H64 Effect of Angled Impact on Bone Fracture Pattern

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After attending this presentation, attendees will gain a deeper understanding of the different fracture patterns that may result from angled versus perpendicular impacts to human long bones.

This presentation will impact the forensic science community by providing information to better analyze fracture patterns and determine more precise mechanisms of injury or rule out potential causes of fractures.

The complex protein structure and mineral composition of bone provide phenomenal tensile strength despite being low in density. The unique structure of bone yields a strange array of fracture patterns that depend on the mechanism of force, be it torsion, compression, or impact. Fracture patterns provide valuable insight into the nature of the applied force that resulted in the injury, particularly if the mechanism of fracture was not observed. In the field of forensic science, there is an obvious advantage to understanding fracture mechanics when testifying about the cause of a particular injury. Though previous studies have examined patterns that result from changes in impact velocity and force, few other factors have been investigated, such as the specific angle of an impact and how it might affect fracture pattern. Some have claimed that particular fracture patterns (e.g., transverse versus oblique) can be attributed to a specific angle of impact. It was previously shown in this study's laboratory that perpendicular impacts result in typical bending-type fractures that include transverse, oblique, and wedge (a.k.a. butterfly) patterns.

For this project, 21 human long bones (five humeri, eight femurs, and eight tibias) were subjected to angled impacts in order to study the resultant patterns. The bones were retrieved from five embalmed cadaver donors. Two died from cancer (76yF and 46yM), two from coronary disease (91yF and 90yF), and one from a stroke (84yM). Each bone was impacted approximately mid-shaft on its anterior surface with a 4.75cm-diameter hardened steel pipe in a custom-built spring-loaded impact machine. Impact force was recorded using a load cell and the signal was fed to a personal computer. Data were formed into plots of time versus force via specialized software. Left-side long bones were impacted at a 60-65 degree angle with respect to the long axis of the bone. Their right-side counterparts were impacted at 70-75 degrees. Each trial was recorded on high-speed video (300fps) and resultant fractures were documented photographically.

All three classical fracture patterns (oblique, transverse, and wedge) as well as comminuted fractures were observed as a result of the angled impacts. Of the 21 fractures, 38% were oblique, 24% transverse, 24% comminuted, and 14% wedge. The perpendicular impacts of 109 bones (tibias and femurs) previously observed in this study's laboratory resulted in 26% oblique, 15% transverse, 34% comminuted, and 26% wedge.

The results of this study indicate that impact or bending fractures result in a variety of patterns regardless of impact angle. Fracture pattern, therefore, cannot be used to determine angle of impact. Moving forward, force data from these fractures will be correlated with mineral composition and calcium content (by bone ashing and calcium atomic absorption spectroscopy) to investigate their potential role in fracture patterns.

Angle, Impact, Fracture

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