

Non-invasive HIFU treatment of the liver using a toroidal transducer. Large and fast ablation in an *in vivo* porcine model

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Background

A toroidal transducer was developed and is currently used clinically to treat liver metastases intraoperatively. We now aim to use this toroidal device noninvasively. One of the innovative aspect of our approach consisted in adjusting the energy emitted by the transducer to take into account the attenuation and the thickness of intervening tissues to prevent any secondary lesions. An *in vivo* study was conducted in the liver using a porcine model for creating safe, large and fast ablations allowing to use the device by hand.

Materials/Methods

The diameter and the radius of curvature of the toroidal transducer were 70 mm. The toroidal transducer focused the beam on a circle of 30 mm in diameter. The operating frequency was 2.5MHz. The transducer was divided into 32 concentric rings of equal surface. An ultrasound imaging probe operating at 7.5 MHz was placed in the center of the HIFU transducer. An *in vivo* trial was conducted in nine animals that were followed for over 7 days after HIFU exposure. The applied energy was adjusted according to the thickness of intervening tissues and the corresponding attenuation.

Results/Discussion

The thickness of intervening tissues was on average 14.9 ± 2.0 mm. The delivered acoustic energy ranged between 3870J to 7000J. HIFU ablations were visible in ultrasound images. The dimensions of the HIFU ablations were 21.2 ± 6.0 mm long by 14.7 ± 5.3 mm large and correlated with the dimensions measured in ultrasound images ($r=0.91$, $p<0.05$). No skin burns were observed. Treatment was well tolerated over 7 days. Therefore, HIFU a treatment of the liver is safe and feasible using a toroidal transducer. Large volumes of ablation were obtained in less than one minute without resorting to mechanical scanning, allowing to use the device by hand. Treatment parameters are strongly sensitive to the thickness and to the attenuation of intervening tissues.