1. Title: Assessment of Strain Patterns in the Brain from Real-World Acceleration Data from Collegiate Football Players

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3. Abstract: The purpose of this study was to determine how linear and rotational accelerations affected the location of high strain areas in the brain. Acceleration pulses obtained from instrumented football helmets were used as the input to the SIMon finite element model (FEM) of the brain. The acceleration pulses used for this study were isolated from a dataset that included 1,712 impacts recorded during one season of a NCAA football team. A multiple step process was used to select pulses of interest for modeling. First, the pulses were sorted by severity along each axis in linear and rotational acceleration. Next, each pulse was evaluated to determine the contribution of off-axis acceleration. The inclusion criterion for this study was that the off-axis acceleration could not be more than 30 percent of the acceleration of interest. The maximum acceleration of the pulses ranged from 27.2 to 56.3 g's in linear acceleration and 580 to 4180 rad/s^2 in rotational acceleration. These selected acceleration pulses were used as the input to the SIMon model (v4.0). The location of high strain and the Cumulative Strain Damage Measure (CSDM) were compared for all simulations. A quantitative measure of the different location of high strain elements was evaluated with three dimensional metrics. Relative strength of linear and angular peak acceleration and total velocity change as predictors of CSDM was also evaluated. The rotational acceleration and velocity were more predictive of CSDM with p-values of 0.06 and 0.002 for a second degree polynomial regression. In comparison, the p-values for the linear acceleration and velocity were 0.71 and 0.38. This study demonstrates that the strain patterns in the brain are more related to rotational acceleration than linear acceleration. Additionally, the spatial distribution of the high strain elements varies with the direction of acceleration in a potentially important way.

4. Poster or Oral: Oral