COMPARATIVE PHANTOM LIPID STUDY UTILIZING VARIOUS MRI SEQUENCES

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- No financial disclosures

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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 hepatocellularcarinoma[2]

[1]Non-Alcoholic Fatty Liver Disease. *Non-Alcoholic Fatty Liver Disease*. American Liver Foundation, n.d. Web.
[2]Lonardo A, Loria P, Adinolfi LE, Carulli N, Ruggiero G. Hepatitis C and steatosis: a reappraisal. J Viral Hepat. 2006;13(2):73-80.

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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*

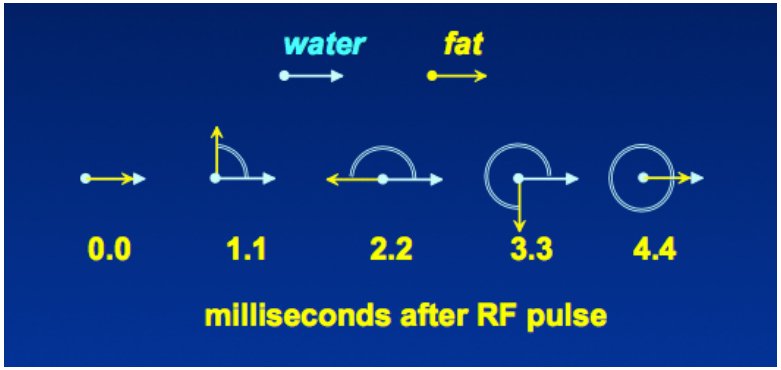

Figure 1. In/Out of Phase Imaging[1]

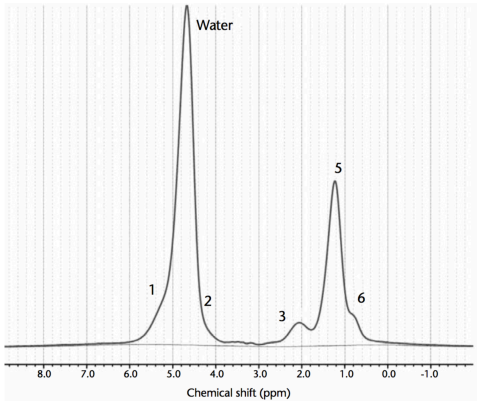

Figure 2. Six Lipids shown in MR Spectropscopy[2]

1. Outwater EK, Blasbalg R, Siegelman ES, Vala M.
Detection of lipid in abdominal tissues with opposed-phase gradient-echo images at 1.5T: techniques and diagnostic importance. Radiographics 1998; 18:1465-80
2. Sharma P, Altbach M, Galons J-P, Kalb B, Martin DR. Measurement of liver fat fraction and iron with MRI and MR spectroscopy techniques. *Diagnostic and Interventional Radiology*. 2014;20(1):17-26. doi:10.5152/dir.2013.13124.

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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

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Methodology

Figure 3. Microlipid bottle[1]

- 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

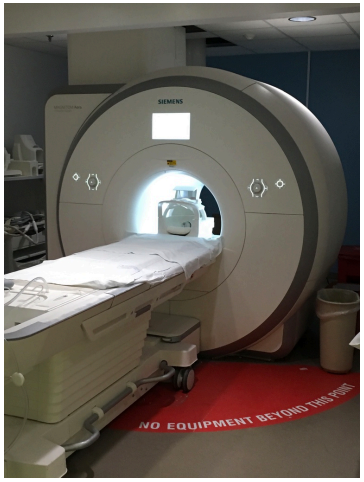

Figure 4. Phantom Lipid in 1.5T Siemens

1. MICROLIPID®. (n.d.). Retrieved April 24, 2016, from https://www.nestlehealthscience.us/brands/microlipid/microlipid

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Methodology-TARGUIN GUI

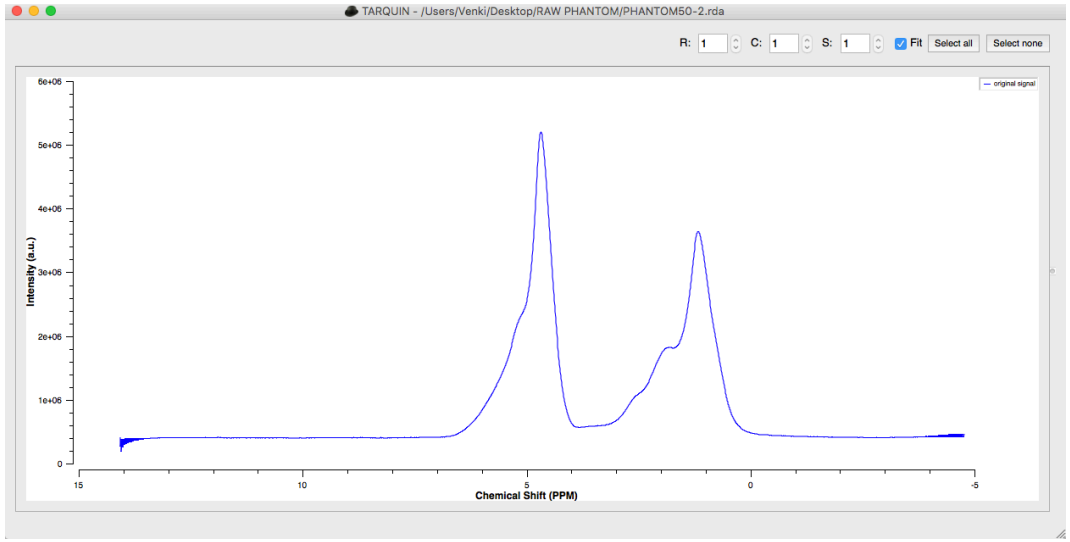

Figure 5. Targuin GUI to visualize 1D MRS spectrum of 50% Lipid Fraction
Water Peak at 4.7 ppm and major lipid peak at 1.3 ppm

Figure 6. Phantom Lipid in head coil of 1.5T MRI

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Results- MR Phantom Data Graphs

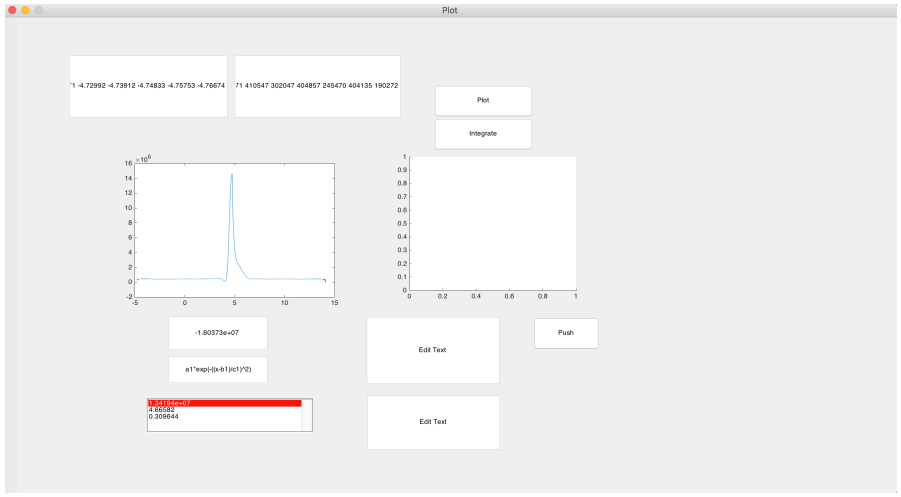

Figure 7. MATLAB Program used to calculate hepatic fat fraction

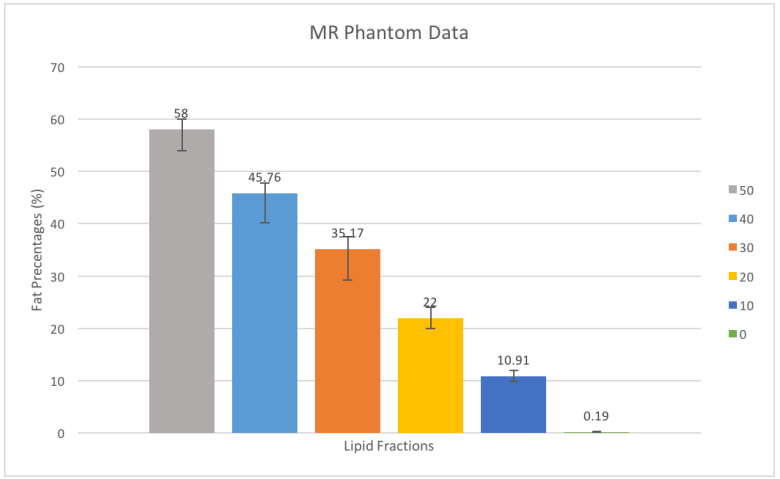

Figure 8. Quantification of lipid fractions using MR Spectroscopy

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Findings-Comparing the Different Imaging Techniques

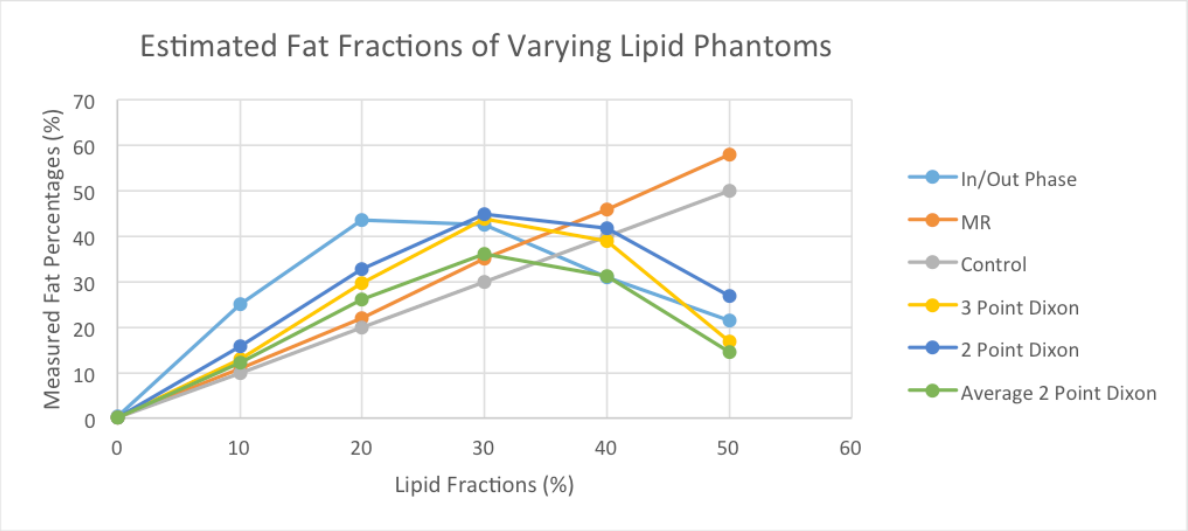

Figure 9. Comparison of various MR imaging techniques

- 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%

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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

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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

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