Optimal heating strategies for a 2D phased array transducer: a numerical and experimental investigation

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Introduction

The increase in single lesion size and reduction of total treatment time are two important practical goals in MR guided Focused Ultrasound Surgery (MRgFUS) for the treatments of large and irregular shaped tumours. Since the single element focused ultrasound transducer is faced with insurmountable problems in achieving these two goals, the phased array transducer has been identified as the most promising solution.

Materials and Methods

In this study, 2D/3D finite element method has been used to solve the acoustic patterns, the 'loss' patterns, the thermal patterns (temperature and thermal dose), and etc, for a 1024-element, 2D phased array transducer (Insightec Ltd., Israel). Especially, strongly focused sonication patterns and multi-foci sonication patterns with well controllable focal length and lesion size were studied respectively. Rapid acoustic characterization were performed to validate the beam steering, and ex vivo experiments on phantom/tissue were also conducted using the ExAblate® 2000/2100 system combined with the GE 1.5T MRI scanner.

Results and Conclusion:

Both numerical and experimental results showed that the heating efficiency could be significantly improved when using appropriate heating strategies, and the outcome also showed high robustness to various driving pressure and heating duration combinations. This study presents useful information in the treatment of large tumours, and may potentially offer solutions for the problems encountered with the transcostal focused ultrasound applications.