607 A Two-Dimensional Array System for Studies of Ultrasonic Imaging with Aberration Correction

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OBJECTIVE: To describe a two-dimensional array system for pulse-echo studies of aberration correction. *METHODS*: The transducer array is 80 × 80 with a center frequency of 3.0 MHz and a –6 dB bandwidth of 56%. At the center frequency, each element has a physical size of 1.04 wavelengths and spacing of 1.2 wavelengths. A multiplexer accesses any contiguous 128 elements for transmission and any contiguous 16 elements for simultaneous reception. Transmit electronics have independently programmable waveforms. Each receive channel includes a 20 MHz, 12-bit A/D converter, and a time varied gain programmable over 40 dB. Transmit and receive apertures up to the size of the array are formed synthetically. *RESULTS*: A method that iteratively predistorts transmit waveforms to produce a transmit focus compensated for aberration has been implemented. Point-spread functions have been measured for propagation through a water path and through a tissue-mimicking aberration path. Pulse-echo images have been formed through a water path, through a tissue-mimicking aberrator, and through the aberrator using aberration correction that consists of time-shift compensation in the transmit-receive aperture or backpropagation followed by time-shift compensation. *CONCLUSIONS*: The system is useful for pulse-echo measurements of aberration, development of adaptive focusing techniques, and formation of high-resolution ultrasonic images using aberration correction.

608 Mechanical Scanning of High-Intensity Focused Ultrasound for Hemostatic Treatment of Lacerated Blood Vessels

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OBJECTIVE: We have demonstrated that high-intensity focused ultrasound (HIFU) could successfully cauterize surgically exposed bleeding punctured blood vessels. Studying more severely damaged vessels, we investigated the use of mechanical scanning to achieve a broader distribution of intense HIFU energy for effective and rapid hemostasis. *METHODS*: Longitudinal incisions of 2–8 mm length were made in vessels of four anesthetized pigs. A 3.5 MHz spherically concave-shaped HIFU transducer (35 mm diameter, 55 mm radius of curvature, 55 mm focal depth, with a 1 mm × 10 mm focal region) was used. An electromechanical vibrator was attached to the transducer. This scanned the beam over a 5–10 mm displacement dimension, at a rate of 15–25 times/sec, thus broadening the region of heating. *RESULTS*: In 76 lacerations, and treatments, an approximately 80% reduction in the bleeding rate in all, was achieved in an average time of 17 sec. Most of the initial bleeding was quite profuse and would have been life threatening if left unabated. Complete hemostasis was achieved in 91% of the vessels with an average treatment time of 25 sec. Vessel patency was preserved in 74% of the cases. *CONCLUSIONS*: Rapidly distributed HIFU energy may provide an effective method of hemostasis in lacerated blood vessels.

606 Nonlinear Processing for High Frame Rate Imaging

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OBJECTIVE: To study the effects of nonlinear processing of high frame rate images (up to 3750 frames or volumes/sec for biological soft tissues at a depth of 200 mm) obtained with the Fourier method developed recently with limited diffraction beams. *METHODS*: Three methods of nonlinear processing are used to process the high frame rate images. The first is to used frequency compounding where the RF signals are divided into multiple narrow-band signals and resulting envelope images are superposed to form a new image. The second is to superpose envelope images obtained with different Axicon angles of X waves. The last is to average the overlapping regions of the envelope images obtained at a few steering angles. *RESULTS*: The contrast of the images obtained with the nonlinear processing methods mentioned above is increased greatly and speckles are reduced dramatically. *CONCLUSIONS*: The high frame rate imaging has a potential to obtain high contrast images at a conventional frame rate (about 30 frames/sec).(This work was supported in part by the grant HL60301 from the National Institutes of Health.)

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