INTRODUCTION

- Thorax injuries, specifically rib fractures, are common in motor vehicle crashes and can lead to high rates of morbidity and mortality (Kent et al. 2008). In order to ultimately improve thoracic injury prevention measures, quantifying variation in rib response for all occupants is crucial.

- Many studies have been conducted on single impacts of ribs in dynamic testing (Agnew et al. 2018) and on non-injurious quasi-static fatigue loading (Li et al. 2010). However, repeated dynamic test data for whole human ribs are lacking.

- The goal of this study was to explore why some ribs did not fail during a dynamic impact to better understand differential fracture risk. Additionally, we investigated changes in structural properties between multiple impacts.

MATERIALS & METHODS

- Three-hundred and seventy-two ribs from 204 post-mortem human subjects (72 females, 132 males, 4 - 108 years) were dynamically impacted in anterior to posterior loading (Fig. 1). Displacement was measured by a linear string potentiometer attached to the moving plate of the fixture. Force was measured in the direction of impact (X) by a 6-axis load cell behind the vertebral end of the rib. Strain gages attached at 30% and 60% of whole rib curve length on the cutaneous and pleural surfaces measured strain. Structural properties were calculated from force vs. displacement (F-D) curves (Fig. 2).

- Eleven ribs did not fracture during initial impact and were subsequently impacted again. These ribs fell into three distinct cases according to impact velocity (1 m/s or 2 m/s) and failure or not during the second impact (Fig. 2).

RESULTS & DISCUSSION

- Eleven ribs did not fail on first impact and were impacted again.

Between Subjects
- Age was lower (4 - 30 years) than the fractured sample
- Both sexes: 7 Males, 2 Females

Structural Properties
- Average structural properties in all cases for these 11 ribs were greater than the average of the sample of fractured ribs.

Cross-Sectional Geometric Properties
- Larger Ct.Th and Ct.Ar (Fig. 6) in these 11 ribs were found when compared to age- and sex-matched ribs from the fractured sample, and likely contributed to increased fracture resistance.

CONCLUSIONS

- Results from this study and future work in exploring complex loading mechanisms will be crucial in quantifying variation in rib response for a large population with the overall goal of identifying differential injury thresholds and preventing thoracic injuries in motor vehicle crashes.

REFERENCES CITED