H37 Features of Preexisting Trauma and Burned Cranial Bone

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After this presentation, the attendee will be able to: 1) recognize problems associated with analyzing burned human cranial remains,
2) establish expectations of normal artifacts from fire trauma, and 3) identification of aberrant features that may indicate preexisting trauma.

The majority of accidental fire deaths occur in homes or vehicles, but some are set to intentionally obliterate homicidal acts, personal identity, or incriminating evidence. Recognizing these is compounded when burning destroys the soft and hard tissues of the human body. With respect to the head, identity and injuries are readily obscured because of its structural vulnerability as protective layers of skin and muscle are quickly burned away, exposing bone to rapid organic degradation from heat. Absence of organic components leaves thin cranial bone fragile and susceptible to additional heat fracturing, mechanical fractures, deformation, and delamination (separation of tables). Within limits, these are expected to occur in thermally stressed cranial bone, but the danger lies when they either mimic or obscure antecedent traumatic features.

This problem is explored using a sample of 15 unembalmed human heads from anatomical gift donations, fully fleshed and preserved by freezing. Prior to and following placement of known trauma, each head was documented with lateral and anterior-posterior radiographs. Once fracture patterns and sites of impact were visualized on X-ray, each head was burned under controlled conditions while photographically recording soft tissue reactions of traumatized areas, followed by burn patterns in cranial bone. Experiments varied from partial to full cremation in order to appreciate the range of thermal degradation of traumatic stigmata and identifying characteristics. The fragmentary cranial remains were recovered, processed, and reconstructed to differentiate between trauma and the expected alterations of thermal destruction. In addition, known cases of homicide-related fires with trauma to the head were included in the study. All specimens were examined grossly and microscopically for patterns associated with trauma.

It is important to recognize the expected heat-related fractures in cranial bone prior to discussion of traumatic characteristics. Fleshed human crania burn according to the anatomically distributed insulative covering of soft tissue. Usually the superficial bony areas under the thin uniform scalp and forehead burn first followed by the thick muscular areas of the lower face. Heat dehydrates, shrinks and splits the to expose underlying muscle and bone. Heat destroys the organic composition, expressed through a progressive color range of buff (initial organic degradation), black (carbonized organic destruction), and white/gray (calcined inorganic structure). Aggressive interactions among rapid heating, vigorous shrinking of soft tissue including periosteum, and organic loss from the bone are responsible for initial creation of heat fractures in all stages of color, especially calcination.

A multitude of these may be present in the external table as small surface tensile cracks or superficial sites of delamination where the outer layer shrinks, separates and exposes the diploe. In several experimental crania, this produces a beveled appearance mimicking ballistic and blunt trauma. Advanced incineration or impacts while burning may produce fractures extending into the inner table. In calcined bone, sites such as these or open sutures may have a deep black outline around the breach from pressurized venting of organic materials within the vault. Examination of this feature is important since it was present in both known traumatized and non-traumatized (sutures and full thickness heat fractures) sites of the skull.

Linear fractures seen in a burned skull initially fall into a gray area since they have features of either heat or pre-existent trauma. These can occur during the earliest stage of burning as organic material undergoes destruction causing shrinking and splitting of bone. In areas of prolonged heat exposure, they may also radiate out from charred black areas into buff-colored bone freshly undergoing initial thermal alteration. However, they should not extend into green (unburned bone), as this is a feature of a preexisting fracture. Deep linear fractures sectioning all tables of cranial bone should be examined for morphologies along corresponding margins. Well-defined sharp margins are incurred in advanced calcined bone from thermal or mechanical fractures, possibly accompanied with deformation and shrinkage. Traumatic fractures have blunted deformed or even warped margins from thermal alteration. The difference becomes obvious following reconstruction, since heat fractures communicate more perfectly than traumatic fractures distorted by heat.

Features of traumatic injuries were easily evaluated during early stages of burning. Any compromise in skin integrity over the cranium prematurely exposed bone to thermal destruction. Sites of cut marks or lacerations opened quickly and accelerated damage much like the effects of advanced decomposition around an open perimortem injury. Partial incineration provided an opportunity to observe the progressive effects of heat on the blunt, sharp, and ballistic trauma in cranial bone. Pre-existent linear fractures undergo little change through the ranges of unburned, initial buff, charred; calcined fractures become difficult to assess as margins gradually become beveled, ragged, blunted, or deformed. Suspected features should be closely examined and visually compared with a multiplicity of known dry postmortem heat or mechanical fractures surrounding the area.

Several distinct characteristics of blunt, ballistic, and sharp trauma do survive varying degrees of thermal

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destruction. With careful recovery and reconstruction techniques areas of inwardly crushed bone, ballistic and blunt beveling, features of impact sites, and sharp margins from edged weapons are preserved. Unfortunately dynamics of the burning environment, extinguishment methods, collapse of debris, and improper or incomplete recovery techniques can destroy these features. Therefore the likelihood of finding obvious signatures diminishes and less discernible than in unburned bone. Exercise extreme caution when looking for preexisting trauma and strive to use multiple indicators as supportive evidence. A variety of traumatic and non-traumatic features in burned cranial bone will be illustrated along with their forensic applications for evaluating burned bodies and bones.

Skeletal Trauma, Burned Bone, Fire investigation

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