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EVALUATION OF INFLUENCE OF ULTRASOUND EXPOSURE PARAMETERS ON NECROTIC LESIONS INDUCED IN TISSUE BY A ROBOTIC ULTRASOUND-GUIDED HIFU ABLATION DEVICE

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OBJECTIVES
Ultrasound Imaging-guided High Intensity Focused Ultrasound (USIgHIFU) technique is dynamically developing thermal technology for treating solid tumors due to its non-invasion and non-ionization nature, repeatability and fewer complications after treatment. We have designed and built a robotic USIgHIFU device for destroying solid tumors in small animals. Before the device is used, a series of experimental studies on tissues ex vivo were needed to assess the location and extent of necrotic lesions. The objective of this studies was to investigate the influence of sonication parameters on the location and extent of necrotic lesions induced in the tested tissue during exposure less than 3s. The results of this studies were necessary to determine the step and speed of the HIFU beam movement to cover with necrosis the whole treated tissue volume.
METHODS
The HIFU beam was generated by a bowl-shaped, 64 mm transducer (f-number 0.98) with a 20 mm central hole, operating at a 1.08 MHz or 3.21 MHz frequency. Multiple thermal lesions were created within pork loin tissue ex vivo at a depth of 12.6 mm below its surface during 3 s of exposure. The in situ intensity estimated assuming nonlinear propagation model was about 700 W/cm2. Beams with the same duty-factor and varying pulse duration (30 μs - 300 ms) as well as with the same pulse duration and varying duty factor (0.2 - 0.8) propagated in two-layer media: water / tissue (50 mm / 40 mm) were studied.
RESULTS
Dependence of lesion dimensions on frequency, pulse duration and duty-factor was determined.
CONCLUSIONS
Lesion extent depended strongly on frequency and duty-factor, but slightly on pulse duration. The lesions created by shorter pulses were hardly visible on ultrasound images. Based on the experimental results the HIFU beam acoustic parameters, the step and speed of its movement to cover the whole treated tissue volume were designated.
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Keywords
ultrasound imaging-guided HIFU, ex vivo tissue, robotic system