Evaluation of the attenuation coefficient of primary and secondary human liver tumours recovered from hepatectomy. Impact on High Intensity Focused Ultrasound (HIFU) treatments.

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Background, Motivation and Objective

High Intensity Focused Ultrasound (HIFU) is a non-invasive technique allowing the treatment of several pathologies by thermal ablation. In particular, it is a promising modality in the treatment of Hepatocellular carcinoma (HCC) and metastasis in the liver. The knowledge of the attenuation coefficient is essential to adjust treatment parameters but remains not well documented, mainly for human tissues. In this study, the attenuation coefficients of primary and secondary liver tumors, as well as the surrounding liver were measured in Human samples recovered from hepatecttomy. Numerical simulations were performed using these values to estimate their effect on HIFU treatments.

Statement of Contribution/Methods

Nineteen samples were used in this study. Twelve samples contained liver metastases and seven samples contained primary liver tumors. The acoustic properties were determined using a pulse-echo setup, where a broadband unfocused piston transducer with a diameter of 13 mm and a centre frequency of 2.25 MHz was axially aligned with an acoustic reflector. The transducer and the reflector were spaced 100 mm apart using a customised mechanical part. The pulse-echo transducer was driven by a pulser/receiver. Several measurements were performed only in the surrounding liver only and then in through the tumor in order to determine the attenuation coefficient of both. Backscattered signal from the tissue and the reflected pulse were recorded so that the attenuation coefficient and the thickness of the tissue can be computed. Numerical simulations were performed for each case using a homemade software in order to estimate thermal ablation that can be created using a spherical HIFU transducer in both primary and secondary liver tumors.

Results, Discussion and Conclusions

The average values of the attenuation coefficients in primary liver tumors and in liver metastases were $0.08 \pm 0.03\, Np.cm^{-1}.MHz^{-1}$ and $0.20 \pm 0.04\, Np.cm^{-1}.MHz^{-1}$ respectively. The attenuation coefficient of the liver containing metastases was $0.08 \pm 0.04\, Np.cm^{-1}.MHz^{-1}$. In the case of cirrhotic livers, the attenuation coefficient was $0.16\, Np\, cm^{-1}\, MHz^{-1}$. In all cases the frequency dependence of attenuation was in the range of 1 to 1.5. The resulting temperature/ablation profiles produced by the same insonation parameters were two times larger in liver metastases when compared with primary tumors. This is due to the higher attenuation in liver metastases when compared to the background liver. Treating primary or secondary liver tumors should be performed with completely different parameters taking into account specific attenuation of each tissues.