Austin M. Moore
MD/PhD Student, Year 4
Biomedical Engineering, Wake Forest School of Medicine

Characterization of Subcutaneous Pelvic Adipose Tissue for the Enhancement of Human Surrogate Models

Austin M. Moore; Samantha M. Efobi; Jazmine Aira, MS; Leon Lenchik, MD; Fang-Chi Hsu, PhD; Ashley A. Weaver, PhD; F. Scott Gayzik, PhD

The objective of this study was to characterize subcutaneous adipose tissue (SAT) cross-sectional area, depth, and structure in the vicinity of the pelvis using image data, with BMI, sex, and age as predictor variables. Population-based data describing morphological characteristics of SAT in this region are critical for improved human surrogate models concerned with the occupant interface with passive safety systems, notably the lap belt.

Analysis was conducted in an axial plane at the anterior superior iliac spine (ASIS). SAT depth was measured normal to the skin at the rectus abdominis bilaterally and at the linea alba. At ASIS, SAT thickness was measured bilaterally along a path from the anterior aspect of the sacroiliac joint, and in the lateral and anterior-posterior directions. SAT area and the ratio of anterior to posterior SAT were measured. Perimeter and diametric lengths (anterior-posterior and left-right) were measured. For some scans, a symmetry-based, modified protocol was required because the full SAT was only visible unilaterally. A linear regression model was performed to relate the predictor variables (age, sex, BMI) to each of the quantitative outcome measures. Prior to analyzing the full dataset, all measures were assessed by three researchers to quantify inter-observer variability. Eighty-five deidentified retrospective CT datasets were collected at Wake Forest School of Medicine, M:F 1:1, age range 25 – 45 years, BMI range 9 – 35. Image analysis was covered by IRB #00006511, IRB #0013200, and BG05-483. Scans were excluded if SAT was clipped on both sides or there was evidence of local trauma.

Fifteen regression models were developed for outcome measures, using age, sex, and BMI as predictor variables. Of the outcome measures analyzed, 13 were significant with BMI, 11 with sex, and 6 with age. Perimeter, maximum diameter, and all 3 depth measures at ASIS were significant for all predictor variables. The findings indicate significantly greater values of SAT area and depth measures for females than males controlling for BMI and age.

The SAT depth at ASIS plays an important role in human-safety system interaction, particularly for the lap belt and in safety design challenges such as submarining. Given the increased importance of gender equity in safety design, the results further indicate sex-based differences in this area exist and must be considered. These data may be used to improve human surrogate models (computational and physical).

Research reported in this abstract was supported by the Research Consortium for Crashworthiness in Automated Driving Systems (RCCADS). The content is solely the responsibility of the authors and does not necessarily represent the official views of RCCADS. The authors thank the National Highway Traffic Safety Administration for support of the CIREN program and the WFU-VT CIREN Center (DTN2210H00294, DTNH2217R00069).