Methods: A 13-bit Barker code (pulse duration (PD) = 4.36 μs), a short chirp (PD = 4.49 μs), and a long chirp (PD = 8.98 μs) were programmed on the Vantage system (Verasonics Inc.) and compared with a CSP (PD = 0.33 μs). The Cramér-Rao lower bound (CRLB) was used to predict the SW SNR at given ultrasound radio frequency (RF) signal SNR. Two phantom experiments (with and without pork belly) were designed to test: 1) the penetration of SW detection; 2) the sensitivity to SW motion by gradually decreasing the SW motion; 3) and the robustness to weak RF signal by gradually decreasing the ultrasound transmit voltage. Then an *in vivo* liver case study was conducted on a healthy subject (BMI = 40) to compare the performance of the different pulses.

Results: The measured SW SNRs were all in good agreement with the theoretically predicted SNRs by CRLB. The phantom studies showed all CE pulses outperformed the CSP by providing SW signals with substantially higher SNR and a penetration gain of 2, 3, and 4 cm for the Barker code, the short chirp, and the long chirp, respectively. All CE pulses also showed superior sensitivity to small motion and robustness to weak RF signals, with the chirp long pulse providing the best performance. The *in vivo* liver study showed that all CE pulses could provide higher SNR SW signals from the liver than the CSP.

Conclusions: The results indicate that by using CE for SW detection, one can benefit from the ultrafast FR and large FOV provided by PWI while preserving good penetration and SW signal quality, which is essential for obtaining robust shear elasticity measurement of tissue.

2089030 Do Ultrasound Scanners Adequately Present the "Image Contrast Frequency" to the User

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Objectives: Frequency dependence of scattering has been widely discussed in the literature. Understanding that ultrasound (US) images are impacted by this dependence, a clear presentation of the frequency content in an image is essential. We propose the term, "image contrast frequency" (ICF) to represent the system's frequency response for a given scan configuration. The aim of this work is to assess whether the displayed frequency on the system monitor effectively reports a correct ICF.

Methods: A phantom with targets and background having well described backscatter coefficients (BSC) versus frequency was used. Targets exhibit significant, frequency dependent changes in scattering and thus, contrast versus the background. US scanners were operated in a fundamental mode of operation. B-mode images were acquired of the targets for a number of transducers operating at all available nominal frequencies. Background images covering the same depths were also acquired. For each frequency, image contrast between the cylinders and background was obtained. This allowed an estimate of the ICF, which was compared to the nominal image frequency available on the scanner during acquisition.

Results: Each target exhibited gray-scale contrast that varied with transducer and frequency setting. Estimates of ICF were often not consistent with the nominal transmit frequency presented on the scanner. As an example, using three different probes on the same scanner operating at "4MHz", different levels of target contrast were observed between probes, indicating that each probe was actually working at a different ICF. In particular, one target appeared hypo-, iso-, or hyper- (echoic), depending on which 4MHz transducer was used. Based on BSC's estimates of the ICF of the scanner could be predicted.

Conclusions: The ICF was demonstrated to not always correspond with the nominal transmit frequency, making the interpretation of changes in image contrast based on changes in parameters affecting frequency content in the image difficult. As all diagnostic modalities strive for better quantitative imaging and biomarker assessment, it might be useful to have available more standardized information about the frequency content in the images being presented.

2088809 Clinical Validation of the Statistical Analysis of US RF Signals in Differentiation of the Breast Lesions

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Objectives: The scattering is the fundamental phenomena used for US imaging of specific organs. In this study the method searching for best fitted statistical distribution of the acquired echoes from the breast tissue is discussed, especially addressing the "effective" number of scatterers. The aim of the study was finding the relationship between the specific properties of statistics of envelope of the ultrasonic echoes backscattered in the breast tissue in vivo, and its morphological properties for normal tissue and the pathological lesions.

Methods: 72 patients with 83 suspicious breast lesions (BIRADS 3, 4, 5) were examined. The analysis method was based on the parametric imaging representing a map of local statistical properties of the scattering of ultrasound waves in normal and pathological tissues. Both, the RF echo-signal and B-mode images from the lesions and surrounding tissue were recorded. The statistics of backscattered speckle-like echoes envelopes were modelled using K and Nakagami distributions. For all lesions the set of sub-ROIs covering full lesion was chosen. The statistical analysis was done for every sub-ROI separately. The shape parameters were calculated including the compensation for TGC applied and for the attenuation.

Results: The evaluation of all 83 breasts lesions revealed 23 malignant and 60 benign lesions. Typically, both, shape parameters for malignant lesions were statistically larger than for surrounding tissue. On the other hand, the benign lesions revealed much larger variance of the parameters comparing to the surrounding and malignant tissue. The sensitivity and specificity of B-mode imaging with the cut-off points BIRADS-4a/4b were 93%, 86%. For K and Nakagami distributions obtained sensitivity and specificity were respectively 85% and 91%.

Conclusions: The quantitative measurements of the breast tissue backscattering statistical properties improve the specificity of B-mode examinations and can be helpful in the differentiation the character of the breast lesions. It was proved that the range of the shape parameters appears to be rather large and can not be interpreted without taking into account the corresponding values in the surrounding "normal" tissue.

Contrast-Enhanced: 2

Moderators: David Cosgrove, MA, MSc, Paul Dayton, PhD

2083783 The Two Faces of Non-Invasive Diagnosis of Liver Disease Severity: Correlation Between Liver Stiffness and Hepatic Vein Arrival Times

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Objectives: The time a ultrasound contrast agent reaches the hepatic vein after intravenous injection is lower in cirrhotic patients. Transient elastography is directly related with liver stiffness .Aim of this study was to correlate the liver stiffness with HVAT.

Methods: Thirty consecutive patients affected by viral chronic liver diseases were enrolled. After a standard B-Mode examination, a bolus injection of 2.5 ml of Sonovue® (Bracco SpA, Milan, Italy) was injected. Using an ultrasound machine built-in contrast software, the intensity of a main hepatic vein was recorded from 20 seconds before (the basal enhancement trace) to 2 minutes after SonoVue® injection and we evaluated: the Hepatic Vein Arrival Time (HVAT), the Time To Peak (TTP) and the peak of contrast enhancement. Liver stiffness measurement was performed by FibroScan® (Echosens, Paris, France). All patients were measured using the 3.5 MHz standard M probe.

Results: Spearmann's coefficient of rank correlation between HVAT and liver stiffness was -0,399 (95% Confidence interval -0,664 to -0,0453, $p<0.05$) thus confirming the hypothesis that cirrhotic patients showed lower HVATs and higher values of liver stiffness. No significant correlation was observed among liver stiffness and TTP or the peak of contrast enhancement.

When endoscopic signs of Portal Hypertension (such as oesophageal varices or hypertensive gastropathy) were assumed to be as the gold standard of liver cirrhosis, Receiver Operating Curves (ROC) analysis demonstrated liver stiffness to have the best accuracy in diagnosing liver cirrhosis with respect to HVAT (Area Under the ROC [AUROC]: 0.972 vs. 0.781). Combining liver stiffness[3] 12.5 kPa and HVAT £ 18 seconds we reached a 100% specificity for the diagnosis of liver cirrhosis.Earlier HVATs and higher values of liver stiffness can be observed during the development of liver diseases.

Conclusions: Liver CEUS and liver stiffness showed a good accuracy and combining these tools a non-invasive diagnosis of liver cirrhosis can be reliability done.

2090095 Differential Diagnosis Between Benign and Malignant Gallbladder Diseases With Contrast-Enhanced Ultrasound

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Objectives: To analysis blood perfusion features and quantitative parameters of gallbladder diseases using contrast–enhanced ultrasound (CEUS). Furthermore, evaluate the value of CEUS in differentiating malignant from benign gallbladder diseases.

Methods: Sixty-four patients with suspicion of space-occupying lesions in the gallbladder via conventional ultrasound were examined by CEUS. CEUS was performed by GE LOGIQ E9 with High-fidelity Amplitude Modulation Contrast Imaging and Esaote Mylab 90 with contrast tuned imaging. Contrast agent SonoVue was used. The parameters of the time to enhancement, enhancement extent, morphology and pattern were recorded, furthermore observed the intactness of gallbladder wall, whether infiltrated adjacent hepatic parenchyma.

Results: Twenty patients showed no enhancement in gallbladder and diagnosed gallbladder sludge using CEUS. The remained 44 patients with gallbladder solid lesions were underwent surgery, twenty-two of whom were proved malignant by pathology, while the others were benign. (1) There was significant difference between malignant and benign diseases for the time to enchantment. Time to peak intensity had no significant difference between benign group and malignant group. (2) It was significant different between benign and malignant gallbladder diseases ($P<0.05$), which including their enhanced morphology, pattern and integrity of gallbladder wall. 70.0% (14/20) in malignant group revealed intactness of gallbladder wall destruction. The enhancement extent had no significant difference between benign and malignant groups. (3) The sensitivity, specificity and accuracy was 95.0% (19/20)、95.8% (23/24)、95.4% (42/44) respectively for the diagnosis of benign and malignant gallbladder diseases using CEUS, while sensitivity, specificity and accuracy was 70.% (14/20), 83.3% (20/24)、77.2% (34/44) respectively for conventional ultrasound.

Conclusions: CEUS can reflect different perfusion characteristics of malignant and benign gallbladder lesion, which shows a more confident diagnosis than conventional ultrasound. The CEUS can display gallbladder cancer to infiltrate the gallbladder wall and adjacent hepatic parenchyma.

2090059 Subharmonic and Endoscopic Contrast Imaging of Pancreatic Masses

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Objectives: There is an urgent clinical need to improve the detection and evaluation of pancreatic cancers. We undertook this project to demonstrate the feasibility of using subharmonic imaging (SHI) to depict pancreatic masses in humans and to compare results to contrast enhanced endoscopic ultrasound imaging (EUS) as well as to pathology as a first step towards that long-term goal.

Methods: Nine patients scheduled for an EUS guided biopsy of a pancreatic mass were enrolled in an ongoing, IRB approved study. Pulse inversion SHI