

Effect of Posture on Subcutaneous Adipose Tissue: A Preliminary Imaging Study

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Introduction

Studies on Human Body Models (HBMs) and Post-Mortem Human Subjects (PMHS) have identified the need to better understand the biomechanical behavior of subcutaneous adipose tissue (SAT) in the region of the anterior superior iliac spine (ASIS) [1-3]. Although mechanical properties recently have been characterized, a knowledge gap remains in the morphology of SAT in this area with respect to bony landmarks of the pelvis. Occupant submarining is a main cause of severe (AIS 3+) abdominal injuries in frontal crashes, and initial position of the occupant has been found to be a contributing factor [4, 5]. The current study builds off of previous work characterizing the morphology of SAT in this region using supine CT data. The objective is twofold: **First, we seek to establish correspondence between measures of SAT in matched abdominal CT and MRI scans from the same individuals in the supine posture. Next, we seek to expand that analysis by comparing data from the same individuals between supine and a seated posture.**

Methods

A retrospective study of matched supine CT, supine MRI, and supine MRI scans (at 23 degree seatback angle) from 6 living subjects was conducted. Images from a previous study were downloaded from the WFU PACS (Picture Archiving and Communication System) under IRB00013200 [6]. Image data were loaded in Mimics v23.0 (Materialise, Leuven, Belgium) and resliced to reorient the images to the anatomical axes of the pelvis. Eleven measurements that describe SAT area, quality, and linear depth were collected from each scan. Measures were cross-plotted to compare linearity by image modality. Wilcoxon rank-sum tests for differences in measures ($\alpha = 0.05$) were performed between all three cohorts; CT vs MRI, MRI vs. uMRI, and CT vs uMRI.

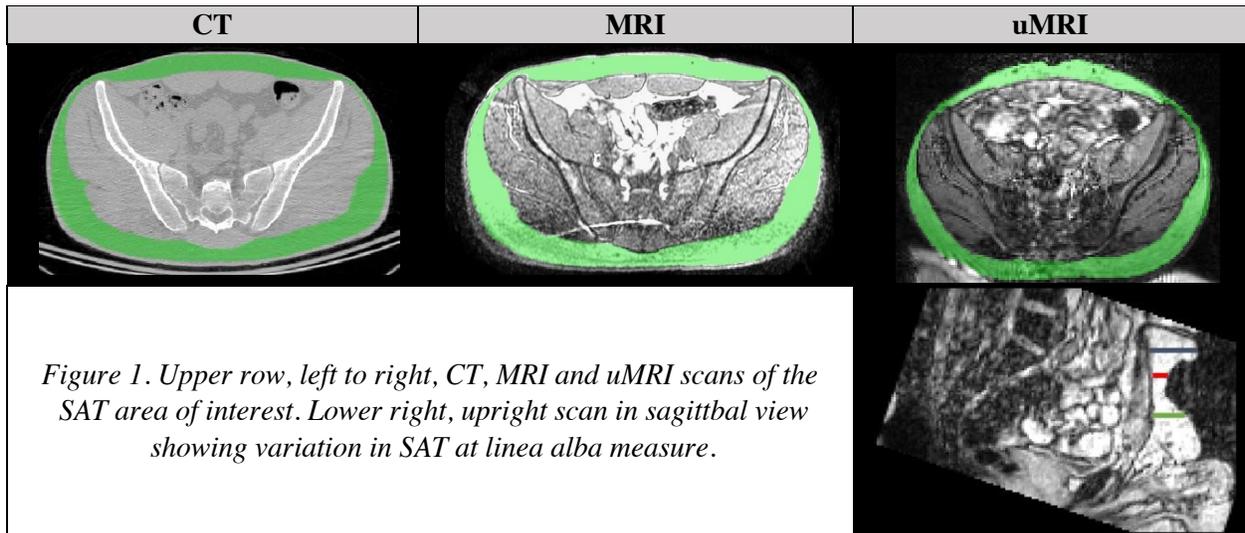
Results

SAT measures were found to correlate linearly between CT and MRI in the supine posture (mean slope = 0.98 and $R^2 = 0.98$). Greater variation was found when analyzing supine scans (CT or MRI) vs. upright MRI scans. When assessing postural changes, SAT section area remained unchanged from supine to upright posture, yet ASIS depth measures increase in upright scans and were found to be statistically significant ($p = 0.0313$ for ASIS depth along path from the sacroiliac joint). The most significant difference is seen in the anterior component of the ASIS depth measurement, suggesting that compared to supine position, SAT is distributed more anteriorly when seated at 23 degrees. Depth of SAT at the linea alba was highly sensitive to the plane at which the measurement was taken for most individuals, with some measures more than doubling when moving inferiorly or superiorly through the pannus (Figure 1). Results are limited by the number of subjects and a single seatback recline angle.

Conclusions

Despite the limited sample size, significant differences were observed in ASIS depth measures from the supine to seated posture among the individuals assed. The results therefore suggest the shortcomings of using supine data to develop HBMs and ATDs in seated and reclined settings. This finding indicates the

need for further analysis, and a need for more robust imaging data describing SAT morphology with variation the posture.



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