Ultrasound-guided Characterization of ablated Tissue Using RF Time Series

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Thermal ablation therapy is a minimally invasive procedure for localized cancer treatment. One of the current challenges in the application of this procedure in clinic is accurate monitoring of the ablation zone to avoid necrosis of healthy tissue, and enable complete targeting of tumours. Recently, our group has proposed a tissue characterization method that uses RF time series signals acquired from stationary tissue and transducer following continuous irradiation of the tissue over a few seconds. This method has been effectively used to distinguish between various tissue types, including healthy and cancerous prostate tissue.

Here we report the application of RF time series for characterizing ablated tissue. RF time series echo signals are acquired prior to and following high intensity ultrasound ablation from ex vivo tissue samples. We calculate time and frequency domain features of the time series, and correlate them with ablated and non-ablated tissue properties in a supervised framework. The results show promising classification accuracies for characterizing ablated tissue. We also investigate the physical process underlying the interaction of the time series with the tissue. It is shown that acoustic propagation in tissue increases temperature where its rate of change is tissue-dependent. The change in temperature, in turn, alters tissue sound speed and causes virtual displacement of backscattered signals. In summary, the results of this study suggest RF echo time series as a promising approach for characterizing ablation, and capturing the changes in the tissue microstructure as a result of heat-induced necrosis.