Acoustical evaluation of disease-related fatty acid species with 250-MHz ultrasound

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Background, Motivation and Objective

Accurate discrimination of Non-alcoholic steatohepatitis (NASH) from simple steatosis (SS) is a critical issue in current clinical practice. To successfully diagnose NASH by ultrasound, a better understanding of the relationship between tissue-specific acoustic properties and pathological features is required. A previous study with 80-MHz has demonstrated that acoustic impedance has a possibility to evaluate fatty acid in liver. Since disease related cell degeneration occurs in a scale of cell (or subcellular scale), it is also necessary to understand at cellular-scale. This paper investigated the relationship among fatty acid species in liver and acoustic impedance of diseased livers with 250-MHz ultrasound.

Statement of Contribution/Methods

A total of 13 specimens enucleated from surgery were enrolled to this study. They have different etiology and different histological characters (fibsrosis stage, grade of steatosis). Acoustic impedance (Z) assessment with fresh samples were demonstrated using a customized scanning acoustic microscopy (SAM) system (modified AMS-50SI, Honda electronics, Japan) equipped with 250-MHz transducer (Fraunhofer IBMT, Germany). The value of Z of fresh samples put on 50-um thick polystyrene film dish (PS film dish, Menicon, Japan) was estimated from surface-echo amplitude. To correct the film flexibility-related error in amplitude, TOF based correction was conducted. Fatty acid quantity in the specimen was also investigated with gas chromatography (GCMS-QP2010Ultra, Shimadzu corporation, Japan).

Results/Discussion

Two dimensional Z image in Fig.1 shows the contrast which is considered to be fiber. Fatty acid composition is higher in Palmitate acid (PA) and DHA in the NASH group compared to the SS group. Z was significantly lower in the NASH group compared to the SS group $(1.76 \pm 0.007 \text{ vs}, 1.84 \pm 0.02, 1.84 \pm 0.02)$ p=0.011). Compared to our previous work which measured fatty acid solution, Z of PA, DHA were significantly lower than the standard solution, and considered to be a factor of these difference between NASH and SS. These results suggests that the capability of acoustic impedance evaluation with 250-MHz, and it might be possible to investigate fatty acid species in the liver, which specific to disease state with ultrasound.



stained by masson trichrome (right). Navy color represents the position of fiber.