Albunex® and pipetted into a dialysis tubing exposure vessel that was rotated at 200 rpm while being exposed for 1 min. to 1MHz pulsed ultrasound (PRF = 20 Hz) with mean pressure amplitude 3.9 MPa (I_{SPPA} = 500 W/cm²). Eight identical runs were made for each tone burst duration: 0 (sham), 20, 100, 200, 500, and 1000 ms. Hemolysis was measured in the samples spectrophotometrically. Acoustic cavitation occurring within the vessel was monitored acoustically by a 20 MHz focused transducer. The average root mean squared (RMS) value of the received cavitation signal was recorded for each exposure. *RESULTS*: The percent hemolysis at a particular exposure setting correlated well (r = 0.97; n = 48) with the average RMS value during the insonification period. Hemolysis decreased with pulse length, suggesting that typical clinical exposures are safe. *CONCLUSIONS*: An acoustic system was developed to assess the amount of cavitation when diluted blood is exposed to intense ultrasound in vitro, and produced results in good correlation with hemolysis.

0406 Feasibility of Doppler Ultrasound Computed Tomography

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OBJECTIVE: To study the feasibility of a novel Doppler imaging technique for producing high-resolution cross-sectional quantitative images of blood velocity in a vessel. *METHODS*: Our method of Doppler ultrasound computed tomography (D-JCI) utilizes an acoustic transmitter, which illuminates the field of view of a ring of 256 transducers. By recording the detected complex amplitude as a function of time, Doppler information is extracted. By forming the receiver-receiver correlation matrix and solving for the object scattering matrix, a high-resolution cross-sectional map of flow velocities is obtained. Computer simulations and initial laboratory experiments using our custom ultrasound CI system have been made. *RESULTS*: Computer simulations and experimental results have shown that high resolution (A/2 or better) cross-sectional imaging is possible. Experimentally, we have obtained images of blood mimicking fluid flowing in latex tubing. The simulations have also shown that it may be possible to significantly reduce the number of transducers without appreciable image degradation and that the use of spectral estimation techniques may offer improved resolution. *CONCLUSIONS*: We have shown that in laboratory conditions the DUCT approach can produce high quality images and are currently working on a practical implementation, such as the use of sparsely spaced transducers arranged in an arc, for in vivo operation.

0407 Unsymmetrical Limited Diffraction Beams for Sidelobe Reduction

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OBJECTIVE: Limited diffraction beams have a large depth of field but high sidelobes. We want to reduce sidelobes of limited diffraction beams to improve contrast in medical imaging. *METHODS*: Unsymmetrical limited diffraction beams are obtained by taking derivatives of symmetric bearns along one lateral direction. The sidelobes of the resulting beams change with the radial angle. The one-way sidelobes at a radial distance of 25 mm are about –38 dB at the radial angle of 0 degrees, and –16 dB at an angle of 90 degrees (sidelobes for the zeroth-order symmetric X wave are about –18 dB at any angle). A pulse-echo imaging system could be constructed to transmit unsymmetrical limited diffraction beams and to receive echoes with the beam rotated electronically by 90 degrees, thus decreasing sidelobes significantly. *RESULTS*: Sidelobes of the above pulse-echo system are about –51 dB and –42 dB at the radial angles of 0 and 90 degrees, respectively, as compared to –36 dB for the zeroth-order X wave. The –6 dB beam width is about 2 mm and the depth of field is about 150 mm at the central frequency of 3.5 MHz. *CONCLUSION*: The sidelobes of limited diffraction beams can be reduced with unsymmetrical beams. This may improve the contrast of medical imaging with limited diffraction bearns. This work was supported in part by CA 43820 and CA 54212 from the National Institutes of Health.

Ophthalmology

1200 Variability of Normal Central Retinal Artery Velocity Measurements

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OBJECTIVE: Central retinal artery velocity (CRA) measurements with color-flow and pulsed Doppler are being used to diagnose ischemic optic syndromes. We studied the reproducibility of velocity measurements in the CRA in normal subjects. *METHODS*: Eleven subjects were studied with a Q2000 (Siemens-Quantum) 7.5 MHz linear array. Pulsed Doppler measurements of CRA velocity were made in the intraneural segment of the artery. 2D color flow images were also analyzed with a threshold control that allows the operator to select a level above which all velocities are colored green. *RESULTS*: The peak systolic velocity in the CRA increased from an average of 8.16 cm/sec to 13.9 cm/sec (range, 5.8 to 22.5) as the sample volume was moved toward the retina. Maximum velocity occurred at 1.8 mm from the disc. Threshold green coloring also showed maximum velocity at 1.8 mm from the disc. *CONCLUSION*: There is an average velocity increase of 70% in the distal CRA of normal subjects as it approaches the lamina cribrosa and optic disc. Definition of abnormal flow patterns in the CRA must take this normal variation into account.

1201 Color Doppler Imaging in Central Retinal Vein Occlusion: Prediction of Iris Neovascularization

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OBJECTIVE: Central retinal vein occlusion (CRVO) is a common cause of sudden visual loss and can occur at any age. Accurate diagnosis is essential as separation into ischemic and non ischemic forms has prognostic significance, the former being at risk of developing iris neovascularisation and further visual deterioration. *METHOD*: A prospective trial was conducted in which 80 patients with CRVO and 95 control subjects were investigated by color Doppler ultrasound. Ophthalmoscopy, relative afferent pupillary defect (RAPD), fluorescein angiography, and electroretinography (EEG) were also performed to estimate the degree of retinal ischemia. The ultrasonologist was masked to the clinical findings. *RESULTS*: A marked reduction in venous velocity was recorded from the central retinal vein of the affected CRVO eyes when compared with the fellow eyes and controls ($P < 0.0001$). This reduction was most marked in those eyes with ischemic CRVO. Furthermore, a velocity of $< 3\ cms^{-1}$ in the central retinal vein predicted iris neovascularization with a sensitivity of 75% and specificity of 86%. *CONCLUSION*: These initial results suggest that color Doppler imaging may have a role in the assessment of CRVO. It can predict the development of iris neovascularization and is superior in this respect to conventional tests.

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