INTRODUCTION: Liver lipid content is known to be altered by the oral intake of polyunsaturated fatty acid (PUFA) and monounsaturated fatty acid (MUFA) [1]; however, the temporal relationship between the unsaturated lipid intake and liver lipid profile change is remains largely unclear. Choline is known for its essential role in the removal of the excessive lipid from liver, and the plasma choline concentration decrease is in conjunction with hepatic steatosis in patients receiving long-term lipid infusion (e.g., as parenteral nutrition) [2]. No study has determined the liver choline dynamics in response to the acute lipid nutrition) [2]. However, no study has determined the liver lipid profile in response to the acute lipid intake. The liver proton MR spectroscopy (MRS) is typically used for quantifying lipid content [3, 4]. Previous MRS studies have reported the quantifications of liver lipid profile [5, 6] and liver choline in vivo [7, 8]. This study aimed to examine whether dynamic proton MRS can assess the time courses of liver choline level and lipid profile in response to the acute lipid intake.

MATERIALS AND METHODS: Male Sprague-Dawley rats (~350g, n=4) were infused with 0.9 ml heparinized saline followed by 10 ml 20% Intralipid (with 20U heparin/ml, 0.1 ml/min) via tail vein. During experiment, rats were anesthetized with 1.5% isoflurane, mechanically ventilated and kept warm at 37°C. MR experiments: All experiments were performed on a 7T MRI scanner. A stimulated-echo (STEAM) based single-voxel MRS sequence with echo time (TE) of 3 ms was used for spectra acquisition with respiratory triggering. Note that such short TE was chosen to minimize T2 weighting. Other parameters were TE=2 s, NEX=512, voxel size=4×4×4 mm3.

Data Analysis: Individual frequency realignment and phase correction were applied to the 512 FIDs before the average in order to mitigate the motion induced signal loss and spectral broadening. Spectral analysis was performed using the JMRUI software package. Ten spectral resonances were quantified by fitting the spectrum to a Gaussian line shape using the AMARES algorithm. Six fitted data points with SNR<1 or severe motion contamination were excluded from further analysis. For statistic analysis, a two-tailed paired t-test was used.

RESULTS: Figure 1a shows the drastic increase of seven lipid peaks and the peak of glycerol backbone during and after the lipid infusion. Figure 1b shows the dip of choline peak amplitude immediately after the 100 mins lipid infusion. In Figure 2, the residual spectrum after fitting was relatively flat, suggesting good fitting quality. In Figure 3a, the hepatic lipid level drastically increased after the lipid infusion, i.e., from 49.5±9.8 at 0 mins to 171.1±6.8 at 220 mins (p<0.001). In Figure 3b, the choline level significantly decreased from 3.3±0.7 at 0 mins to 2.6±0.9 at 120 mins (p<0.01) and 2.5±1.0 at 140 mins (p<0.05). The choline level was significantly increased after 140 mins, i.e., 3.5±0.9 at 180 mins vs. 2.6±0.9 at 120 mins (p<0.01). No apparent changes in the fraction of total unsaturated lipid were observed. In Figure 3d, the estimated fractions of PUFA consistently increased in four rats, while the MUFA deceased, as a result of the paired t-test was used.

CONCLUSION: Our preliminary results suggested that dynamic proton MRS could measure the changes of choline level and lipid profile in normal rat liver with acute intravenous lipid infusion.