Correlation of liver injury and vascular pressure: a study of lateral impacts to post-mortem human subjects

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ABSTRACT

Abdominal injuries account for 3-5% of the total number of injuries due to automotive crashe. However, abdominal injuries, especially to the solid organs of the abdomen, represent a higher proportion of serious injuries. For example, Elhagediab and Rouhana reported that abdominal injuries constituted 20.5% of AIS $\geq$ 5 injuries in frontal impacts in the NASS database for the years 1988 to 1994 [3]. Previous work has shown a correlation between vascular pressure and liver injury in human surrogates and in pressurized ex vivo human and porcine livers when subjected to blunt impact . The purpose of this work was to further investigate the relationship between pressure and liver injury using post-mortem human subjects (PMHS). Specifically, the goals were to (1) conduct lateral impacts on PMHS with re-pressurized abdominal vascular systems and measure the vascular pressure and (2) determine if a correlation exists between the measured vascular pressure and liver injury. For the study, four PMHS were instrumented with pressure sensors in the abdominal vessels, including the abdominal aorta, the hepatic veins, and the inferior vena cava. For each test, the subject's abdomen was pressurized to physiological pressures using saline. The seated subject was held upright by a head restraint which was released immediately before contact with the pneumatic ram, ensuring the subject was not suspended at the time of impact. The lateral impact was applied to the right side at the level of the liver. The measurements from this test series verified the results of the ex vivo liver and human surrogate testing which showed that higher pressure related to a greater liver injury severity. However, the absolute values of the pressure measured were different than previously reported values. The compression and the viscous criterion also were good predictors of injury. These results can also be applied to improve the abdominal injury assessment in both anthropomorphic test devices and in computer models of the human body used in vehicle safety research.