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A77 Pediatric Antemortem Healing Standards Based on Microscopic Analysis of Fractures in Known Forensic Child Abuse Cases

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The goal of this presentation is to examine the theoretical and anatomical foundations for pediatric antemortem fracture healing and to present microscopically derived healing standards for use in forensic antemortem trauma cases.

This presentation will impact the forensic science community by providing forensic anthropologists and pathologists with more realistic and useable standards for classification and interpretation of forensic pediatric antemortem fractures. This will aid in determination of time-since-injury for these fractures and provide evidence relating to determination of accidental vs. non-accidental etiology for peri-mortem fractures in pediatric death investigations.

This presentation reviews the theoretical and anatomical basis for antemortem healing, particularly in regard to subadults. The process of bone healing from trauma is a complex and dynamic one which does not lend itself well to compilation of finite stages. Numerous phases/stages for antemortem fracture healing have been presented in the medical and forensic literature and are commonly used by forensic anthropologists and pathologists in determination of time-since-injury in pediatric death investigations.^{1,2} These assessments heavily influence determinations of accidental vs. non-accidental origin of peri-mortem pediatric fractures. A comparison of these healing phases reveals inconsistencies in their terminology and definition, in part due to reliance on clinical (non-forensic) samples imaged through radiology. Prosser doubts the relevance of these radiological standards to forensic cases because they are based on immobilized fractures in otherwise healthy children examined in a clinical setting.³ McCormick and Love have called for revised guidelines for antemortem fracture interpretation based on macroscopic forensic samples.⁴

More accurate observation of the antemortem healing process is accomplished through microscopy. In this study, evidence for this healing process is assessed microscopically in a sample of 679 images taken from a digital light microscope, the Keyence VHX-1000 at 5x-200x, representing 48 fractures from five known cases of pediatric death from child abuse. Forty-one of these fractures are present on ribs; the remainder affect long bones and the clavicle. These cases represent the range of the healing process (early to late); in two cases, fairly precise healing times are known or inferred.

These microscopic images are used to illustrate the healing process and develop microscopically based guidelines for bone healing. Key microscopic signatures observed include evidence for acute inflammation, fracture margin rounding, early beginnings of subperiosteal new bone formation, progressive organization of immature fibrous bone leading to bridging and eventual replacement of woven with lamellar bone, resorption of necrotic bone tissue, loss of fracture margins, and advanced signs of remodeling. A series of images showing this bone healing progression is presented.

Based on this analysis, it is proposed that antemortem healing is a continuous process which is not conducive to rigid interpretation using a finite staging system. Stages, as defined, should be used as an interpretive model representing this continuous process.

Reference(s):

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