COMPARATIVE PHANTOM LIPID STUDY UTILIZING VARIOUS MRI SEQUENCES

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Hepatic Steatosis

- Also known as “Fatty Liver”
- Main causes are from obesity, insulin resistance and hyperlipidemia\(^1\)
- Affects 25% of the US population, affecting the Hispanic population more than others\(^1\)
- Can lead to steatohepatitis, cirrhosis possibly leading to hepatocellular carcinoma\(^2\)

Background

- Liver Biopsy (Gold Standard)
  - Error of overestimation in sampling error
- Non-invasive methods
  - CT
  - Ultrasound
  - MRI (Magnetic Resonance Imaging)
    - DIXON Method
    - In/Out Phase
    - Magnetic Resonance Spectroscopy
      - Six different spectral lipid peaks exist in vivo

Objectives/Hypothesis

• To develop an accurate tool in measuring hepatic steatosis
• To compare In/Out of Phase Imaging, 2 Point DIXON, Average 2 Point DIXON, 3 Point DIXON and MR Spectroscopy
• We hypothesize that MR spectroscopy is the most accurate method in quantifying hepatic steatosis
Methodology

- Development of the MRI Sequence for imaging
  - Thanks to Dr. Puneet Sharma (Emory University)
  - Sequence utilizes In/Out Phase, 2 Point DIXON, 3 Point DIXON and MR Spectroscopy
- Used OsiriX Lite to visualize and interpret MRI images from DIXON and In/Out Phase images
- Used Tarquin and Excel to extract MR spectroscopy data
- Developed a MATLAB program to analyze the phantom lipids based on 4 out of the 6 spectroscopy peaks
  - Calculates area under curve
  - Imaging of various concentrations of lipid phantom controls
    - 0% to 50% lipid phantom controls using Nestle Microlipid (50%)
    - Acquired MR data five times for each lipid phantom
- Testing the algorithm against controls

Methodology-TARGUIN GUI

Figure 5. Targuin GUI to visualize 1D MRS spectrum of 50% Lipid Fraction Water Peak at 4.7 ppm and major lipid peak at 1.3 ppm

Figure 6. Phantom Lipid in head coil of 1.5T MRI
Results- MR Phantom Data Graphs

Figure 7. MATLAB Program used to calculate hepatic fat fraction

Figure 8. Quantification of lipid fractions using MR Spectroscopy
Findings-Comparing the Different Imaging Techniques

MR Spectroscopy is the most accurate of the various imaging techniques.

At fat fractions 30% lipid fractions and greater, MR Spectroscopy found to be most accurate than other tested techniques.

Of the tested methods, Average 2 Point DIXON and MR spectroscopy are the most accurate in lipid fraction phantoms below 30%.

Figure 9. Comparison of various MR imaging techniques
Conclusions

- MR Spectroscopy is the most accurate of the methods tested in quantifying fat fractions in phantom models

**Future Work**
- Use these developed MR spectroscopy technique to determine variability of hepatic fractions in the eight lobes of the liver
- Use these developed MR sequences to quantify the change in hepatic fat in bariatric patients undergoing 2 week pre-operative restrictive diets
Limitations of the Study

• *In vivo* conditions are different
  • Physiological lipid is heterogeneous in nature and would exhibit varying fat fractions
  • *In vivo* tissue contains other compounds such as iron that is known to alter spectroscopy measurements