D28 Forces Transmission to the Skull in a Case of Mandibular Impact

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After attending this presentation, attendees will better understand direct mandible impact, the level of energy required to create a mandible fracture, and the energy dispersion to the skull and to the brain.

This presentation will impact the forensic science community by providing a better understanding of the force transfer mechanisms into and from the mandible.

Background: Forensic investigations have been reported regarding the loss of consciousness and cardiac arrests resulting from direct mandible impact; however, the mechanisms by which the forces are transferred to the skull through direct mandible impact remain unclear.[1] A study was conducted regarding direct mandible impact on the level of energy required to create a mandible fracture and on the energy dispersion phenomenon to the skull and to the brain.

Materials and Methods: This study combines an experimental and numerical approach. Mandible strike was studied using experimental trials performed on postmortem human subjects. A finite element model of the head and face of a male was also developed based on tomodensitometry scans. The model was validated with literature data and experimental trials. A parametric study was then performed to study the effect of diverse variables such as the dentition integrity, cortical bone thickness, etc.

Results: The forces measured on the reference model were 3,000N on the chin, 1,800N at the condyles, and 970N in the occiput. Of all the results, a decrease of approximately one-third of the efforts from the chin to the base of the skull and a lower half of the still forces at the occiput was observed, except in the edentulous and for the lateral and frontal impact where the force is transmitted directly to the skull base area.

In this study, the skull model was validated to demonstrate the energy transmission to the skull, but the focus was the von Mises stress distribution of the cerebral pressure areas. The von Mises stress was distributed with an anterior-to-posterior orientation through the temporal lobe and ended at the brainstem level. Viano et al. found that a hook strike increases the stress in the temporal region and at the midbrain level.[2] Belingardi et al. developed a Finite Element Method (FEM) of the head based on the experimental trials performed by Nahum et al. and found increased cerebral pressure with significant stress in the coronal section of the brainstem, which confirms its pivotal role in movement of the brain.[3,4]

Thus, it can be supposed that during an uppercut, part of the impact energy reaches the brainstem, which is obviously supported by the levels of stress found at the condyles during the simulations and the fractures observed at the temporomandibular joint in both experiments. This result is interesting from a forensic point of view because the pressures observed in the brainstem could lead to a vagus nucleus stimulation, which may be involved in cardiac arrest via the cardio-inhibitory reflex.

Conclusion: A 3D model of the mandible and face bones was created for this study to better understand the force transfer mechanisms into and from the mandible. The parameters of the model may be modified to suit the individual characteristics for forensic investigations and legal matters.

Reference(s):

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