XSENSOR High-Speed Impact System in PMHS Thoracic Impact Testing

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Background & Research Objective

Past thoracic research has relied on instrumentation and technology like chestbands, strain gages, accelerometers, and VICON motion tracking systems to try to define the biofidelic response and injury threshold of the thorax to blunt impacts. All instrumentation has strengths and weaknesses, but a common weakness across all of these examples is that they sense the loading at a single point, or in the case of the chestband, at a single cross-section of the thorax. This limitation does not allow researchers to understand how the thoracic region as a whole is interacting with the impacting surface. The XSENSOR High-Speed Impact System is newer technology that can measure the pressure profile of the thorax during an impact event. The goal of this testing was to use the XSENSOR High-Speed Impact System in a series of PMHS thoracic impacts to investigate the sensors potential to predict thoracic injury and response to blunt loading.

Methodology

This testing was completed with a single PMHS who fit the 50th percentile male criteria for age, weight, BMI, and also had a “normal” aBMD score. Instrumentation for the impact series included a mix of strain gages to determine fracture timing, located anterior and anterior-oblique on ribs 2-8 on both the right and left sides, 6DX motion blocks placed on the manubrium, T1, T4, T12, and S1, and the XSENSOR pad placed in the thoracic region of interest to measure the pressure profile during each impact. A series of seven thoracic impacts were conducted which included: impacts to the front, left, and right aspects, two different impactor faces and two different energy levels.

Results & Discussion

Findings from each test focused on comparing the dynamic pressure profiles of the impact area to the recorded strains from the attached gages on each rib, and also to any injury locations that were documented during autopsy. The timing of each fracture, as determined from the strain gages, were also compared to the timing of the peak pressures from the XSENSOR output in each given region of interest. The pressure maps revealed that the XSENSOR High-Speed Impact System was able to identify the thoracic areas that contained fractures and additionally the timing of the peak pressures correlated to the predicted timing of fracture from the strain gages. A limitation of the testing was that a single PMHS was impacted multiple times in order to collect a large quantity of comparable data between instrumentation techniques. Also, while the conducted impacts did mimic historical thoracic impact tests, the tests were performed under very basic boundary conditions. Further investigation with the XSENSOR High-Speed Impact System in a dynamic sled environment should be conducted to test the system’s durability and ability to document interaction between a PMHS and typical safety devices. Given the findings from this laboratory setting, it appears that the XSENSOR High-Speed Impact System has the ability to map pressure distributions during dynamic impacts that could help to identify injuries in blunt high impact scenarios.