RESULTS & DISCUSSION

Non-traditional seating configurations, such as rear-facing (RF) seats for front-row occupants, may be adopted in vehicles with automated driving systems.

Previous studies have found pelvis injuries in high-speed frontal impacts on post-mortem human subjects (PMHS) tested in RF seats. Figure 1 shows overall PMHS kinematics during the event.

The deformation of the pelvis was evident in injuries from inspection of medical images from Computed Tomography (CT) scans, but the exact deformation and its direction were unclear.

This study aims to quantify the direction of pelvic deformation in the RF frontal impact scenario using pre-test and post-test CT scans.

Figure 1: PMHS motion in a RF frontal impact scenario

MATERIALS & METHODS

Eight fresh male PMHS were tested dynamically in the RF frontal impact scenario.

Pre-test and post-test CT scans of the eight PMHS (n = 4 for both injured and non-injured conditions) were acquired for data collection.

Create 3D models of pelvises from test CT scans of the same PMHS in 3D Slicer

Overlap models using fixed sacrum reference points

Figure 2: Placement of points digitized with measurement variables

A: Inter-Anterior-Superior-Iliac Spine (Inter-ASIS)
B: Inter-Posterior-Superior-Iliac Spine (Inter-PSIS)
C: Inter-Ishial Tuberosity (Inter-IT)
D: Left IT to Inferior Endplate of S5 (Right IT-S5)
E: Right IT to Inferior Endplate of S5 (Left IT-S5)
F: Pubic Symphysis Angle to S1 (PS Angle)

Digital points (Figure 2) using 3D Slicer three times and export to MATLAB

Calculate measurement variables and angles (Figure 2) for pre and post tests

Figure 3: Images of pelvis overlapping. Red arrows denote fractures

Calculate intra-observer error

Compare with Mann-Whitney U Test (SPSS)

1. Coefficient of Variation (Equation 1)
2. Repeated Measures ANOVA (SPSS)

\[ CV = \frac{\sigma}{\mu} \times 100\% \]

Equation 1: Coefficient of Variation

SPSS Version 28.0.1.1

CONCLUSIONS

A methodology was developed to quantify pelvic deformation and its direction that cannot be ascertained from a post-test autopsy.

The changes in measurement variables taken from pre-test and post-test CT scans of PMHS indicated that the pelvis deformed outwardly as a result of the RF high-speed frontal impacts.

This study will help us understand the mechanisms of pelvic injuries from these impact scenarios. The results will inform placement of instrumentation for future RF high-speed frontal impact tests to collect data during the deformation of pelvises.

The preliminary sample size is too small to establish definitive conclusions in this study. Future research should include data from more PMHS and data from female PMHS to further characterize the mechanism of pelvic injury.

REFERENCES CITED


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