INTRODUCTION

- There are over 350,000 powered two-wheeler (PTW) fatalities annually around the world [1], but there remains a lack of validated safety tools (ATDs, HBMs) to aid in creating protection systems for riders.
- In 2020, the National Highway Traffic Safety Administration’s (NHTSA) Fatality Analysis Reporting System (FARS) reported more than 82,000 motorcyclists related injuries with over 5,500 fatalities in the US [2].
- Sport motorcycles in the US are most involved in fatal accidents with 1,775 fatalities in 2020 [3] averaging a speed of approximately 50 kph [4].
- Previous literature recorded common injuries such as pelvis [5], thoracic [6], and thoracic spine [7] fractures with theorized injury mechanisms but had no testing or data to support these theories.
- The objective of this study was to create a repeatable test methodology with comparable speeds, deformation, PTW impact location, rider kinematics, and resulting injuries consistent with real-world crash scenarios.

MATERIALS & METHODS

- One of the most common crash configurations was determined to be 313, with the digit coding seen in Figure 1. This test aimed to mimic the 313 configuration by placing the stationary car at a 30° offset to account for the vehicle not moving.
- The following were used each test for repeatability:
  - 2022 KTM 390 Duke (Figure 2)
  - 2011 Honda Accord (Figure 3)
  - Bell Qualifier helmet (Figure 4)
- Three 50th percentile male post-mortem human subjects (PMHS) were instrumented with strain gages and 6 degrees of freedom motion sensors (6DX), which allowed for analysis of fracture timing and kinematic response.
- The PMHS were positioned on the PTW with a 10° forward lean of the thorax, with hands and heels on the handlebars, and footpegs respectively. Additional anatomical angle measurements were recorded (Table 2) to quantify the pre-test positioning.

RESULTS & DISCUSSION

- Figure 4 and Table 2 show the pre-test positioning angles for each test. These demonstrate the positions were similar with only minor differences due to human variation.
- Figure 6 reveals similar timing and PMHS interaction with the vehicle upon impact. Table 3 supports the consistency with common injuries and fracture response.
- Test 3 had a higher AIS score for T11 when compared to Test 1 and 2 due to a complete transaction of the spinal cord. Without this, the AIS score for the Test 3 T11 fracture would have an AIS of 3.

CONCLUSIONS

- The study was successful in creating a repeatable test methodology that accurately reflects real-world PTW and motor vehicle crash scenarios with an instrumented PMHS occupant.
- Repeatability was supported by data from strain gages to determine fracture timing. Alignment with high-speed video gave more context to the impact and aided in determining injury mechanism.
- Future work will include further evaluation of the kinematic response from 6DX sensors and resolving all injury mechanisms to help improve safety tools to the development of protection systems.

REFERENCES CITED

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CONTACT INFORMATION

Daniel.Meringolo@osumc.edu