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The effect of brain mass and moment of inertia on relative brain–skull displacement during low-severity impacts

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Abstract

Traumatic brain injury is the leading cause of death in automobile crashes. The sensitivity of human brain injury prediction to small parameter changes is a critical element of both experimental and mathematical work yet to be adequately investigated. This work proposes a new analytical human brain injury model to determine the parameters to which injury prediction is most sensitive. The trajectory sensitivity analysis explicitly indicates that injury prediction is most sensitive to brain mass moment of inertia, followed by brain mass. A number of finite element (FE) simulations were executed with various brain sizes. The maximum relative brain motions decrease with decreased brain size, and they are very close in the FE and analytical models. We conclude that brain mass moment of inertia, primarily, and brain mass, secondarily, should be varied in focused experimental and FE modeling work to

ensure that conclusions are not drawn from individual data points at which injury predictions are highly sensitive to small parameter changes.

Key words:

Head impact | sensitivity analysis | analytical method | finite element method | brain displacement | brain mass | brain moment of inertia

Notes

[a] K, bulk modulus.

[b] EA, force/unit strain.