Strain Energy Density Analysis of Head Impact

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Abstract

Objective: This study Aimed to reveal the strain energy density propagation features in the brain when the head is subjected to impact load.

Material & methods: (1) Modeling of the head geometry includes scarp, membrane, bone, skin, brain and nerve bundle in addition to all the interfaces. (2) Normal and shear impact load were at head front (pulse with specified duration). The skull could be fixed locally or free to move. (3) Two-dimension numerical calculations were made to reveal how the energy density propagates around the nerve bundle from the front of the impacted head to back and becomes most severe when it returns to the front again.

Results: (1) Fixed condition (normal impact) - the sequence of 3 pictures is from 1.7-4.7 ms where the energy density is seen to be concentrated in a region near the nerve bundle; it moves around the central nerve and then back to the front with increased intensity. (2) Free condition (normal impact) - the same feature is observed except that local energy density intensity is more severe. Additionally, at 7.5 ms the region near the skull base also intensifies, a site of potential damage. (3) Fixed (shear impact after 1.7 ms) - the local region of energy density is more intensified when compared with normal impact. (4) Free (shear impact after 1.7 ms) - two energy density intensified regions were found at the base skull: one in the front and another in the back. This is more damaging.

Conclusions: The results of this calculation show that it is the most vulnerable region where the dynamic energy integrity moves around the nerve bundle and does the damage. So, this is the region where autopsy should be done for pathological examination.

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