H13 Mandible and Cranial Base Fractures in Adults: Experimental Testing

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This goal of this presentation is to outline results from a recent study on fracture production and propagation in the human skull, and

demonstrate the biomechanical forces behind blunt force trauma, cranial base fractures, and mandible fractures.

This presentation will impact the forensic community and/or humanity by showing the biomechanics behind the creation and propagation of cranial base and mandible fractures using experimental testing.

Fracture biomechanics can contribute a great deal to the field of physical anthropology, with trauma analysis aiding in determining cause and manner of death (1). Postmortem trauma assessment is an essential tool for identifying the type of trauma location of impact sites, sequencing blows, and establishing the characteristics of the object responsible for injury (1). In anthropological trauma analysis, one of the most complicated and confusing areas is blunt force trauma. Within the realm of blunt force trauma, cranial base fractures and mandible fractures are two areas that are extremely hard to interpret and have confused anthropologists for years.

Fractures that travel through the cranial base have been designated a wide range of terminology, and an even wider range of biomechanical explanations for their creation. They have been attributed to falls, blows to the top of the skull, and hinge fractures (1). However, the exact mechanisms behind the creation and propagation of cranial base fractures remain unclear. Mandible fractures are similarly confusing, due to the unique shape and biomechanical properties of the mandible which can produce abnormal fracture patterns. The curved shape of the mandible causes it to react to forces in a different manner than do more regular bones, such as the long bones leading to difficulty identifying point of impact.

To illuminate the creation and propagation of cranial base fractures and mandible fractures, a study design was developed that would utilize the cutting edge technology in the fields of industrial and biomedical engineering, while keeping with the needs of anthropology. Because of the unique biomechanical properties of the human skull, it was decided that a non-human substitute was not an option. Fifteen fully fleshed, unembalmed cadaver heads were used. A small portion of the cranial vault was removed from each head, as well as the brain to allow viewing of the creation of the cranial base fractures by high-speed film. An engineering drop tower system was constructed to delivered calibrated, fully monitored blows to each specimen.

Each specimen was impacted in several designated areas in a controlled experiment to produce cranial base fractures. In addition, each head was impacted in the mandible, with five heads impacted at the apex of the chin, five at the midline of the horizontal ramus, and five at the gonial angle. Five data acquisition load cells monitored the biomechanical response of the skulls for compressive and shear stress in the X, Y, and Z moments in millisecond intervals. With the data from the load cells, the forces throughout the impact and fracture propagation were charted and analyzed. After testing, each of the specimens was examined, with fractures charted and photographed. Each head was then processed and reconstructed to analyze the fracture patterns that resulted from each impact location. The experimental design allowed for complete monitoring throughout the impact event, and provided extensive data on how the cranium responds to blunt force trauma and how fractures occur.

Results from the testing showed that cranial base fractures can be created by a strong blow to the lower parietal region, and fracture propagation travels through the areas of least support with in the base. Radiating fractures were also observed around the external auditory meatus. The mandible was shown to have characteristic fracture patterns correlating to the location of impact and resulting stress. Each of the three test areas displayed different patterns, and characteristic areas of tension and compression. Results from testing may help forensic anthropologists to understand confusing fracture patterns in the cranial base and mandible, and provide better trauma analysis.

References:

1. Berryman HE, Symes SA. Recognizing gunshot and blunt cranial trauma through fracture interpretation. In: Reichs KJ, editor. Forensic Osteology: Advances in the identification of human remains. Illinois: Charles C. Thomas, 1998.
2. Galloway A. Fracture patterns and skeletal morphology: introduction and the skull. In: Galloway A, editor. Broken Bones. Springfeild, IL: Charles C. Thomas, 1998.

 ** Presenting Author*

3. Symes SA, Berrryman HE, Smith OC. The changing role of the forensic anthropologist: pattern and mechanism of fracture production. Lecture presented at Mountain, Swamp, and Beach meeting of practicing forensic anthropologists. Gatlinburg, TN, 1989.

Cranial Base Fractures, Mandible Fractures, Impact Biomechanics

