Lipid Assessment With Magnetic Resonance Imaging And Magnetic Resonance Spectroscopic Imaging

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Introduction

Obesity is epidemic in the United States and Europe, which may be associated with various forms of heart disease such as coronary artery disease and diabetes. In this study, we investigated MR methods for myocardial lipid assessment. Specifically, we assessed the relationship of MR signal to fat concentration on lipid phantoms with magnetic resonance imaging (MRI) by combining chemical shift and inversion recovery methods in order to suppress water. The mean signal intensity showed near linearity proportional to lipid concentration. We also assessed myocardial lipid distribution *in vivo* in a short time with Gaussian weighting magnetic resonance spectroscopic imaging (MRSI). Using MRSI, both intramyocellular lipid (IMCL) and extramyocellular lipid (EMCL) could be assessed.

Method

The signal of magnetic resonance imaging mainly comes from water and fat. The main component of fat is tryglyceride. There is 3.5ppm chemical shift difference between water and tryglyceride [1]. Prior to imaging of the fat distribution, the signal from water was suppressed in two ways: 1)Water was suppressed by exciting water magnetization and spoiling it. 2) water was saturated by using an appropriate inversion recovery time to null water magnetization since water has a long T1 relative to fat. By combining both chemical shift and T1 weighting, water was successfully suppressed to the noise level on lipid phantoms as shown in Fig 1. Lipid signal intensity showed near linearity proportional to lipid concentration[1]. To distinguish between intramyocellular (IMCL) and extramyocellular lipid(EMCL), MRSI was used to assess myocardial lipid distribution *in vivo* on 1.5T Magnetom Sonata (Siemens Medical Solutions, Erlangen, Germany). Gaussian weighting in k-space was used in order to increase signal-noise ratio and reduce acquisition time[2][3][4][5]. Gaussian weighting has higher signal-noise ratio than uniform acquisition and takes about half of uniform acquisition time. It has less voxel contamination in comparison to sinc weighting if using full width at 1/9 maximum as threshold to discriminate between the signal inside the voxel and outside the voxel. Data of free induction decay (FID) was acquired *in vivo* right after 1000μs gradient duration. TR=750ms.

Result

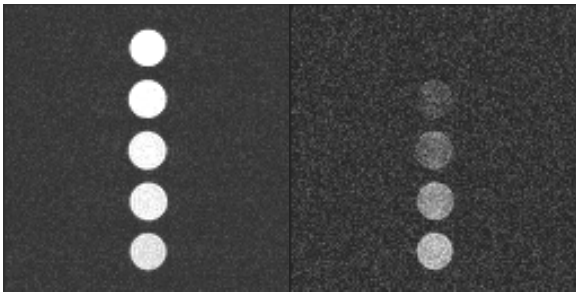

Figure 1 A B

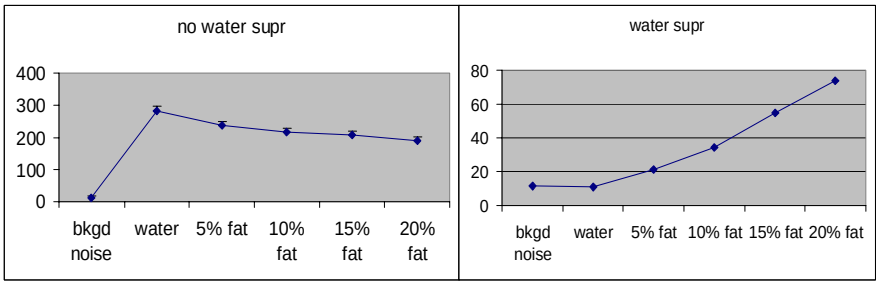

Figure 2 A B

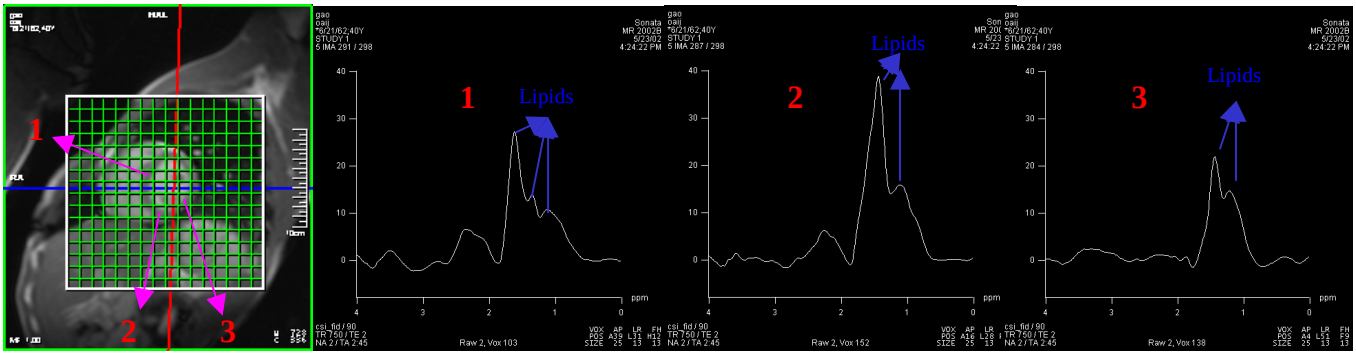

Figure 3 A B C D

Figure 1A shows phantoms made of intralipid mixed with water. From top to bottom, there are five tubes containing 0%(pure water), 5%, 10%, 15%, and 20% lipid respectively. Without water suppression, the signal intensity decreases due to chemical shift effect. With water signal suppressed to the noise level, Figure 1B shows that the signal intensity increases as lipid concentration increases. Figure 2A shows that the mean signal intensity curve of Figure 1A decreases as lipid concentration increases. Figure 2B shows that the mean signal intensity in Figure 1B has near linearity corresponding to lipid concentration of the phantoms with water suppressed to the noise level. Figure 3 shows short axis left ventricle myocardial lipid distribution using Gaussian weighting MRSI. Acquisition time was 2min33sec. Spectra from three voxels show that both extramyocellular lipid (located at 1.5ppm and 1.1ppm) and intramyocellular lipid (located at 1.3ppm) can be observed. Figure 3A shows the imaging matrix location. Voxel size is 12.5mmx12.5mm. Figure 3B, 3C show spectra from two septal myocardial voxels. Figure 3D shows the spectrum from the left wall.

Conclusion

In conclusion, triglyceride, the main component of fat, can be assessed using water saturation with inversion recovery and chemical shift methods combined. water was suppressed to the noise level. Lipid signal intensity shows near linearity corresponding to lipid concentration. Gaussian weighting MRSI was able to assess both intramyocellular lipid and extramyocellular lipid in a short time.

References:

1. Stark DD, Magn. Reson. Imag, 3rd Edition
2. Mareci TH et al, J. Magn. Reson. 92, 229-246, 1991
3. Brooker HR et al, Magn. Reson. Med. 5, 417-433, 1987
4. Hendrich K et al, J. Magn. Reson. Series B 105, 225-232, 1994
5. Gao Y et al, 2002 ISMRM