BI-01

**Acoustic Vortex for Confining and Enhancing Light Fluence**

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Although optical imaging and stimulation are widely used in biomedical researches, optical scattering from biological and neural tissue limit the depth to which externally focused light can penetrate tissue. To overcome this limitation, we propose that acoustic vortex can be used to focus the light within scattering media by creating local pressure differences created and result in refractive index contrasts. In this method, acoustic vortex was capable of producing a central null with zero amplitude surrounded by a high-pressure area to create an annular bubble wall via cavitation. As a result, our strategy would immediately create a lower refractive index area in the periphery of the focus to form an optical fiber like structure, where the photons are kept confined and relayed during its traveling. Through phantom experiments, we demonstrate that acoustic vortex was capable of reducing the beam width of laser by 50%, while the light fluence was improved for 15%. We also demonstrate that this technology could confine light through mouse brain tissue without directly action onto the sample, potentially avoiding the occurrence of inversible damage and improving the repeatability.

BI-02

**High Frequency Ultrasound Imaging for Hand Tendon Diagnosis**

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Neovascularization of injured tendon increases the healing in proliferative phase but also improper healing and painful if it prolonged presence. Currently, ultrasound Doppler imaging has been used for measuring the neovascularization of injured tendon, such as Achilles tendon. However, the resolution of the state-of-the-art clinical ultrasound machine is insufficient for visualizing the neovascularization in finger tendon. Therefore, a high frequency micro-Doppler imaging (HFμDI) based on a 40 MHz ultrafast ultrasound imaging was proposed for visualization of neovascularization in injured finger tendons during different rehabilitation phases in this study. The visibility of vessels was enhanced based on block-wise singular value decomposition (BWSVD) filter through several curvilinear structure enhancement strategies, including the bowler-hat (BH) transform and Hessian-based vessel enhancement filtering (VEF). The HFμDI was verified via small animal kidney and spleen imaging since the vessel structure patterns are well known in the mouse. A total of five patients with finger tenon injuries were involved for HFμDI examination at different rehabilitation phases after surgery (from 11-56 weeks), and the finger function evaluations were also carried out for comparisons. Small animal experimental results showed that the proposed HFμDI provides the excellent ability for microvasculature imaging, which the contrast-to-noise ratio (CNR) of HFμDI is higher about 15 dB than it from traditional SVD filter, and the minimum detectable vessel size is 35 $\mu m$ in mice kidney without injecting any contrast agent. In human study, neovascularization was observed obviously in injured finger tendons in the early phase of healing from 11-21 weeks, but it regresses after 52-56 weeks. The rehabilitation of finger seems to help reducing the neovascularization: neovascular density decreases about 1.8% to 8.0% in subjects after rehabilitation for 4 weeks. All the experimental results showed the ability of HFμDI for microvasculature imaging, which exhibits a high potential for injured finger tendon evaluation.

BI-03

**Artificial Intelligence-assisted Prognosis**

**Prediction of Perineural Dextrose Injection in Carpal Tunnel Syndrome Using Dynamic Ultrasonography**

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Perineural dextrose injection (PDI) is a promising treatment to alleviate symptoms for patients with carpal tunnel syndrome, a prevalent nerve entrapment disorder. However, PDI is an invasive procedure and a standardized method for predicting the treatment outcome prior to injection remains intractable. We aimed to develop a PDI recommendation system by assessing the correlation between dynamic ultrasonography of median nerve prior to injection with the patient outcome after injection using artificial intelligence. Specifically, we applied deep learning models successful in action recognition, such as R(2+1)D, C2D, and TimeSformer, to differentiate the pre-injection image sequences associated with improved outcome. These models achieved an average 85.71% accuracy in predicting post-injection outcomes based on pre-injection images. Inspecting the attention maps of trained model revealed that the neural network primarily predicts patient prognosis after PDI treatment based on the spatiotemporal features at the radial part of the subsynovial connective tissues encompassing the carpal tunnel during the dynamic maneuver. Our findings demonstrate the feasibility of predicting dextrose injection therapy outcomes using pre-injection ultrasound data, offering valuable guidance for physicians.

BI-04

**Wireless Capsule Endoscopy in Clinical Diagnosis Applications**

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Wireless capsule endoscopy (WCE) has revolutionized gastrointestinal diagnosis by offering a minimally invasive, patient-friendly alternative to traditional endoscopic techniques. This presentation delves into the integration of advanced technologies, such as small angle approaches and electrowetting liquid lens scanning devices, in next-generation capsule ultrasound devices. These innovations enhance WCE capabilities, allowing for detailed imaging and precise drug delivery within the gastrointestinal tract. By examining recent clinical applications and outcomes, we highlight significant improvements in diagnostic accuracy, patient comfort, and overall clinical efficiency. The discussion also addresses current challenges and future directions in the routine clinical adoption of WCE technology.

BI-05

**Fundamentals and Clinical Applications of Ultrafast Doppler**

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The core principle of ultrafast Doppler lies in its use of plane waves rather than focused beams on transmission. By emitting plane waves, the system can interrogate a larger region simultaneously, reducing acquisition time and increasing the frame rate. Ultrafast Doppler can capture thousands of frames per second, allowing for the detailed

visualization of rapid blood flow and complex hemodynamic events. In contrast, conventional Doppler ultrasound measures blood flow by emitting pulses of sound waves and detecting their echoes using focused beams, but its temporal resolution is limited. Additionally, because the plane wave transmissions enable a longer observation time, ultrafast Doppler can detect very slow blood flows. This technique also utilizes a singular value decomposition filter to separate flow signals from tissue signals, providing high-quality images of blood flow. Clinically, ultrafast Doppler has diverse applications. It is particularly valuable in cardiology for assessing coronary vascularization and in neurology for evaluating neonatal cerebral blood flows. Additionally, it has shown promise in oncology for characterizing tumor vascularity and in rheumatology for assessing synovial microvascularity. By providing detailed insights into blood flow, ultrafast Doppler enhances diagnostic accuracy and improves patient outcomes.

BI-06

## Emerging Ultrasound Technologies in Anesthesiology and Pain Medicine

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This presentation will begin with beamforming technology and electronic focusing, exploring the RCA-addressed 2D array transducer and its application in ultrasound-guided imaging for spinal puncture. Subsequently, it will discuss B-mode speckle reduction techniques, such as frequency compounding and tissue harmonic imaging, as well as clinical image post-processing simulation using CycleGAN and shear wave viscoelasticity mapping based on physics-informed neural network. Finally, the presentation will cover needle navigation technology and the prospects of CMUT in the field of ultrasonics.

BI-07

## Quality Assurance of Ultrasound Systems: QA Guidelines and QA Implementation Experience in CCH

*Shih Chih-Chieh*
*Changhua Christian Hospital Department of Biomedical Engineering*

The presentation highlights the significance of regular QA procedures for various stakeholders, including clinical physicians, medical engineers, ultrasound technicians, and hospital administrators. The presentation details the three stages of ultrasound probe QA: quality assurance checks, testing and validation, and repair and exchange.

It explains that regular QA ensures reliable imaging, which enhances diagnostic accuracy and prolongs equipment lifespan. The presentation also covers specific QA tasks such as routine equipment performance evaluations, identifying physical damages on probes, and ensuring proper cleaning and disinfection.

Further, the presentation discusses the American Institute of Ultrasound in Medicine (AIUM) routine QA tests, including those for probe performance and image quality, and provides practical guidelines for executing QA checks. It also emphasizes the importance of medical engineers' role in evaluating ultrasound systems, aiding in procurement decisions, and ensuring ongoing system accuracy.

The presentation concludes by providing resources and references for implementing an effective ultrasound probe QA program experience in CCH.

BI-P01

## Point-of-Care Ultrasound for Diagnosing B Cell Lymphoma in the Chest Cavit

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B cell lymphomas, including diffuse large B-cell lymphoma (DLBCL), represent a diverse group of neoplasms arising from B lymphocytes. While DLBCL is the most common subtype of non-Hodgkin lymphoma, its diagnosis within the chest cavity can be challenging. These lymphomas can manifest in various mediastinal and pulmonary locations. Symptoms may include cough, dyspnea, chest pain, or superior vena cava syndrome. Distinguishing B-cell lymphomas from other mediastinal masses is crucial for optimal management. Point-of-care ultrasound (PoCUS) has emerged as a valuable tool for early detection, characterization, and monitoring of chest cavity tumors. It provides real-time visualization of tumor location, size, and vascularity, differentiating solid from cystic components, and ensuring accurate tissue sampling. Here, we present a case report of a huge chest B-cell lymphoma that point-of-care ultrasonography (POCUS) demonstrates a well-demarcated mass with cystic components with areas of hemorrhage, necrosis, and SVC syndrome.