patients. Here, we assess the effect of Ta on sleep and seizures in the pilocarpine mouse model of chronic temporal lobe epilepsy. With IACUC approval, each mouse (n=4) was implanted for EEG recording and, following recovery, exposed to 30°C on alternate days from 7 a.m.- 9 p.m. for four weeks; Ta reverted to baseline (23°C) at other times. Vigilance state was scored by inspection of the EEG in 4-s epochs. Mice spent more time in NREM and less in Wake ($p<0.05$) at 30°C. NREM bouts increased significantly with Ta ($p<0.001$). Deep and light sleep increased at 30°C ($p<0.05$). Daily seizure rates pooled for all animals were not significantly different during elevated Ta compared to baseline. The seizure rate increased in two animals and decreased for the others at 30°C. To test the feasibility of using Ta as a control variable for modulating sleep in a way that reduces seizures, a simple strategy for dynamic sleep titration was implemented to observe changes in behavior in a control mouse. The trials showed that thermal sleep modulation in real time is feasible. Thus, active manipulation of Ta could serve as an unobtrusive means of sleep modulation in epilepsy patients for seizure control.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #150

Abstract Title: **Predictive Value of Autonomic Variables for Seizures in Refractory Epilepsy**

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Abstract: There has been much recent interest in the role played by autonomic dysfunction in seizure generation. Here we investigate circadian and peri-ictal changes in surrogate measures of autonomic activity in epilepsy patients using a wearable device. With prior IRB approval, one patient admitted for presurgical evaluation using electrocorticography (ECoG) was monitored for four days with additional sensors for surface EEG (fronto-central), submental EMG and a wrist-worn device that measured acceleration (ACC), heart rate (HR), electrodermal activity (EDA), skin temperature (ST), and blood volume pulse (BVP). Six clinical seizures, all during sleep, and corresponding one-hour preictal segments, were extracted for analysis along with six one-hour interictal segments, 4 during wakefulness and 2 during sleep. In each segment, the mean value of each variable (excluding EEG and EMG) was computed in successive 2-min epochs and compared for interictal sleep, interictal wake, and preictal periods using ANOVA. A naive Bayes classifier was designed and tested using ten-fold cross-validation to assess the feasibility of distinguishing preictal from interictal epochs using autonomic variables alone. EDA increased drastically, while ACC, HR and BVP experienced marked variability, in the ictal versus the preictal period. There were significant differences in EDA and HR between preictal and interictal segments (ANOVA; $p < 0.001$); a slight difference seen in skin temperature (ST) did not reach significance ($p = 0.052$). The naive Bayes classifier labeled preictal epochs with 90% sensitivity and 96% specificity. Appreciable preictal changes in EDA, ST, and HR were documented in the one patient monitored thus far. These findings, though anecdotal, raise the possibility that autonomic measurements may help detect critical states in patients with epilepsy.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #151

Abstract Title:	**Low-Frequency Oscillation in Resting Brain Detected by a Fast-Diffuse Correlation Spectroscopy**
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Abstract: Cerebral autoregulation (CA) maintains cerebral blood flow (CBF) constant during blood pressure (BP) fluctuations. CA can be assessed by quantification of the phase shift between low-frequency oscillations (LFOs, ~0.1 Hz) of CBF and BP. Near-infrared diffuse correlation spectroscopy (DCS) was used previously to capture LFOs in CBF. Due to the limited sampling rate of DCS (up to 3 Hz), a bed-tilting protocol was used to enhance LFOs, which increased the risk of fainting or syncope of the subject. In this study, we optimize the DCS technique via using a fast data acquisition board with the flexibility of computing/analyzing small segments of the autocorrelation function. This optimization enables us to increase the sampling rate up to 20 Hz. To test this fast sampling system, a DCS probe with source-detector separation of 2.4 cm was placed on the subject's frontal head and CBF data were continuously collected from two young healthy adults at rest for five minutes using the sampling rates of 3, 6, 10, 15 and 20 Hz, respectively. Data collected from three DCS detectors were averaged to increase the signal-to-noise ratio. Results show that LFO signals can be clearly detected at all sampling rates higher than 3 Hz. Data obtained at 6 and 10 Hz have less noises than those at 15 and 20 Hz. More subjects should be measured to validate the findings. Future study may investigate LFOs in patients with cerebral impairment/injury and evaluate their CAs via the quantification of LFO phase shifts between the CBF and BP.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #152

Abstract Title: **Auditory Entrainment of Autonomic Rhythms**

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Abstract: It is increasingly becoming clear that music has palliative effect on recovery in a hospital setting and during the pre-operative stage. Rhythmic components in music entrain cardiovascular and cerebrovascular rhythms that result from autonomic neural activity. The current understanding of the mechanisms via which this entrainment occurs is not complete. Further, the contribution to entrainment from cognitive processing also remains unknown. In the present study, we investigate the interaction between cardio-respiratory and neural oscillations while the subjects listen to audio stimuli. Noninvasive continuous blood pressure, ECG (lead II), respiration (inductotrace), EEG (6 locations) are recorded in subjects as they listen to music that is expected to evoke a cognitive response and music that has similar sensory structure but is unlikely to evoke a cognitive response. To obtain music with similar sensory structure but with minimized cognitive response, we scramble the phase spectrum of the music while maintaining the magnitude. Autospectra of RR intervals (heart rate variability), coherence between RR intervals and respiration, between RR intervals and EEGs and baro-reflex measures are used to assess entrainment. Initial results suggest that this approach will allow us to determine causal relationships among rhythm generator networks and, importantly, the sequence in which these networks engage to produce auditory evoked autonomic modulation. We expect that these results will further clarify whether respiratory entrainment is an intermediate and causal step in autonomic entrainment or if it is a correlated step.

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POSTER PRESENTATION #153

Abstract Title:	**Frequency Adaptations at the Knee and Hip Following ACL Reconstruction**
Author(s):	G.F. Boggess, Departments of Mechanical Engineering and Materials Engineering B. Noehren, Division of Physical Therapy

Abstract: HYPOTHESIS: Low frequency forces in the body are attenuated by muscle while higher frequency forces are attenuated by passive structures. Elucidating frequency changes post-ACL Reconstruction (ACLR) may improve treatments. We hypothesize that the reconstructed limb will exhibit greater power spectral density (PSD) in knee and hip abduction/adduction angles at low and high frequency, and less attenuation at the knee and hip than the non-reconstructed limb. NUMBER OF SUBJECTS: 22 subjects (mass: 70.3 ± 11.1 kg, height: 1.74 ± 0.11 m) METHODS: Subjects were instrumented and instructed to perform a drop landing from a 30-cm tall box and immediately perform a maximal vertical jump. FFTs were performed on the subjects' lower extremity joint angles and segmental accelerations. Frequencies were divided into low (<8 Hz) and high (8<f<30 Hz) frequencies. STATISTICAL ANALYSIS: A two-tailed, paired t-test compared PSD between injured limb and non-injured limb (a = 0.05). RESULTS: ACLR limbs displayed significantly greater high frequency knee abduction/adduction PSD (Control: 4.81 ± 2.32, ACLR: 5.71 ± 2.46, p = 0.02). At the hip, the control limb displayed greater high frequency frontal plane attenuation (Control: 7.34 ± 3.58, ACLR: 6.23 ± 2.65, p = 0.01) and overall frontal plane attenuation (Control: 6.61 ± 3.28, ACLR: 5.51 ± 2.30, p = 0.01). CONCLUSIONS: Increased high frequency attenuation may indicate the presence of a passive protective mechanism in healthy limbs to protect the limb from poor abduction/adduction control. These results indicate that post-ACLR rehabilitation should focus on hip proprioception\differences which may improve passive attenuation properties.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #154

Abstract Title:	**Mechanical Protection of Living Cells Via Hydrogel Encapsulation for Single Cell Resolution 3D Bioprinting**
Author(s):	C. F. Cahall, Department of Chemical and Materials Engineering, U of Kentucky B. J. Berron, Department of Chemical and Materials Engineering, U of Kentucky

Abstract: Bioprinting of 3-Dimensional structures is an increasingly growing field for tissue engineering and regenerative medicine. 3D bioprinting is the process of printing structures and scaffolds with cells for the regeneration of tissues such as ligaments and vasculature with ultimate goals of printing viable, functional organs for transplant. Over the past twenty years, the demand for organ transplant has greatly increased to having over 100,000 people currently on the waiting list.1 Printing complex 3D structures such as organs presents challenges such as printing multiple cell types, quickly printing large numbers of cells, and exact placement or high resolution of the printed cells. For viable bioprinting, another level of complexity is introduced with chemical and physical limitations for cell friendly conditions. Although many types of “bio ink” or cell friendly, printable solutions have been used, the physical limitations of high resolution at high throughput still remains a major issue. Currently, technologies are limited to approximately 10 nL/s when at high printing resolutions.2 Here we explore the protective potential of single cell hydrogel encapsulation against shear forces to maintain the integrity of the cell membrane. A common method of 3D bioprinting is extrusion of a cell laden gel through a thin needle directly onto a substrate. Typically, extrusion printing is done through needles with approximately 200-500 µm diameter and therefore obtaining resolutions on the order of hundreds of microns. Higher resolutions require smaller needle diameter until the ultimate printing resolution of single cell is achieved. At a needle diameter near that of a single cell, cells experience a velocity gradient and come into contact with the channel wall causing shear stress as they travel through the channel. With increased printing rates and therefore flow rates these stresses greatly increase and can be enough to damage the cell membrane and even cause cell lysis. We believe that complete single cell encapsulation will provide the mechanical strength necessary to maintain structural integrity of the cell membrane and remain viable following extrusion. This shear protection will allow single cell resolution 3D bioprinting of viable cells at high throughput.

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POSTER PRESENTATION #155

Abstract Title:	**The Effects of Backpack Type on the Muscle Activity of Rectus Abdominis and External Oblique When Performing Different Physical Activities**
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Abstract: Lower back pain (LBP) is the fifth most common reason for physician visits in the United States. Low back pain at a young age has been suggested to play an important role in developing chronic back pain in adults. Large loads on the lower back due to carrying heavy backpacks by students have been identified as an important risk factor for developing LBP at young age. As such, ergonomically designed backpacks have been designed and used to reduce the adverse effects of carrying heavy backpack on the lower back. However, it is not clear whether an ergonomically designed backpack vs. a normal backpack will result in differences in biomechanical demand of carrying the backpack on the lower back. The objective of this study was set to investigate the differences in biomechanical demand of carrying two different types of backpacks using the electromyography (EMG) activity of select abdominal muscles. Forty gender-balanced participants (18-22 years old) with no history of LBP will complete the study. Each participant will complete several tasks of daily activities with three types of load carrying options (i.e., no backpack, normal backpack, or ergonomic backpack). The tasks include two trunk ranges of motion tasks (i.e., preferred and fast paces), walking and jogging on a treadmill for thirty seconds, and stairs ascending and descending. EMG activity of bilateral rectus abdominis and external oblique will be measured using surface EMG electrodes. The maximum and mean values of EMG signals for each activity will be obtained and the effects of the types of load carry options on the EMG values will be investigated.

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POSTER PRESENTATION #156

Abstract Title:	**Does an ergonomically designed backpack, compared to a normal backpack, impose smaller external loads on the lower back?**
Author(s):	C. Dowling, Department of Mechanical Engineering, U of Kentucky I. Shojaei, Department of Biomedical Engineering, U of Kentucky C. Suri, Department of Biomedical Engineering, U of Kentucky B. Bazrgari Department of Biomedical Engineering, U of kentucky

Abstract: Low back pain (LBP) is one of the most prominent reasons for clinical visits in the United States. An early indicator of future chronic back pain as an adult is development in adolescences. Large loads as a result of carrying heavy backpacks is one source of LBP in children. To counter this potential risk factor, ergonomic backpacks have been designed and recommended to reduce the adverse effects of carrying backpacks on the lower back. It is, however, not clear whether carrying an ergonomically designed backpack vs. a normal backpack will improve such adverse effects. The objective of this study is to observe the differences in mechanical demands of carrying an ergonomically designed vs. a normal backpacks on the lower back of students. Forty gender-balanced participants at a near adolescent age (18-22) with no history of LBP will complete two trunk range of motion tasks; one at a preferred and another one at a fast pace. Three cases of carrying workload (i.e., No load, normal backpack, ergonomic backpack) will be considered for each task. Kinematics of body segments were measured using a set of accelerometers placed alongside the lower extremities (i.e., shank, thigh, and hip), pelvis, and the sternum whereas ground reaction forces were measured using a multi-directional force plate. The kinematics and ground reaction forces are combined to determine acting planar forces in the lower back. The maximum and mean values of reaction forces for each activity will be obtained and the effects of the types of load carry options on the force values will be investigated.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #157

Abstract Title: **Bone Microdamage and Teriparatide**

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Abstract: Osteoporosis is a pervasive disease afflicting more than 10 million Americans. Osteoporosis caused by high bone turnover has been successfully treated with antiresorptive medications, but osteoporosis caused by low bone turnover has not been well treated until the advent of anabolic agents (e.g. teriparatide). This pharmaceutical agent mimics the action of natural parathyroid hormone and promotes new bone formation. It thereby provides a new therapeutic approach to restore lost bone and thus enhance bone quality. Although reduction in clinical fractures accompanying teriparatide treatment have been shown, insufficient information exists regarding the mechanism by which this anabolic agent favorably alters key parameters governing bone quality. The objective of this study is to quantify the relationship between teriparatide use and changes in bone microdamage. A laboratory study was performed to assess microdamage in cancellous bone samples from four female patients. Patient inclusion criteria were: female gender, prior non-traumatic fractures, a two year (approximate) course of treatment with teriparatide, and bone sample procurement before and after treatment. These bone samples were stained with fuchsin, mounted in polymethylmethacrylate, cut to a thickness of 100 microns, then examined using light and fluorescence microscopy at 200x magnification. Total area of trabecular bone, number of microcracks, and length of each microcrack were measured in each bone sample using a blinded approach. The study is ongoing at the time of press and since this is a blinded analysis, no information is available until all samples have been measured and the results analyzed. Such measurements and analyses will be complete in time for the data to be presented. Data will be presented showing: a) mean crack number, b) crack density (number/bone area), and c) mean crack length pre and post- teriparatide treatment. If the results of teriparatide treatment show statistically significant reduction in the density (i.e., microdamage accumulation) or length (microdamage growth) of micro cracks, then evidence for the beneficial effects of teriparatide on bone turnover and microdamage repair will have been obtained. If the results of teriparatide treatment do not show a statistically significant reduction in microdamage accumulation or growth, then a power analysis will be performed to determine how many additional samples will be needed to detect a statistically significant difference, or conclude that teriparatide has no relationship with microdamage repair, and thus may be related to some other parameter of bone quality. This study will provide useful information regardless of outcome.

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POSTER PRESENTATION #158

Abstract Title: **Microcracks in Human Bone**

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Abstract: Bone quality is the term applied to the ability of human bone to resist excess deformation and avoid fracture. Bone quality is governed by the amount, composition, structural arrangement, and level of perfection of bone material. The latter variable is quantified by the number and length of cracks in bone. These cracks arise as a consequence of normal physiologic loading and are ordinarily repaired by bone turnover. Increases in the rate of crack generation, as occurs in extensive military training or decreases in bone turnover, as occurs in certain pathological conditions or accompanying specific medications, lead to excess numbers and lengths of bone cracks and potentially gross clinically manifested bone fractures. Bone cracks come in two varieties: diffuse damage and microcracks. Diffuse damage refers to small (< 30 microns) cracks that are predominantly found in young adults. Microcracks refer to cracks > 30 microns and which are predominantly found in older adults. This presentation will: a) raise awareness regarding the existence and importance of cracks in human bone, b) review the methods used to identify these cracks, and c) identify the current level of understanding regarding the biomechanical relationship between crack number/length and established metrics of bones load bearing mechanical competence.

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POSTER PRESENTATION #159

Abstract Title: **Does Backpack Type Affect Lumbar Kinematics While Performing Physical Activities?**

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Abstract: In the United States, lower back pain (LBP) ranks as the fifth most prevalent reason for physician visits. In many cases, adults who have chronic back pain also experienced back pain as a youth. Due to the already established role of large loads in risk for lower back injury and LBP, ergonomic features in backpacks have been advertised to help reduce such risks. However, to the best of our knowledge, no research has investigated the biomechanical differences in the lower back when carrying an ergonomic backpack vs. a normal backpack. The objective of this study was to investigate such differences through measures of lower back kinematics. The kinematics were recorded during several activities of daily living for forty gender-balanced participants (students ages 18 to 22) with no history of LBP. Each participant completed several tasks of daily activities with one of three types of carrying options (i.e., no backpack, normal backpack, or ergonomic backpack). The tasks included two range of motion tests (i.e., self-selected and fast paces), walking and jogging on a treadmill for thirty seconds, and stairs ascending and descending. The range of motion in the lumbar region of the spine was investigated using body kinematic data collected with accelerometers placed on the lower extremities as well as the sternum of the subject.

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POSTER PRESENTATION #160

Abstract Title:	**Towards characterization of movement-related cortical dynamics using electroencephalography and diffuse correlation spectroscopy**
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Abstract: Brain-computer interfaces (BCI) show promise as a direct line of communication between the brain and the outside world for individuals with neuromuscular disorders that impair motor function. This requires characterization of brain activity alone for use as a communication signal. Movement-related brain activity is commonly used as a BCI signal but how brain signals differ in motor planning, initiation, and grip force control is poorly understood. Improved characterization of cortical dynamics during movement could result in better BCI control strategies. In this project, to better characterize movement-related neurophysiological change, we propose to measure not only electrical activity through the electroencephalogram (EEG) but also cerebral blood flow (CBF) using a relatively new technology, near-infrared diffuse correlation spectroscopy (DCS). In a single preliminary trial, EEG and DCS data were simultaneously recorded from a human subject during a cue-triggered hand grip task. Eight channels of EEG were acquired from frontal, central, and occipital regions, and DCS data from locations over frontal and motor cortex. Event-related desynchronization (ERD), a measure of task-related EEG band power changes with respect to a baseline, was observed just before hand movement and lasting until movement ceased. EEG from motor areas showed significant ERD of -7.1 % in the 8-13 Hz mu band, the idling sensorimotor rhythm ($p<0.001$). Additionally, mean CBF increased during the task in the motor location by 6.8% ($p<0.001$) and in the frontal location by 4.5% ($p<0.001$). These preliminary results hint at measurable changes that are worth exploring in a broader study that combines electrical and optical measurements, with the potential benefit of increased specificity of command signal classification.

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POSTER PRESENTATION #161

Abstract Title:	**Using a Respiratory Navigator Significantly Reduces Variability when Quantifying Left Ventricular Torsion with Cardiac MRI**
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Abstract: Background- Left ventricular torsion is an important indicator of cardiac function that is limited by high inter-test variability. We hypothesized that this high inter-test variability is partly due to inconsistent breath-hold positions during serial image acquisitions, which could be significantly improved by using a respiratory navigator for cardiac magnetic resonance imaging (MRI) based quantification of torsion. Methods- We assessed respiratory-related variability in torsion with two experiments. First, 17 volunteers were recruited for displacement-encoded (DENSE) MRI in which a respiratory navigator was used to measure and enforce variability in end-expiratory position between acquisitions. For experiment 2 (20 volunteers), 10 pairs of DENSE basal and apical images were each acquired from consecutive breath-holds and consecutive navigator-gated scans. From each experiment, we computed the variability of torsion in the absence and presence of end-expiratory position variability. We also quantified the reduction in sample size required to detect a clinically meaningful change in torsion. Results- The mean torsion was 3.4±0.2°/cm. From experiment 1, variability in measured torsion was 57% lower with a consistent end-expiratory position compared to enforced variability in end-expiratory position (0.24±0.16°/cm vs 0.56±0.34°/cm, $p<0.001$). From experiment 2, variability in measured torsion was significantly lower with navigator-gated scans compared to consecutive breath-holds (0.18±0.06°/cm vs 0.24±0.10°/cm, $p=0.02$). By using a respiratory navigator, sample sizes were reduced from 66 to 16 and 26 to 15 as calculated from the two experiments. Conclusions- A substantial portion (22-57%) of the inter-test variability of torsion can be reduced by using a respiratory navigator to ensure a consistent breath-hold position between image acquisitions.

Supported by: This work was supported by a National Institute of Health (NIH) Director's Early Independence Award (DP5 OD-012132), a grant from the National Institute of General Medical Science (P20 GM103527) of the National Institutes of Health, a NIH Ruth L. Kirschstein fellowship (NIH 1F31HL126403), and grant UL1TR000117 from the National Center for Research Resources (NCRR), funded by the Office of the Director, National Institutes of Health and supported by the NIH Roadmap for Medical Research. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding sources.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #162

Abstract Title:	**Changes in Sleep Architecture Accompanying Alzheimer's Disease in Mice: A Computational Approach**
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Abstract: Sleep, aging, memory, and cognition form an intricate lattice with Alzheimer's Disease (AD) – all inter-dependent and often exaggerating the effects of one another. Early AD progression has been shown to impact sleep well before memory and cognition, opening the door for sleep analysis as a potential AD screening method. Due to the inherent complications associated with human sleep studies, animal models are now widely used. While data collection from animal models is straightforward, identifying sleep architecture through manual scoring, the gold standard, is time-consuming and subject to inter- and intra-rater bias and variability. However, computational modeling of physiological signals has shown great potential in serving as an objective surrogate. Here, we implemented a sleep modeling method that has shown promising performance on wild-type (WT) animals, and explore its validity in an animal model of AD. According to IACUC approved protocols, six WT and six AD animals were implanted with EEG/EMG electrodes, recorded for 24-hours, and manually scored into wakefulness, NREM, and REM sleep. By inspecting hidden Markov models fitted to data from both groups, we were able to identify AD-related differences in sleep architecture. The number of bouts, mean bout duration, proportion of each stage, and total sleep time (TST) were compared between manual scores and model output. Overall, manual scoring showed trends in AD sleep consistent with other studies (more Wake; less NREM, REM, and TST). Additionally, NREM bouts over 5 minutes were less likely in AD, indicative of more fragmented sleep. Model output captured the main features of sleep observed from manual scores, with agreement ranging from 76-87%.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #163

Abstract Title: **Sprayable Drug Delivery System for Prevention of Surgical Site Infection**

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Abstract: Surgical site infection (SSI) remains one of the most prevalent reasons for sustained hospitalization, tissue morbidity, and death. The typical method to prevent SSI is to deliver antibiotics intravenously or apply vancomycin directly to the wound area. For that latter, most of the antibiotic is lost through wound drainage, substantially decreasing the effective concentration and duration of exposure. This research explores the idea of vancomycin-loaded poly(lactic-co-glycolic acid) microspheres, which upon degradation would continuously release vancomycin for up to six weeks. A water-based spraying system was used to obtain a good distribution of microspheres in the treatment area. Furthermore, to prevent microsphere runoff, 0.25% carboxymethylcellulose was added to increase the viscosity of the spraying medium. This system provided an adequate area of coverage and showed release profiles that indicated extended release of vancomycin above minimum inhibitory concentration levels.

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POSTER PRESENTATION #164

Abstract Title: **Quantification of 3D Langragian Strains and Torsion Using DENSE MRI**

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Abstract: Literatures suggests that heart disease might cause a statistically significant change on cardiac mechanics, such as strains and torsion, which can provide evidences for medical therapies. Displacement ENcoding with Stimulated Echoes (DENSE) cardiac magnetic resonance (CMR) images are used to generate non-invasively a detailed profile of regional cardiac mechanics. A methodology for quantification of 3D Lagrangian strain and torsion in the left ventricle (LV) was proposed. Tools written in MATLAB were developed for the methodology. The LV was meshed, followed by displacements tracking for all elements. Lagrangian strain was then calculated for each element. Average strains of all mid-ventricular segments were compared and discussed individually. Torsion of the whole LV was also evaluated. Radial strain, circumferential strain, longitudinal strain, and CL shear angle provide a measurement of mechanical deformations in the cardiac wall over a cardiac cycle. They are provided for future statistical comparisons across subjects.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #165

Abstract Title:	**A Photometric Stereo Technique to Acquire Tissue Surface Geometry for 3D Imaging of Blood Flow Distribution**
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Abstract: A novel noncontact CCD-based speckle contrast diffuse correlation tomography was recently developed in our laboratory for intraoperative 3D imaging of tissue blood flow distribution for the prediction of mastectomy skin necrosis. To obtain tissue surface geometry for flow image reconstruction, an advanced photometric stereo technique is explored, which uses multiple 2D images obtained from the same CCD camera perspective with different illuminations of four LEDs. Four custom-designed mechanical arms attached to the CCD camera hold these LEDs for illuminations. Once the camera is aligned to focus on targeted tissue, image acquisitions are triggered with the four LEDs being flashing successively. This procedure provides four separate images of the object, each with shading determined by a different lighting vector. These images are then integrated to generate a 3D surface geometry. With this unique technique, the geometry of a 3D mannequin breast is successfully recovered. Comparing to other methods (e.g., interferometry, stereo vision, or structured illumination), the 3D photometric stereo technique is simpler and faster. Most importantly, the unique design of using one single CCD camera for both flow and geometry measurements obviate the need of complex co-registration of two measurements. Future work will apply the novel technique for 3D imaging of mastectomy skin flap, with the goal of providing objective information for prediction and prevention of mastectomy skin flap necrosis.

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POSTER PRESENTATION #166

Abstract Title: **Seamless Scaffolds Containing Gradients of Microspheres for Tissue Engineering**

Author(s): A. Najarzadeh
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Abstract: Introduction: Spatiotemporal control and patterning of signals is a critical design element in the engineering of tissues to mimic and maintain complex signal patterns. Seamless polymer scaffolds may provide a path to achieve spatiotemporal control of signal distribution. In this study, a novel microsphere (MS) based scaffold fabrication technique is introduced as a method to create seamless gradient scaffolds using poly(β-amino ester) (PBAE) MS in a uniform poly(lactic-co-glycolic acid) (PLGA) matrix. The combined effects of time-dependent degradation and graded spatial distribution of PBAE MS in PLGA matrix results in porosity development advantageous to design scaffolds that can maintain the initial physiological mechanical properties needed while degrading away with the rate commensurate with the intended new tissue formation. Materials and Methods: PBAE macromer was synthesized through a step-wise reaction between poly(ethylene glycol) diacrylate (“H”; Polysciences), diethylene glycol diacrylate (“A”; Polysciences), and isobutylamine (“6”; Sigma-Aldrich). Macromers were made with A:H molar ratios of 1:1, with a 1:1.2 ratio of amine to total diacrylate. PBAE MS of varying sizes were prepared via a previously developed method combining a syringe pump with oil-in-water emulsification in conjunction with photo-polymerization. Poly(lactic-co-glycolic acid) (PLGA; 75:25, ester-terminated; Sigma-Aldrich) with 75,000 Da molecular weight was dissolved in dichloromethane (DCM) at three varying concentrations of 16, 33, and 41 %, mixed with constant 500 mg amount of PBAE MS , and followed by centrifugation technique with varying speed and duration for each group. The end result mixtures were exposed to 1.6 °C for 48 hours for gradual DCM evaporation, followed by freeze-drying. Scaffolds were placed in 4 mL phosphate-buffered saline (PBS), pH 7.4, on a plate shaker at 37°C for almost 40 days. Samples were removed at predetermined time points to conduct compression testing in the wet state, nondestructive swelling and mass loss measurements, and examine degradation of PBAE porogen and PLGA matrix via microCT. Results: Compression testing was used to evaluate the modulus of samples in their initial dry state and in their ‘wet-state’ of degradation. Once samples were placed in PBS, PBAE MS used as porogens embedded within the PLGA matrix underwent hydrolysis leaving a gradient porous structure behind as shown in Figure 1. It was observed that after the hydrogel porogen was degraded, the residual PLGA matrix with different PLGA content degraded at a much slower rate influencing the overall porosity and compression modulus. The larger decrease in modulus as PBAE MS degraded and overall porosity increased can be seen in the 16% followed by 33% and then 41% PLGA systems. The lower properties of 16% scaffolds can be attributed to the lack of PLGA matrix as the integrity of the scaffold was compromised. Another factor for the overall modulus decrease in all three systems is likely due to the swelling properties of the PBAE MS that put added stress on the PLGA matrix. Conclusions: The proposed systems demonstrate the effect of time-dependent degradation of PBAE MS that allows for rapid aqueous infiltration leaving a gradient interconnected porous structure of varying physicochemical and mechanical properties. These application based scaffolds may be designed to release opposing gradients of bioactive signals and/or to create transversely isotropic scaffolds capable of maintaining the initial physiological mechanical properties for the intended tissue formation.

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POSTER PRESENTATION #167

Abstract Title: **Synthesis and Degradation of Poly(β-amino ester) Fibers and Microspheres**

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Abstract: Statement of Purpose Major initial factors influencing myogenesis include promotion of neovascularization and allowing macrophages access to the site of the wound. Hydrogels, such as poly(β-amino ester) (PBAE), have tunable degradation properties and the ability to achieve multiphase drug release. The overall purpose of this project is to develop a method to polymerize PBAE into fast-degrading fibers or microspheres that can be inserted into a slow-degrading matrix. In the present studies, methods for creating degradable PBAE fibers and microspheres with controlled diameters were developed, and their degradation patterns were studied in in vitro. Methods To polymerize H6 fibers, synthesized macromer was thoroughly vortexed with 1 wt% of 2,2'-Azobisisobutyronitrile and 10 wt% dichloromethane (DCM.) The prepared macromer was transferred to a syringe and immersed in an 115°C oil bath for 1 minute. Polymerized fibers were placed in an ethanol bath and shaken for 24 hours. Fibers were then air-dried. To polymerize H6 microspheres, synthesized macromer was vortexed with 1 wt% 2,2-Dimethoxy-2-phenylacetophenone (DMPA) and 10 wt% DCM. The prepared macromer was transferred to a syringe and connected to tubing immersed in 15 wt% polyvinyl alcohol in deionized water with a stir bar rotating at 300 rpm and UV polymerized. The microspheres were filtered out of the surfactant solution, transferred into an ethanol bath, shaken for 24 hours, and then air-dried.Polymerized H6 fibers or microspheres were embedded into A6 or AH6 3:1 matrix, respectively, and UV polymerized. Scaffolds were placed in orbital shakers at 37°C in 3mL of phosphate-buffered saline (7.4 pH) and samples were taken at selected time points for microCT evaluation. Results Within 3 days, the embedded H6 fibers degraded both from within and from the surface, as expected from bulk erosion. After 7 days of degradation, the H6 fibers fully degraded within the A6 matrix and formed cylindrical, interconnected internal structures. Some internal structures appeared segmented due to handling of the fibers. The A6 matrix was still intact after 3 weeks of degradation. After 3 days of degradation, the H6 microspheres throughout the AH6 3:1 matrix degraded and formed spherical pores. It was observed that more pores were formed closest to the surfaces of the matrix. The entire scaffold degraded within 7 days. Conclusions A method for preparing H6 fibers and microspheres was developed and degradation patterns were recorded. PBAE fibers or microspheres developed with these methods have tunable degradation properties based on the macromer used and may be inserted into a matrix as a porogen to achieve a desired therapeutic effect.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #168

Abstract Title: **Adhesion of Biofilm Matrix-Mimicking Polymers**

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Abstract: Subgingival biofilms developed from bacteria aggregation between the surfaces of a dental implant and the surrounding tissues can lead to peri-implantitis. This disease inflames soft tissue in the gum and mandible, potentially leading to implant loss. Biofilms are a collection of bacteria that secrete a matrix of extracellular polymeric substances (EPS) which influences a number of processes: attachment between the bacteria and a surface, transport of cellular material, protection, and a pathway for communication between bacteria. Uncontrolled growth between implant and surrounding tissue increases the risk of pathogenesis. Addressing oral biofilm proliferation requires access to the infected site involving undesirable dental or surgical operations. One prophylactic approach is to develop surfaces that prevent strong adhesion strength, reducing the duration of bacterial presence to minimize harmful outcomes. To prevent such adhesion, an appropriate adhesion strength measurement technique must be established. The laser spallation technique is one such method that will quantify adhesion strength in a non-contact manner at high strain rates and is appropriate for low cohesive strength films such as biofilms. Our two polymer films of interest are dextran and chitosan, which are polysaccharides abundant within the EPS of streptococci, a major constituent in deleterious oral biofilms. Films of dextran and chitosan are prepared on titanium-coated SiO2 substrates to mimic the adhesion of biofilms to titanium implant surfaces. By exercising the laser spallation technique, we will develop a quantitative evaluation and comparison of biofilm matrix-mimicking polymers and their adhering strengths to an implant surface.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #169

Abstract Title: **Breast Biopsy Headrest**

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Abstract: The problem that was addressed was how to allow a patient more comfort while undergoing a breast biopsy procedure. To do this, the headrest was focused on. The current model of headrest allows for little to no movement in the patient's head or neck and no flexibility. The current model also has poor vision which can lead to claustrophobia. To combat these, features from the current design had to be addressed and either kept or discarded. To address the lack of movement in the current model, its current method of vertical movement would have to be looked at and replaced. It used a notched set screw type of mechanic. This would make it so that a technician would have to come in and help the patient if they wanted to move their head up or down. In the prototype, these were replaced with four springs with respective housings. These springs would be preloaded and allow for a two inch deflection. They would also be able to hold 6 pounds each for a total of 24 pounds. With the spring-housing mechanism the patient would be able to flex their neck in any direction that they pleased and any force would allow the spring to deflect. The prototype would also make it so the springs wouldn't deflect if the patient is just resting their head, applying no force. This gives total control to the patient and allows for many different options, instead of the limited number that the current model allowed for. The current mirror is tiny and is hard to see anything out of. To combat this, we have simply increased the mirror's surface area. The prototype has a similar slot in its base for a mirror, however testing is being done to find the maximum visibility allowed. 3D printing will allow for any piece that can fit into the prototype to be constructed. In the testing many different variations of mirrors will undergo a laser test to ensure for more visibility, fighting claustrophobia. With these two improvements to the current model, the prototype is believed to give more comfort and visibility to the patient. The headrest is a crucial part to the patient's comfort during a breast biopsy. The current model has many flaws and this prototype was made to try and alleviate as many as possible.

Supported by: Dr. Hardy and Dr. Wang

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POSTER PRESENTATION #170

Abstract Title:	**Development of Thermally Responsive Materials for the Capture and Release of Environmental Pollutants**
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Abstract: Thermally responsive hydrogel based sorbents have gained great attention for environmental remediation, specifically in water treatment, due to their high adsorption capacities and response to external environment change. N-isopropylacrylamide (NIPAAm) is one of the most widely studied thermo-responsive materials, which undergoes reversible phase transition at its lower critical solution temperature (LCST) around 32°C. NIPAAm-based thermally responsive materials can be synthesized with various functionalities, which can provide specific interactions with target environment pollutants (e.g., organic dyes, PCBs). Our group's recent efforts have focused on applying naturally derived polyphenols, such as curcumin and quercetin, to develop materials with binding affinities to such pollutants. The overall goal of this work was to develop thermally responsive materials for on/off binding of pollutants. Specifically, NIPAAm-based thermally responsive hydrogel films and microparticles have been developed. In addition, magnetic nanoparticles have been incorporated into the hydrogel network to enable magnetic separation. The temperature response of the bulk gels were characterized using swelling studies, and their LCSTs were characterized by differential scanning calorimetry (DSC). Lastly, the PCB capture/release performance of the hydrogels/gel microparticles were characterized through binding studies using PCB 126.

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POSTER PRESENTATION #171

Abstract Title: **Alternating Heights of the R Wave in ECG: Possible Link with Depolarization Alternans**

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Abstract: Alternans of the T wave in the ECG (TWA) is widely investigated as a potential predictor of ventricular arrhythmia, however, clinical trials show that TWA has high negative predictive value but poor positive predictive value. A possible reason that TWA has a large number of false positives is that a pattern of alternans, concordant alternans, may not be as arrhythmogenic as discordant alternans. Currently, it is not possible to discern the pattern of alternans using clinical ECGs. However, our research using tissue and cellular level electrophysiological measurements suggest that depolarization alternans which affects the pattern of alternans may manifest itself in the amplitude of the R wave of the ECGs. In order to investigate the link between depolarization alternans and changes in ECGs, we used a mathematical model which simulated ECGs from the cellular level changes observed in our experimental studies. These results suggest that the changes in ECGs should appear as alternating pattern of the heights of the R wave. However, there are a variety of factors which may also cause the R wave heights to change. We use signal analysis and statistical modeling to determine the link between the observed changes in R wave heights and depolarization alternans. Results from ECGs recorded from patients show that heights of the R wave can change as predicted by our experimental results and mathematical models. These results support further exploration of the link between depolarization and repolarization alternans as it has the potential to improve the positive predictive value of TWA.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #172

Abstract Title:	**Lumbar and Pelvic Motion in the Primary and Coupled Planes during Lateral Bending and Axial Twist: Age-related Differences**
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Abstract: Trunk lateral bending and axial twist are associated with pelvic and lumbar motions that occur not purely in the desired or intended anatomical plane (primary plane); rather, they have components in the other anatomical planes (secondary planes). Age-related differences in the range of motion (ROM) of lumbar spine and pelvis in the primary and the secondary planes of trunk motion during lateral bending and axial twist to the left and right directions were compared between 71 participants in five different age groups spanning from 20 to 70 years old. For the sake of better comparisons, the ROM in secondary planes of motion were normalized to ROM in the primary plane of motion and were reported as the coupled motion ratios (CMRs). The lumbar CMR in the transverse plane during the lateral bending to the left, and the pelvic CMR in the sagittal plane during the axial twist to the right were larger in older versus younger age groups. Additionally, the lumbar CMR in the sagittal plane during the lateral bending to the left, and the pelvic ROM in the frontal plane during the lateral bending to both directions were larger in the male versus female participants. Interpretation of these results, particularly concerning age-related differences in potential risk for low back injury and pain, requires a knowledge on age-related differences in active and passive mechanical responses of lower back tissues under lateral bending and axial twist that should be established in future.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #173

Abstract Title: **Noninvasive Seizure Detection with Piezoelectric Sensors**

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Abstract: Animal models are widely used to investigate the neurophysiology of epilepsy and titrate experimental therapies and the pilocarpine mouse model exhibits many of the hallmarks of human limbic epilepsy. Those working with such models typically monitor the animal during the latent period in which spontaneous seizures start to occur. This period can last for weeks, and requires careful monitoring. A stable seizure rate may then need to be documented prior to invasive EEG implantation and experimentation. These factors highlight the need for a noninvasive automated method that would enable detection of the earliest seizures and estimation of seizure rate before EEG implantation. Here we assess the feasibility of noninvasive seizure detection in pilocarpine-implanted mice using a floor-mounted piezoelectric motion sensor. A line length metric was computed from the piezo signal and the ratio with respect to an exponentially smoothed reference value was used for seizure detection by comparing against a preset threshold determined from training data. The detections were verified against EEG to assess the detector's sensitivity (portion of true seizure detected) and precision (proportion of correct detections). This noninvasive seizure detection method shows both promising and stable performance. On a five-fold cross-validation, the detector produced a mean sensitivity of 87.7% and a mean specificity of 28.6%. The thresholds deviated by less than 6.5% of their mean. With this detector, we can expect to discover nearly 90% of all seizures without having to visually verify more than three or four times as many detections, which is a minor inconvenience compared to its alternative.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #174

Abstract Title:	**Characterization of Motor Related Cortical Potential in Individuals with Incomplete Spinal Cord Injury**
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Abstract: Objective: In recent years, movement-related cortical potentials (MRCPs) have received increased attention in brain-machine interface (BMI) applications. Here, the ability to detect and characterize MRCPs from electroencephalogram (EEG) data recorded as part of an ongoing clinical study involving patients with spinal cord injury (SCI) was investigated. Approach: With prior institutional approval and informed consent, sensorimotor EEG signals from central and parietal regions of the scalp were recorded in four SCI patients with impaired hand function. Subjects engaged in an interactive cue-driven hand grip task for twelve sessions over four weeks. Each session consisted of 10 runs—five on each hand—of 20 cue-triggered hand grip movements. To compute MRCPs, the signals were common average referenced (CAR) and bandpass-filtered from 0.1-4 Hz. The onset of each executed movement was determined from grip force measured continuously using a hand dynamometer. The corresponding EEG signals from 2s before to 1s after movement onset were extracted and taken to represent the MRCP. Results: It was seen that a typical MRCP departs from the baseline, shows a progressive increase in slope, and reaches peak negativity at the time of movement onset. In all four subjects, who happened to be right hand dominant, MRCP negativity was most prominent on C3 in the left hemisphere (i.e., right hand area) regardless of the hand used for the task. These preliminary results suggest the feasibility of using the MRCP as a marker of movement intent in individuals with SCI.

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College of Engineering Biomedical Research Day

POSTER PRESENTATION #175

Abstract Title: **Noncontact Diffuse Optical Imaging of Blood Flow Distribution in Mastectomy Skin Flaps**

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Abstract: Background and Objective: Skin flap necrosis is the most common complication after mastectomy and expander-implant based breast reconstruction. Quantification of blood flow in mastectomy skin flaps is important for the prediction of skin flap necrosis. This study was designed to explore 3D imaging of blood flow distributions in mastectomy skin flaps using a novel noncontact diffuse correlation tomography (ncDCT) technique. Methods: Thirteen patients underwent mastectomy were imaged immediately after mastectomy and after breast reconstruction. The patient lay supine on the surgery bed and the noncontact ncDCT probe was driven by a motorized linear stage to scan over the breast along the incision. The measured boundary blood flow data were used to reconstruct the 3D flow image over the mastectomy skin flap. Results: The normalized blood flow values over the reconstructed tissue volume range from 0 to 3.70 folds. Lower blood flow contrasts and larger flow variations were observed in the area close to the incision compared to the surrounding tissues; mean value of lower blood flow contrast was 0.44 ± 0.10. Discussion and Conclusions: The ncDCT system enables noncontact 3D imaging of blood flow contrasts in mastectomy skin flaps without interrupting the surgery. Future study will recruit more subjects and correlate our imaging results with clinical outcomes to determine the effective of ncDCT for predicting the area of mastectomy skin necrosis during surgery. The ultimate goal is to provide objective information for intraoperative alterations to significantly reduce mastectomy skin flap necrosis rates.

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