Erratum

Erratum to: Six Degree-of-Freedom Measurements of Human Mild Traumatic Brain Injury

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Erratum to: Annals of Biomedical Engineering
Vol. 43, No. 8, August 2015
pp. 1918–1934
DOI 10.1007/s10439-014-1212-4

This erratum is to correct our finite element simulation data in Figs. 5 and 6. The corrected versions of these figures are included here and maintain, if not strengthen, the major findings and conclusions of the paper.

For each finite element simulation, translational and rotational head impact measurements were transformed to a ground-fixed (inertial) frame and then used as inputs to the model describing skull motion in the ground-fixed frame. Peak principal strains for the loss of consciousness (LOC) (52.4%) and self-reported (32.9%) injuries were higher than the non-injury median (17.0%, 11–27% interquartile range) over the entire brain (Fig. 5b). Minimum pressures (absolute value) for the LOC (−92.3 kPa) and self-reported (−84.3 kPa) injuries were also higher than the non-injury median (−31.0 kPa, −49 to −20 kPa interquartile range) (Fig. 5e). Maximum pressure for the LOC (87.2 kPa) and self-reported (69.9 kPa) injuries exhibited the same trend compared to the non-injury median (33.2, 22–50 kPa interquartile range) (Fig. 5f). The LOC (52.4%) and self-reported (25.0%) injury strains in the corpus callosum were also higher

than the non-injury median (9.7%, 6–16% interquartile range) (Fig. 5a). The LOC injury peak principal strain was top 5% for the whole brain and the highest in corpus callosum, while the self-reported injury was top 18% and 11% for the whole brain and corpus callosum, respectively. A few non-injury impacts produced strains in the corpus callosum that exceeded the self-reported injury (none exceeded the LOC injury) and the LOC injury was one of two impacts where the peak principal strain occurred in the corpus callosum (Fig. 5k). For both injuries, large pressure differentials occurred between opposite sides of the brain, indicating a possible coup and contrecoup injury mechanism, in planes approximately parallel to the directions of peak translational acceleration (Figs. 5i and 5j).

As part of the correction, fewer non-injury impacts exceeded the injuries in FE criteria, and as a result, these criteria appear more predictive than previously reported. In particular, peak strain in the corpus callosum had an even lower deviance (10.9), still the lowest among all, followed by peak rotational acceleration magnitude (14.9), HIP (15.7), and GAMBIT (15.8) (Fig. 6). The LOC injury was one of two impacts analyzed whose peak strain occurred in the corpus callosum. The self-reported injury still developed a strain concentration in the corpus callosum (Fig. 5h), but there was an earlier moment in the impact where there is higher strain along the periphery of the brain.

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The online version of the original article can be found under doi: [10.1007/s10439-014-1212-4](https://doi.org/10.1007/s10439-014-1212-4).

FIGURE 5. Brain deformation injury criteria. Injury and non-injury values for each (A-F) brain deformation criteria are given for the subset of 110 impacts. Multiplicative standard deviation, σ^* , and log-normal median, μ^* , are indicated (all criteria except CSDM passed a test of log-normality). Fringe plots of (g-h) principal strain and (i-j) pressure indicate regions of greatest brain deformation. (k) The LOC injury was one of two impacts whose peak principal strain occurred in the corpus callosum.

FIGURE 6. Injury prediction using logistic regression. Logistic model coefficients, β_0 and β_1 ($\hat{\beta}_0$ and $\hat{\beta}_1$ for standardized values), are given for 18 injury criteria. Decreasing deviance, D , suggests a criteria logistic regression more closely approximates a perfectly predictive model. Criteria with deviance that significantly differed from the null model deviance are indicated by asterisks over their bar.