H38 Bevel, Bevel in my Bone, Be it Bullet or Be it Stone? Misidentification of Blunt Force Trauma as Ballistic Entrance Wounds in Burned Cranial Bone

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After attending this presentation, attendees will come away with an understanding how heat affects preexisting injury. During the postmortem examination, it is possible to mistake blunt force trauma for ballistic if one is simply looking for an internal bevel to evidence injury type. Awareness of bone's plastic deformation from blunt insults, the telltale tags of bone driven into the calvarium and detached by heat, and metric analysis, can overcome misidentification of traumatic injury.

This presentation will impact the forensic community and/or humanity by providing awareness to the possibility of blunt force traumatic injury in crania being mistaken as ballistic injury in burned human remains.

Analysis of gunshot wounds in cranial bone utilizes characteristic signatures of entrance wounds and its associated internal beveling. These defects are produced by a high energy projectile penetrating the external table, punching out and beveling the diploe, and finally creating a defect on the internal table of a diameter greater than the external defect. Focally delivered blunt force trauma is similar in mechanism but is of lower energy and forces create depression fractures with crushing, plastic deformation, and incomplete beveling of the opposite impacted surface in viscoelastic bone. Fresh blunt force skeletal wounds typically appear as internally levered bone or a punched in plug partially attached or driven into the cranial vault. Burning of the body after these events can produce confusing appearances if the thermal effects are not taken into account.

With burned human remains, heat degrades organic components, leaving bone brittle, and subject to fragmentation. The internally levered fragments or bone plugs from blunt impacts become highly fragile and may detach from the original wound defect. The absence of levered bone or bone plug leaves an internal bevel for postmortem analysis identical to ballistic beveling. Misidentification of this wound type as ballistic injury instead of blunt force trauma allows erroneous estimation of death determination, a misguided search for weapons, and contradictory autopsy findings against testimony.

In order to investigate morphological differences among blunt force and ballistic wounds in burned cranial bone, twelve cadaver heads were subjected to mechanical focal blunt impacts with known weapons and injury sites. Specimens were burned in environments simulating forensic fires. Wound morphology, internal beveling of focally traumatized crania and radiographs were compared to fifteen crania with ballistic injury, burned under similar conditions, and evaluated for morphological differences between traumatic injury types.

Visual inspection revealed blunt injuries ranging from patterned external depressions, crushing with plastic deformation and partial or full penetration of external and internal tables. Focal injuries produced by hammer faces, blunt angled instruments, and edged weapons created circular, angular, or rounded injuries with corresponding internally levered bone or detached plugs in the neurocranium. The embrittlement typified in charred to calcined cranial bone left internally beveled fractures easily mimicking gunshot wounds. The wound morphologies for thirteen blunt force injuries penetrating layers of cranial bone were found to have an internal bevel similar to ballistic entrance wounds. At times portions of bone remain attached in unburned blunt force trauma, but the effects of heat causes structural embrittlement and fragmentation; therefore leading to the detachment of this delicate bone evidence during burning or following recovery. Evidence of this fragile fragment remained attached in only one of the experimental specimens. Blunt injuries were distinguishable from gunshot wounds only when small tags of internally levered bone remained around the external surface of the impact site, reflecting slow deformation and shape of instrument.

Diameters of entrance wounds and their corresponding internal bevel dimensions from blunt force trauma and ballistic injury were subjected to a MANOVA. Results demonstrate the two trauma groups are statistically different ($p<.0001$). Further, a discriminant function analysis correctly identified eight of the 11 blunt force trauma wounds and 14 of the 15 gunshot wounds with an overall cross-validated classification rate of 83%. Ballistic and blunt force injuries overlapped slightly in dimensions but tended to favor smaller diameters for ballistic injury and larger diameters for blunt force trauma. This is also a function of differential penetrating object sizes since a firefighter's pickaxe was indistinguishable in size and beveling from ballistic injuries. Gunshot wound entrances measured around 9 mm14 mm with an internal bevel of 12 mm23 mm while the blunt force entrances measured from 11 mm26 mm with an internal bevel ranging from 17mm-40+ mm.

Both trauma types were radiographed to identify presence of metallic or lead wipe residues retained in bone as evidence of weapon material. Only two of the twelve gunshot wound crania retained radiopaque evidence of bullet penetration and were only present in unburned bone, while none of the blunt force impacts retained metallic residue, thus further complicating differentiation of ballistic from blunt injury in burned bone.

During the postmortem examination, it is possible to mistake blunt force trauma for ballistic if one is simply looking for an internal bevel to evidence injury type. Awareness of bone's plastic deformation from blunt insults, the telltale tags of bone driven into the calvarium and detached by heat, and metric analysis, can overcome

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misidentification of traumatic injury. Fragile skeletal evidence, altered or destroyed from fragmentation during the fire, or by any taphonomic influence [collapse of debris, handling, transportation, and reconstruction] may become impossible to decipher. Immediate documentation and preservation of burned skeletal evidence is critical for correct identification of traumatic etiology.

Burned Bone, Blunt Force Trauma, Ballistic Trauma

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