Effect of logarithmic compression on ultrasonic Nakagami imaging for monitoring of microwave ablation

Shan Wu, Xuewei Wang, Shaoqiang Shang, Ranxiang Xu, Xuewei Qin, Lei Zhang, Junbo Duan, Supin Wang, Mingxi Wan and Siyuan Zhang

The Key Laboratory of Biomedical Information Engineering of Ministry of Education, Department of Biomedical Engineering, School of Life Science and Technology, Xi'an Jiaotong University, Xi'an 710049, PR China.

Background, Motivation and Objective

The effectiveness of clinical microwave ablation (MWA) is dependent on the development of monitoring imaging, such as magnetic resonance imaging (MRI), computed tomography (CT) and ultrasonic imaging. Our previous study suggested that ultrasonic Nakagami imaging has the potential for monitoring of MWA. Logarithmic compression is typically utilized in current ultrasonic imaging systems to enhance the magnitude of weak ultrasonic echoes. The purpose of this study is to evaluate the effect of logarithmic compression on ultrasonic Nakagami imaging for monitoring of MWA.

Statement of Contribution/Methods

Ex vivo and *in vivo* microwave ablation experiments were performed on porcine livers using a clinical MWA system (MH-1Y, M&Y Electronic Limited Corp, Beijing, China) at 2450MHz±50MHz with electrical power of 40-70W for 5 minutes. Radio frequency (RF) data were obtained before and after MWA, to calculate Nakagami parameter m and m_{log} before and after logarithmic compression and build ultrasonic B-mode and two types of Nakagami parametric images. After MWA, photographs of tissue section were taken, and then the contrast-to-noise ratio (CNR) parameter between thermal lesion and surrounding normal tissue was calculated.

Results/Discussion

The mean value of m varied from 0.66 to 0.35 in *ex vivo* liver after MWA, and from 5.08 to 6.22 for m_{log}. Meanwhile, the mean value of m increased from 0.80 to 0.91 in *in vivo* liver after MWA, and from 5.81 to 7.49 for m_{log}. The area of thermal lesions in Nakagami images after logarithmic compression increases with time during MWA treatment. Ultrasound Nakagami images with logarithmic compression outperformed those without for detecting and monitoring of thermal lesion. CNR values of *ex vivo* and *in vivo* liver ranged from 0.45 to 0.63 and 0.49 to 0.52 without logarithmic compression. CNR values increased from 0.34 to 1.40 and 0.55 to 1.21 with logarithmic compression. This work shows that ultrasonic Nakagami imaging with logarithmic compression has the potential as an ultrasonic imaging tools in clinical MWA treatment.

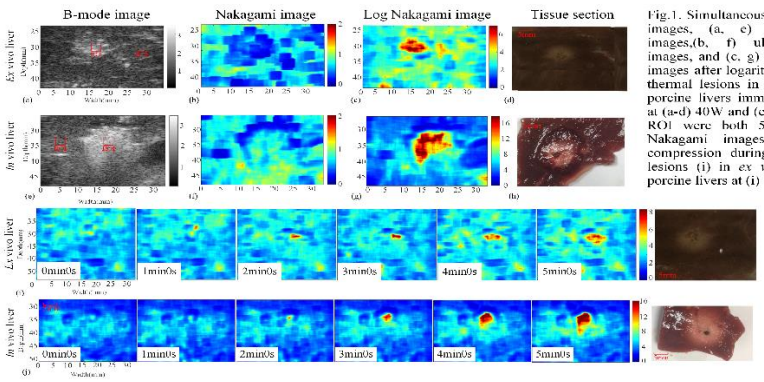

Fig.1. Simultaneous (d, h) tissue section images, (a, e) ultrasonic B-mode images,(b, f) ultrasonic Nakagami images, and (c, g) ultrasonic Nakagami images after logarithmic compression of thermal lesions in *ex vivo* and *in vivo* porcine livers immediately after MWA at (a-d) 40W and (e-h) 70W. The size of ROI were both 5×5 mm. Ultrasonic Nakagami images after logarithmic compression during MWA of thermal lesions (i) in *ex vivo* and (j) *in vivo* porcine livers at (i) 40W and (j) 70W.