Investigation of 3D Lava-flex in fat fraction estimation for patients with hepatic iron-overloading

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Purpose To investigate the use of 3D Lava-flex in fat fraction estimation for patients with liver iron-overloading.

Introduction Knowledge of fat content in liver is not only useful for diagnosis of hepatic disease but also valuable in monitoring recovery and assessing treatment effectiveness. Dual echo 2D spoiled gradient echo (SPGR) is a routinely used sequence for obtaining the quantitative fat fraction by deriving the signal intensity ratios of in-phase and out-of-phase images. However it may fail for patients with liver iron-overloading that leads to substantially shortened T2*, and as a result in the in-phase images suffer from low SNR that affects the accuracy of calculation. Patients with hematopathy that receive metachysis treatment are examples of this. In this study, we investigate if the 3D (liver acquisition with volume acceleration) LAVA-flex sequence may be an iron overloading immune method for fat fraction assessment in patients diagnosed with hematopathy.

Method Comparing to dual echo 2D SPGR, 3D Lava-flex [1] has several technical advantages: 1) it is a 3D acquisition that features intrinsically higher SNR; 2) the 3D k-space sampling strategy has been optimized to reduce the overall scan time within a single breath hold to avoid potential motion artifacts; 3) an B0 inhomogeneity insensitive excitation RF is used; 4) instead of using the potentially low SNR in-phase and out-of phase magnitude images alone, phase maps that contain information of chemical shift are also used in deriving fat and water images. To assess the accuracy of the fat content measurement using 3D Lava-flex, hepatic MRS was included as the gold-standard for comparison. Fat fractions are respectively derived using (1) and (2) for Lava-flex and MRS.

$$FFFF_{Lava} = \frac{Fat}{Water+Fat} \times 100\% \ (1) \qquad FF_{MRS} = \frac{Area\ under\ fat\ peak}{Total\ area\ under\ fat\ and\ water\ peak} \times 100\% \ (2)$$

Experiment A total number of 37 patients with hematopathy who received repeated metachysis were recruited for this study. Two MR exams were scanned for each subject on the same day and written informed consent was obtained from subjects prior to the scans. The scan parameters for the Lava-flex were: TR/TE=3.9/1.8ms,matrix=320×320x50, FOV=32x32x20cm.z. The overall scan time was 15s that allows completion within a breath hold. The imaging parameters for MRS were: TR/TE=5s/35ms. An 8mm voxel was placed in the hepatic region avoiding vascular and biliary structures, no water suppression was performed.

Results **Fig.1** shows correlation of fat fractions obtained using Lava-flex ($FF_{LAVA\text{-}Flex}$)and those obtained using MRS (FF_{MRS}) for 37 patients examined, a strong correlation was observed (r=0.9422, P < 0.001) suggesting high consistency between the measurements. **Fig.2** (a-d) respectively shows the water, fat, out-of-phase and in-phase images obtained in a 21-year-old patient diagnosed with aplastic anemia. It was difficult to assess the presence of fat in liver in this case as the in-phase image (**Fig.2d**) has much lower signal intensity compared to that of out-of-phase (**Fig.2c**). On the other hand, the fat image (**Fig.2b**) shows that the hepatic signal in the liver is higher than that in the spleen, based on which we may infer the presence of fat. This is confirmed by looking at the derived fat fraction map (**Fig.2e**) that a considerable portion of liver did have a fat fraction up to 25%. **Fig.2f** shows the hepatic MRS measurement within the rectangle, which also confirmed the presence of fat infiltration in the liver.

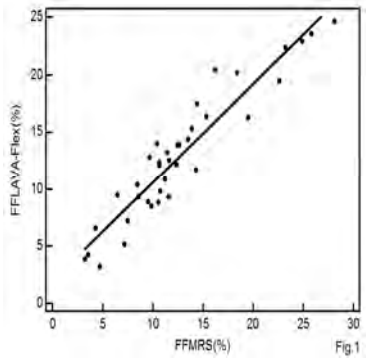

Figure 1 correlation of fat fractions within ROIs obtained using Lava-flex and MRS

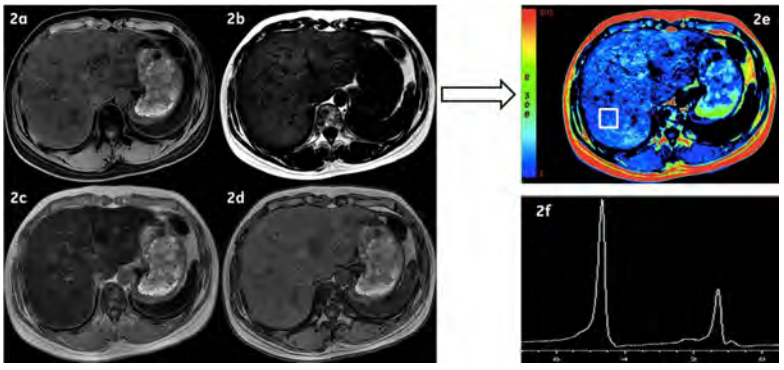

Figure 2 (a) water (b) fat (c) out-of-phase (d) in-phase images obtained in Lava-flex; (e) fat fraction map obtained using lava flex; (f) MRS of selected ROI showing fat and water peaks

Discussion and conclusion Conventional dual echo 2D FGRE acquisition may fail to supply accurate estimation of hepatic fat content when liver iron-overloading is present. MRS may provide reliable measurement of the fat fraction, however is limit by the intrinsic low spatial resolution and long time in practice. Lava-flex is specifically designed to provide robust estimate of fat and water map in liver. In this work, we have demonstrated with a patient population of 37 that the fat fraction obtained with Lava-flex have good agreement with those obtained with MRS, hence may be used as a routine diagnosis tool.

Reference [1] X.H. Li, et al, JMRI, 2013.