Introduction of an Organ Based Thorax for Elderly and Obese ATD’s

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ABSTRACT

The ability to have the correct regional abdominal stiffness, intrusion measurement of the abdominal organs, and loading patterns in the thorax in motor vehicle crash conditions is important for assessing head-neck loads, brain, thorax, and abdominal injuries. Current ATD’s do not have all the components necessary to measure regional abdominal organ loadings necessary in new types of crash test procedures such as offsets. A proper thorax regional stiffness using the proper shaped and stiffness organs in the abdominal cavity covered with a muscle and fat layer are the items described in this paper. As part of the development for these new platforms, the development of new biofidelity corridors and injury criterion will need to be completed.

INTRODUCTION

This project is an effort by Humanetics to determine the important elements of an Elderly or Obese Anthropomorphic Test Device (ATD), and then design a prototype, create a 3D physical model, and discuss with the automotive safety community their input before proceeding to the next step of constructing a full ATD prototype.
METHODS

To complete the first step in the development of a new ATD platform, background information was gathered, appropriate anthropometry was reviewed, and design concepts were created.

Background Research

Elderly and Obese requirements have not yet been completely assembled for an ATD design study. To start the process, Humanetics reviewed available literature and narrowed their priorities for the initial design concept phase. The first priority determined for this design concept was to focus on the Thorax and Abdominal regions and use the THOR M as the base ATD. Three papers guided the design concept work; (1) 2005 Stapp paper 2005-22-001, Kent et al., (2) 2009 AAM paper, Forman et al., and (3) 2011 Stapp paper 2011-12, Kremer et al. Each paper was used to determine items to review during the development process.

Anthropometry

It was determined from the background research that a priority would be to design separate organs into the ATD. To have the proper shapes and placement of the organs, Humanetics discussed this issue with the Radiological Department of OSU School of medicine. They provided Humanetics with options which they use to train students. The best option for the project was to purchase the 3D Inventor human model from Zygote of a US 50% male (height 68-70 inches, weight 184-196 lbs) with models of the all the organs and locations determined from body scans.

The overall anthropometry for the obese size person was determined to follow the 35 BMI PMHS tests that were reported in the 2009 AAAM paper.

Specific elderly anthropometry was determined from the 2005 Stapp paper.

Design Concepts

Upon completion of the background research, a design concept was done. The concept was to be an Adjustable ATD Platform (AAP) so that both the Elderly and Obese could be derived from the same base skeletal layout, head, neck, arms, and legs from the THOR M 50th percentile male. For the thorax and abdominal areas the following design concepts would be applied:

1. Shoulder
   a. Omni Directional shoulder design with flexible plastic clavicle and scapula.

2. Spine
   a. Flexible spine made from rubber segments.

3. Ribs
   a. Flexible plastic ribs with standard THOR M shape as well as the Elderly shaped based on the 2005 Stapp paper.

4. Abdominal Cavity
a. Individual bladder pressure measuring organs design to measure pressure for the Liver, Spleen, Stomach, Kidneys, and Intestinal system.
b. A soft organ sac to supply organ support and properly locate the organs relative to each other.
c. A flexible muscle layer that would support the organ sac into the abdominal cavity and attachment to the spine of the ATD.

5. Outside Flesh
   a. Shapes for the Obese were derived from the 2009 AAAM paper for the anthropometry measurements from the 35 BMI PMHS, and scaled from the current UMTRI AVEO 50th percentile male.
   b. Shapes for the elderly were used directly from the current UMTRI AVEO 50th percentile male
   c. The goals for the material stiffness properties were determined to be such that the pelvis flesh would spread out similar to the UMTRI shape in place of the current ATD limited deformation flesh.

RESULTS

The concept design yielded a viable ATD in which Humanetics can build upon completion of a review with biomechanical experts. Figure 1 contains the Elderly and Obese design concepts. The major difference between the ATD’s is the overall flesh sizes for the Thorax, Pelvis, and Thighs.

Figure 1: Overall Design Concepts
Inside the flesh, Figure 2, shows the organ sac held in place by the muscle layer.

Figure 2: Muscle attachment layer locating organ sac

Figure 3 shows the individual organs suspended by the organ sac. The purple layer is the representation of the placement of the diaphragm.

Figure 3: Individual Organ Placement
Figure 4 provides a view of the rib sternum assembly for the ATD design concept. This figure contains the elderly dummy rib shape with has been rotated upward 7 degrees based on the 2005 Stapp paper.

![Figure 4: Rib, Sternum, Elderly rib shape](image)

Figure 5 contains the 3D printed concept thorax without flesh to demonstrate the concept in full size. The omnidirectional shoulder concept is also shown in the figure.

![Figure 5: 3D printed Thorax Concept for Elderly and Obese ATD](image)
CONCLUSIONS

Humanetics has determined the feasibility of an AAP ATD for both Elderly and Obese requirements. The next steps are to determine with the help of the automotive safety community, which complete ATD should be built first and with which features that were shown in this design concept.

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REFERENCES

