Non-Invasive Quantitation of Muscular and Hepatic Fat Mass and Distribution for Treatment Monitoring

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Introduction

- Fat mass accumulation in the abdomen and extremities has been closely tied to cardiovascular mortality across various diseases.
- Magnetic Resonance Imaging (MRI) allows for direct imaging of fat in the body by using the Dixon method to determine fat volume and distribution.

Hepatic and muscle-fat imaging was utilized for 3 separate studies:

- Study 1: examining if taking a supplement improves health and decreases fat in muscle.
- Study 2: giving spinal cord injury (SCI) patients special exercise and medication and examining health improvements.
- Study 3: examining if testosterone therapy decreases hepatic fat in prostate cancer patients.

Methods

- 2-point Dixon MRI was acquired at 3T (Siemens Skyra, GE Premier) to measure "fat-only" and "water-only" axial images across the torso, Liver, and lower extremities.
- Volumetric masks separating muscle, intramuscular fat, and subcutaneous fat in the thigh and water-fat in the liver were created using manual segmentation (3D Slicer).
- Tissue volumes were calculated (FSL) from each mask, and then compared at baseline and after treatment.
- Statistical tests (PRISM) were then used to detect significant differences before and after treatment.

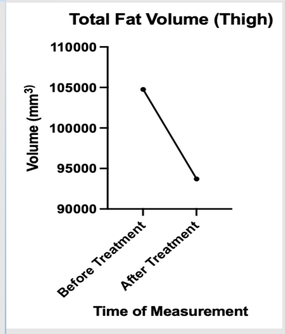

Fig 1. Median change In total fat volume (thigh).

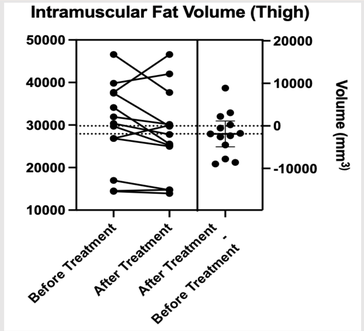

Fig 2. Intramuscular fat vol. change within thigh of 13 patients.

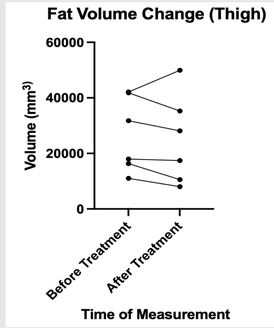

Fig 3. Intramuscular fat vol. changes in SCI patients

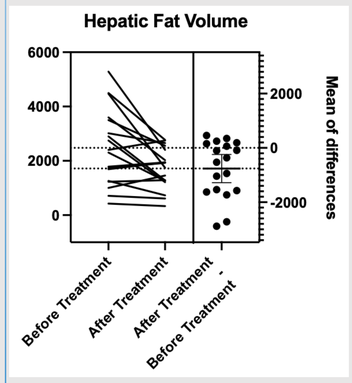

Fig 4. Hepatic fat vol. Changes in Prostate cancer patients before and after treatment.

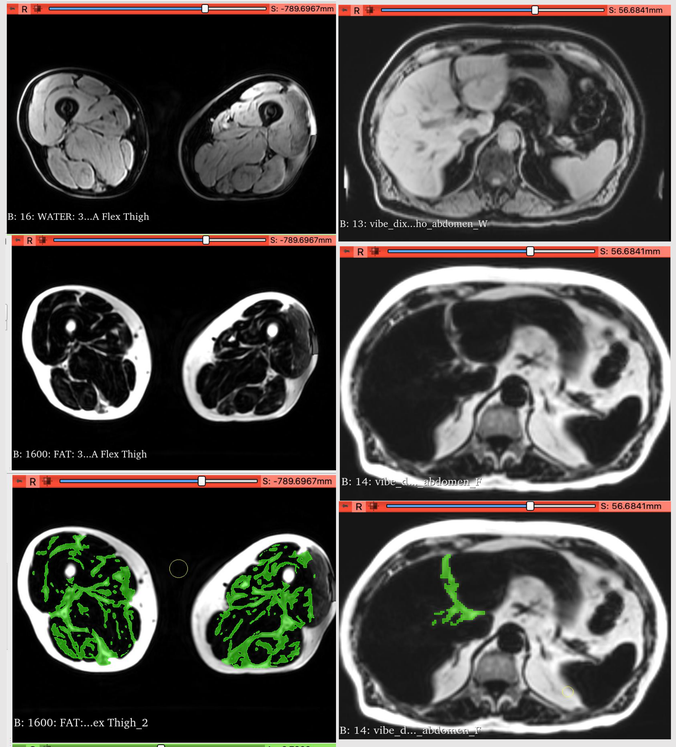

Fig 5. Axial images of patient thigh and liver. Top images are water, middle Images are fat, and bottom images are masks used to calculate volume.

Results

- Lower extremity fat volumes in 13 obese adults decrease after taking a supplement (Wilcoxon signed rank test p=0.0002). Figure 1 and 2.
- Abdominal and lower extremity fat volumes in spinal cord injury (SCI) patients after receiving testosterone and functional electrical intervention therapy (Wilcoxon signed rank test p=0.0312). Figure 3.
- Hepatic fat volumes in prostate cancer patients after receiving testosterone therapy (Paired T-Test p=0.0068). Figure 4.
- Paired T-Test results were only significant for prostate cancer study, and Wilcoxon tests were significant for remaining 2 studies. It is likely that there are differences between the case and controls that will be further tested when data is unblinded.

Discussion

- Dixon MRI is a non-invasive and effective tool for assessing the effect of different therapies across a wide range of diseases.
- Dixon MRI is a valuable tool to help monitor treatment responses to various physical and metabolic therapies.

Future Directions

- Continuing to use MRI techniques to monitor the tissue response to various treatments.
- Developing further techniques that can automate and streamline the MRI tissue quantitation process.