Real-time monitoring of tissue property in a liver phantom using an internal electrode and weighted frequency difference conductivity during microwave ablation

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Abstract: We measured the time difference and weighted frequency difference conductivity images to monitor the changes of temperature and tissue property in a liver phantom due to the microwave ablation. Pixels in regions of interest were compared between conventional boundary surface electrode method and focused configuration with an internal electrode.

1 Introduction

Image-guided thermal therapy has been used for treating of focal metastatic hepatic tumours instead of the standard surgical resection because it is minimally invasive. In order to improve the safety and predict the local recurrence, it requires real-time monitoring method for temperature changes and the tissue property changes *via* successive images. MRI is a good candidate to monitor the internal temperature and property of the tissue with a high resolution. However, it is limited by MR compatible ablation method and cannot confirm the status of tissue after treatment immediately [1]. Ultrasound has a merit for applying ablation and monitoring together, but it required well-trained operator and interpretation [2]. Since the time series of bio-impedance and its spectrum can present temperature changes and tissue property changes together, time-difference and frequency-difference conductivity imaging method may be proposed to monitor them during ablation [3]. In this study, we used an internal electrode and weighted frequency difference conductivity images to improve the sensitivity and estimation for ablated region during microwave ablation.

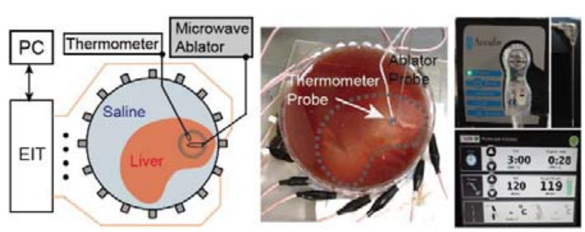

Figure 1: Liver phantom for experiment.

2 Methods

The experimental setup for EIT monitoring with a liver tissue during microwave ablation is shown in Figure 1. Ablation was performed with a frequency of 2.45 GHz (Sulis VpMTA generator, Microsulis Medical Ltd, Denmead, UK) and delivered using a 1.8 mm diameter needle-shaped applicator (Accu2i pMTA applicator, Microsulis Medical Ltd, Denmead, UK). We inserted microwave applicator tip into *ex-vivo* porcine liver (~500g), situated in a cylindrical tank filled with physiological saline (0.9%). 16-channel KHU Mark2.5 EIT system was connected to electrodes surrounding the tank [4]. A thermometer tip was placed beside of applicator tip to record the temperature of heating zone. We applied the ablation as 60W power in 2mins. Data was acquired at 10 and 100 kHz in a scan using dual frequency projections. Time difference and frequency difference images were reconstructed with EIDORS and weighted frequency difference algorithm. We compared the sensitivity and region estimation from the reconstructed images with and without using an internal electrode.

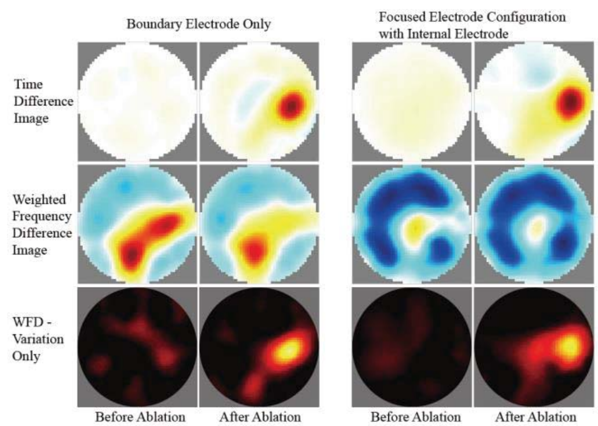

Figure 2: Time difference and weighted frequency difference conductivity images with and without using an internal electrode.

3 Conclusions

We performed the experiment using dual frequency EIT during microwave ablation in *ex-vivo* porcine liver. Time difference image provide conductivity changes due to the temperature changes. On the other hand, weighted frequency difference images showed conductivity change associated with cellular changes better. And when we use focused electrode configuration with an internal electrode, SNR is better in the regions of interest.

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