A139 An Experimental Investigation of Blunt Force Fracture in the Human Mandible

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Learning Overview: After attending this presentation, attendees will be informed of the results of experimental blunt impacts to human mandibles.

Impact on the Forensic Science Community: This presentation impacts the forensic science community by providing baseline data associating known points of mandibular impact with resultant fracture patterns.

Available literature on mandible fractures can largely be categorized into: (1) clinical studies aimed at evaluating frequencies of fracture types; or (2) impact studies aimed at evaluating fracture tolerances. In clinical studies, the precise loading conditions responsible for fracture patterns are unknown. Conversely, tolerance studies typically provide limited information on fracture patterns. The goals of this study were to conduct impacts to human mandibles at five locations, report on fractures produced in each impact, and describe any patterns that emerged.

The experimental sample comprised 13 intact heads from non-edentulous, unembalmed male cadavers. Heads were placed in an upright position using a previously described procedure.[1] A 1-inch long, 2.5-inch diameter cylinder with a mass of 6.45kg was selected as the implement to simulate a single, clenched fist impact. Mandible impacts were performed at an average velocity of 8.06m/s±1.46m/s and input energy of 216.1J±73.5J, which produced fractures in all cases. Impacts were delivered to the following locations: midline (n=3), anterior body at the canine (n=3), mid-body at M1 (n=2), posterior body at M3 (n=2), and ramus (n=3). All non-midline impacts were performed on the left side. Following experimentation, each mandible was resected and macerated, and fracture numbers and locations were assessed. AO Foundation Craniomaxillofacial (AOCMF) standards were applied in assigning fractures to one of nine regions including the left and right condylar processes, coronoid processes, bodies, and angles, and the symphysis.[2]

Peak forces producing fracture showed considerable variation without a clear relationship between impact location and fracture force. Peak forces ranged from 1558.3N to 9669.7N (mean=3733.0N±2056.0N).

Thirteen mandibular impacts produced fractures in six anatomical regions defined by the AOCMF section. No fractures were observed in the coronoid processes or the right mandibular angle.

One key result was that impact location appeared to influence the number of fractures produced. Mandibular body impacts were the only experiments to produce fractures in exactly one location; this was observed in 5/7 cases. In contrast, all ramus and midline impacts generated multiple fractures: fractures were observed at two to three locations in ramus impacts and two to five locations in midline impacts.

Another key finding was that impact location influenced fracture location. Impacts to the left mandible always produced at least one fracture on the left mandible. All three ramus impacts produced impact-side condylar process fractures and one to two additional fractures in the left and/or right mandibular body. Similarly, body impacts consistently produced fractures at or adjacent to the impact site: anterior body impacts generated fractures in the left body; mid-body impacts generated fractures in the left body and angle; and posterior body impacts generated fractures in the left angle. One anterior body impact also produced a right condylar process fracture and one posterior body impact also generated a symphyseal fracture. Midline impacts also produced some consistent results: all three impacts generated symphyseal fractures and unilateral or bilateral fractures of the articular portion of the condyle. One impact also produced mandibular body fractures.

All impacts produced at least one fracture approximately at the impact site. However, cases with multiple fractures exhibited considerable variation in the location of additional fractures. Furthermore, few impact locations produced unique results. Fractures of the mandibular body, condylar processes, and symphysis were observed in impacts to various sites. Only one result appeared unique to an impact site: mandibular angle fractures only occurred in body impacts. These results indicate that when multiple mandibular fractures are present, it is necessary to look to tension and compression features to reconstruct bending direction.

This presentation communicates consistencies and variations in fracture patterns generated in impact experiments to human mandibles. These results contribute a useful comparative sample of known blunt trauma cases for practitioners evaluating mandibular fractures in forensic cases.

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Reference(s):

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Blunt Force Trauma, Trauma Analysis, Facial Fracture