A25 Comparability of Macroscopic, Microscopic, and Radiologically Defined Pediatric Antemortem Healing Stages

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The goal of this presentation is to compare macroscopically, microscopically, and radiologically based standards for assessing and interpreting pediatric antemortem fracture healing.

This presentation will impact the forensic science community by providing forensic anthropologists and pathologists with an understanding of the accuracy and potential problems associated with antemortem pediatric fracture interpretation based on different media and contexts. This research will demonstrate that there is considerable variation in observation of macroscopically, microscopically, and radiographically defined healing stages. Recognition of this variation will ultimately aid in more accurate identification of pediatric antemortem fractures in a forensic setting and lead to more precise determinations of time since injury for these fractures.

Recognition and dating of antemortem pediatric fractures in a medical examiner setting may first occur with the use of radiography, followed, in some cases, by macroscopic (gross), microscopic, and histological observation. Radiographic standards for antemortem pediatric bone healing have been derived from observation of immobilized fractures (of a usually accidental origin) in a clinical non-forensic context restricted in temporal extent. In contrast, macroscopic antemortem fractures observed in a forensic context may not have undergone immobilization and are often attributable to a non-accidental etiology. Temporal range of these fractures (e.g., time since injury) may be much broader.

In this study, more than 700 digital macroscopic, microscopic, and radiographic (both digital and analog) images depicting antemortem healing from 55 fractures originating from seven known forensic pediatric death (child abuse) cases are evaluated for the presence of diagnostic characteristics typically observed in bone healing. These characteristics include, but are not limited to, the presence of localized inflammation, rounding of fracture margins, subperiosteal new bone formation, organization of callus, hard callus formation, presence of distinct fracture lines, and resorption of fracture lines. These bone healing signatures are evaluated in relation to established macroscopic, microscopic, and radiographic standards for antemortem fracture healing and the total number of features observed in each medium compared across groups.[1-3]

Results of this study indicate limitations in radiographic-based identification and interpretation of antemortem fractures. This is especially characteristic of the diagnosis of very recent fractures, as well as aged fractures in late stages of remodeling. Identification of subperiosteal new bone formation, distinct fracture lines (particularly in the rib cage), and metaphyseal fractures are often occult in radiographic images. The highest percentage of identified indicators of the healing process through radiography occurred within the middle reparative stages due to the presence of callus formation. While macroscopic imaging allows greater observation of antemortem healing characteristics compared to radiography (particularly in the early and later stages), microscopic imaging reveals an increased number of clear healing features and holds the greatest promise for dating of these fractures.

These results indicate the following: (1) use of established standards for pediatric antemortem fracture identification, interpretation, and dating are heavily dependent upon the medium used (gross observation, microscopy, radiology) to define the stages; (2) specific standards should be developed for the appropriate medium used to assess and date antemortem fractures; (3) reliance on radiography for identification and interpretation of antemortem pediatric fractures is problematic and those standards developed in clinical settings may not be comparable to forensic ones; and, (4) microscopic imaging of the antemortem healing process is strongly recommended in cases of suspected child abuse.

Reference(s):

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