



Assessment of Adipose Tissue from Whole Body 3T MRI Scans

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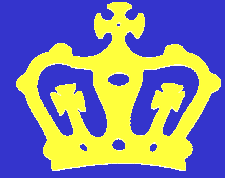
Background



- Adipose tissue quantification plays a central role in studying obesity in children and adults. Statistics show that 60% of American adults are either overweight or obese, and the rates are skyrocketing in children and adolescents.
- Using manual segmentation of MRI scanned images is a problem due to the **high variation** between manual delineations. Manual segmentation also requires highly trained experts with knowledge of anatomy.
- In this study, we used a specific water saturation sequence and histogram based segmentation method that provides robust delineation results for adipose tissue from whole body MRI scans.



Methodology



- *3T clinical T1-weighted MRI Acquisition*

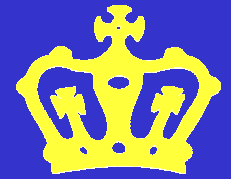
A standard T1-weighted sequence was used on a 3T whole body MR system for routine imaging. Data collected from this scan was compared to the water-saturation sequence described below.

- *Water Saturation Acquisition for Fat*

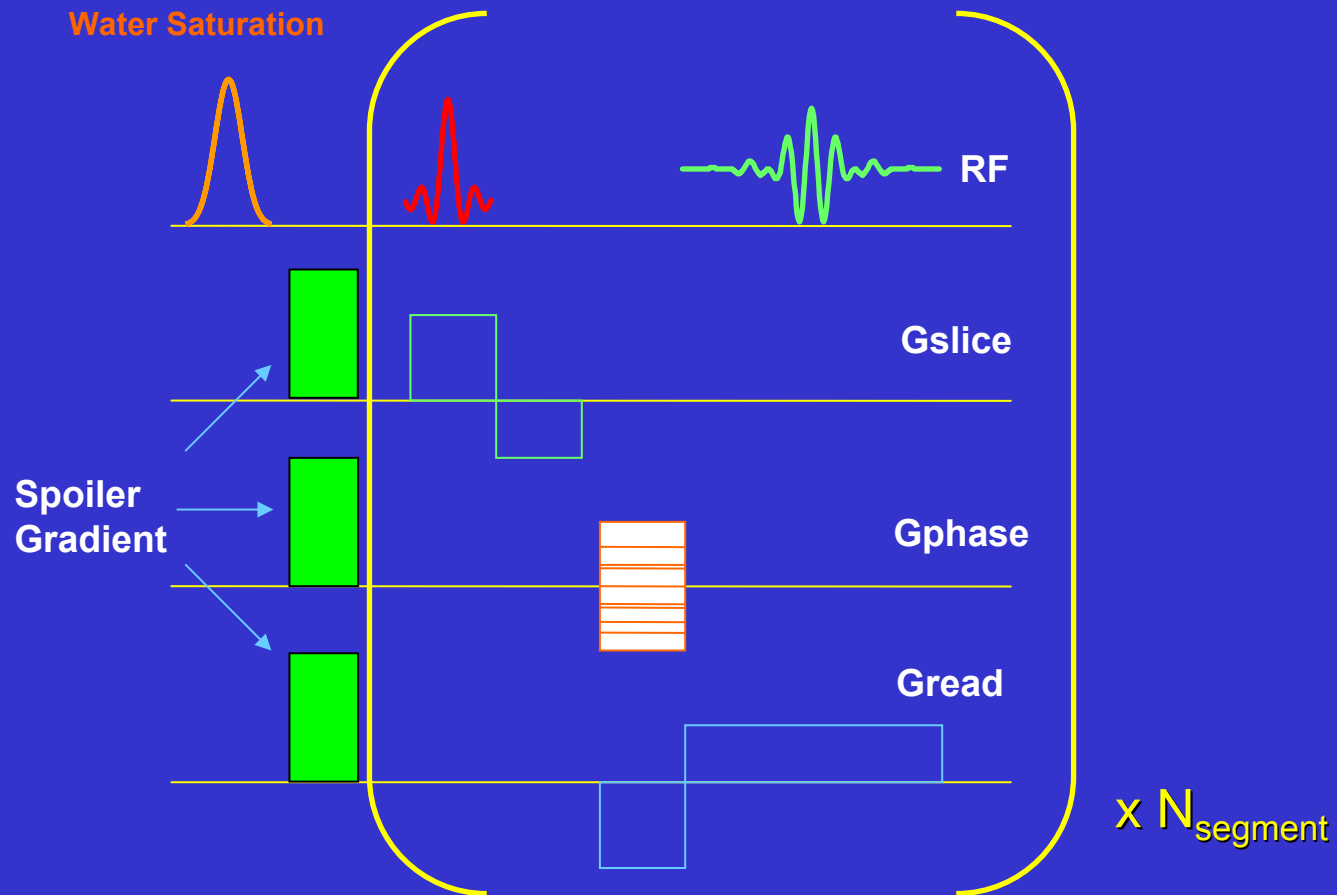
Since fat has a different Larmor frequency than water, a sufficiently narrow band RF (radio frequency) pulse can be used to tip water magnetization into the transverse plane and application of a spoiling gradient pulse can be used to dephase the magnetization. This combination is referred to as a “water saturation pulse.”



Methodology



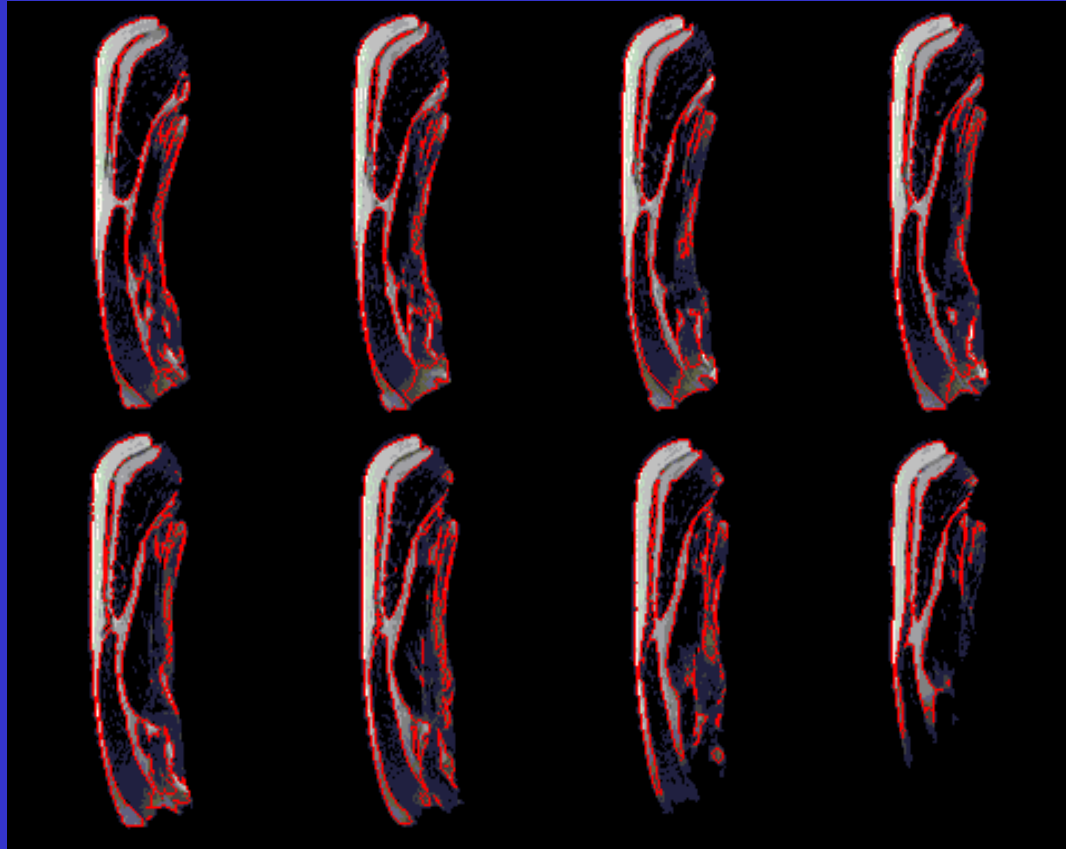
Segmented Gradient Echo Acquisition



The total image acquisition time for each part is about 20 seconds.



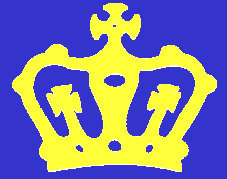
Phantom Study



- We carried out a phantom study on fresh pig meat. Slice thickness is 5mm; pixel spacing is 1.46mm by 1.46mm. Echo time (TE) is 1.64ms, and repetition time (TR) is 200ms.



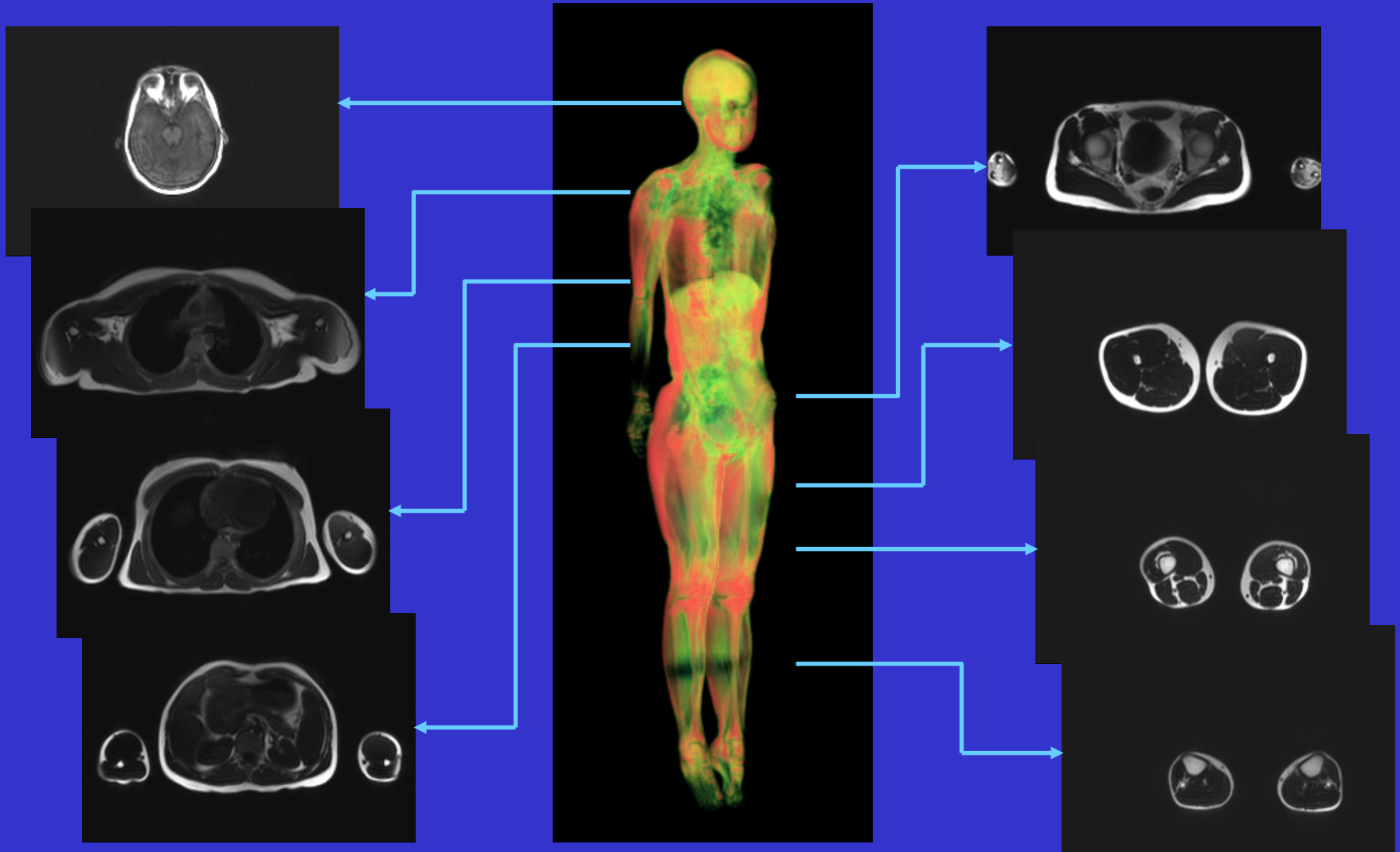
Human Subjects Study



- **Four healthy volunteers** (one female, three males) underwent 3T MR whole-body imaging for determination of fat distribution and quantification.
- MR examinations were performed on a **3T whole-body imager (Trio with TIM, Siemens)**; both regular clinical sequence and the water saturation sequence described above were applied. For the water saturation measurement, slice thickness was 10mm; pixel spacing was 1.95mm by 1.95mm. Echo time (TE) was 2.32ms, and the repetition time (TR) was 280ms.



Human Subjects Study: Water Saturation Method

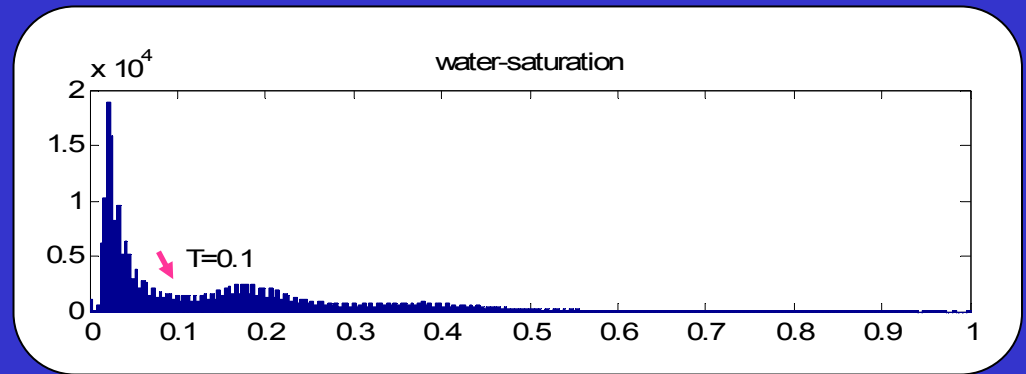
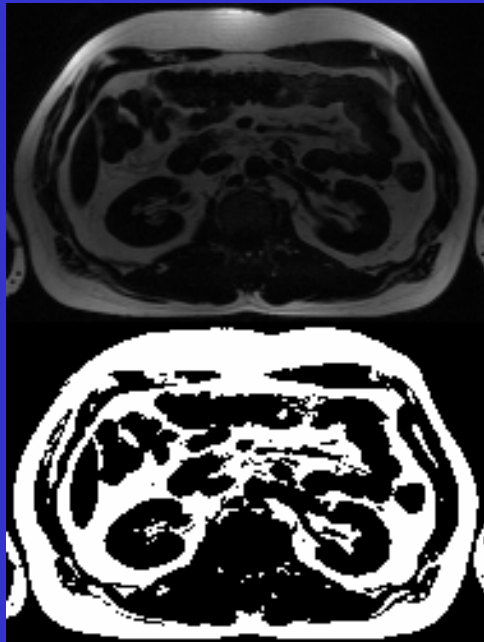




Preliminary Results



Water Saturation Acquisition Method for Adipose Tissues



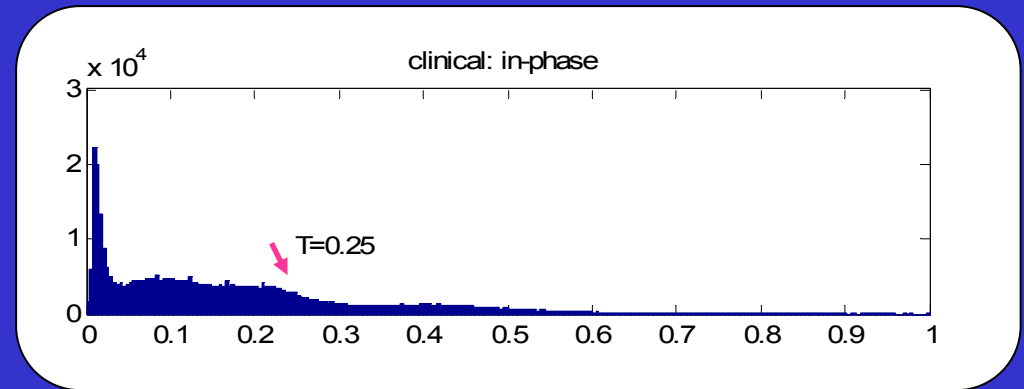
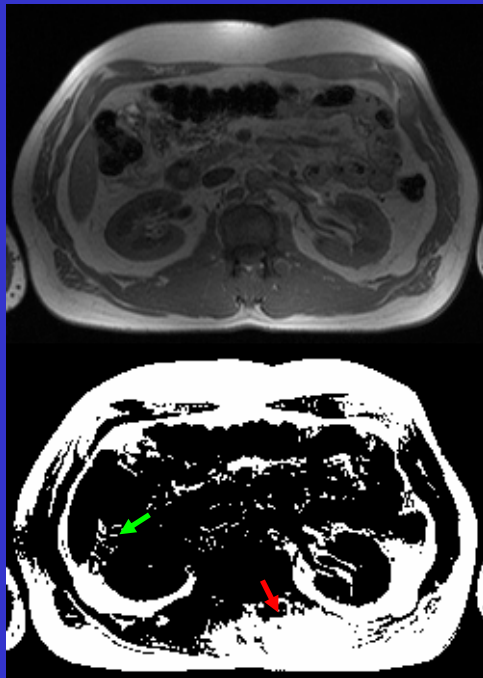
Our strategy for developing an adipose specific protocol was to **reduce the complexity of the segmentation problem** to the degree that **simple methods** could be applied successfully. We compared the results after histogram based threshold method on human subject's data. The valley in the water saturation histogram was a reasonable threshold value to separate fat.



Preliminary Results



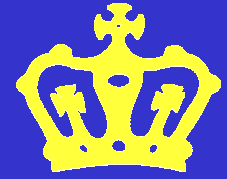
Clinical T1 in-phase



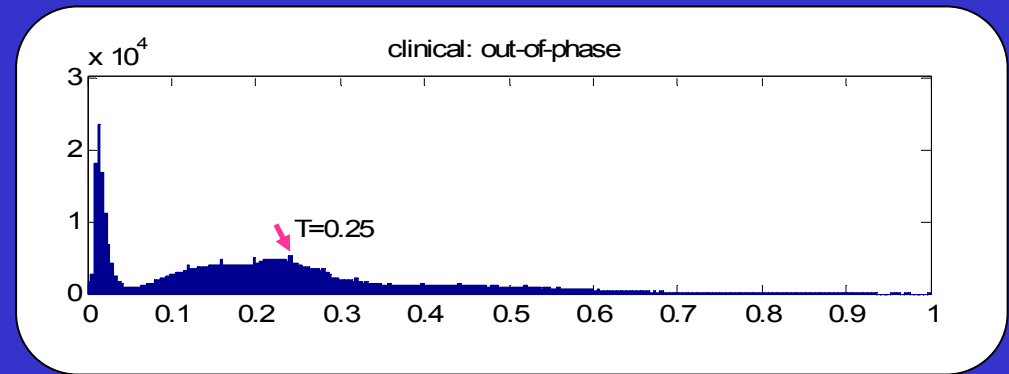
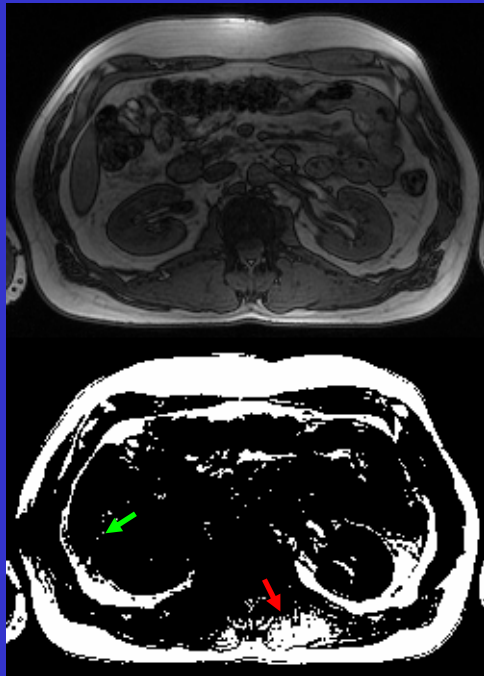
In comparison, clinical in-phase acquisition could not provide consistent intensity values within fat because **over-segmentation** and **under-segmentation** appeared when same threshold method was applied. Furthermore, there was no clear valley in the histogram to provide an effective threshold level.



Preliminary Results



Clinical T1 out-of-phase



Similarly to clinical in-phase results, clinical out-of-phase acquisition could not provide consistent intensity values within fat because **over-segmentation** and **under-segmentation** appeared.



Future Research



- In the future, we plan to focus on **diseases correlated with adipose distribution** such as Type II diabetes and liver diseases.
- **Building a 3D adipose anatomical database** as a resource for clinical studies will be longitudinal study, which would include screening many patients across age, race, and gender and creating a library of 3D adipose “skeletons.”



Conclusions



- The study of whole body fat distribution is becoming recognized as an important metric in the diagnostic screening of disease and therapy.
- Instead of manually segmenting fat from other tissues, an effective water saturation acquisition method and a histogram based segmentation method provided robust delineation of adipose tissue from whole body MRI scans.
- Both phantom and human subject studies were performed. Compared with a standard clinical 3T T1-weighted acquisition protocol, our method gave superior results and suggests a promising new high-speed protocol suitable for screening patients of all ages.



Thank you !

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