A107 Documenting Fracture Time Since Injury (TSI) Through a National Archival Database of Antemortem Fracture Healing

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The goal of this presentation is to document anatomical variability in antemortem fracture healing to aid estimation of TSI in forensic abuse cases. This is accomplished through the creation and demonstration of a national archival database for antemortem fracture healing containing macroscopically, microscopically, and radiologically derived data.

This presentation will impact the forensic science community by providing forensic anthropologists and pathologists with an understanding of the variability inherent in antemortem fracture healing in relation to a number of key attributes. This presentation will aid in the determination of fracture TSI and ultimately provide evidence (and strengthen court testimony) relating to the determination of accidental vs. non-accidental etiology for peri-mortem fractures in forensic death investigations involving suspicions of pediatric, domestic, or elderly abuse.

Assessments of TSI for antemortem fractures heavily influence determinations of accidental vs. non-accidental origin of peri-mortem fractures in cases of suspected abuse. In this presentation, the anatomical basis for antemortem healing is reviewed, particularly in regard to dating of fractures and the factors that influence TSI determination.

Antemortem healing is a continuous process which does not lend itself well to rigid interpretation using a finite staging system.[1] Determining the timing of prior injury is difficult because bone repair is influenced by a number of important variables. These variables include an individual's age, sex, nutritional and disease status, fracture location, type, and severity as well as presence and nature of treatment and repetition of injury.[2,3]

This presentation illustrates the effect of these variables upon the healing rates of antemortem fractures. In this study, the antemortem healing process is chronicled through examination of a sample of more than 1,500 macroscopic, microscopic (from a digital light microscope at 5x-200x), and radiologic digital images representing 106 antemortem fractures from 11 forensic cases (six females, five males) involving pediatric, domestic, and elderly abuse.

These images are used in the creation of a digital archival database for antemortem fracture healing for use in forensic TSI estimation. This archive consists of a searchable, online (web-based) database of antemortem fracture imagery, including macroscopic, microscopic, and radiological modalities. The database is implemented as a web app through the Radford University Forensic Science Institute website, developed in python using a Flask microframework and a MySQL™ database; both the database and website are hosted on a single Linux® platform. This website allows users to search for antemortem fracture images across the three modalities and the variables discussed above (e.g., age, sex, bone, fracture location and type, healing status, and estimated TSI).

The database includes individuals ranging in age from 27 days to 79 years; 58% of all fractures derive from subadults. Fracture location overwhelmingly involves ribs (88%), but also long bones (primarily the diaphysis) and the clavicle. Fracture timing reflects the range of the healing process (early to late) and is categorized in terms of healing status based on criteria developed by Boyd et al.[1] In at least three cases, fairly precise healing times are known or inferred.

These macroscopic, microscopic, and radiological images and their associated metadata are used to illustrate differences in the healing process across the variables examined. It is noted, for example, that metaphyseal lesions, though less visible, manifest quicker healing times. Faster healing times are also documented in the younger subadults.

The database also provides users with the ability to upload additional antemortem fractures cases, including histology images. Future additions to the antemortem fracture database from the forensic anthropology and pathology community will result in larger, more diverse samples, enabling better understanding of fracture healing variability and more precise estimates of TSI in forensic abuse investigations.

Reference(s):

1. Boyd D.C., Roller S., Boyd C.C. Pediatric antemortem healing standards based on microscopic analysis of fractures in known forensic child abuse cases. *Proceedings of the American Academy of Forensic Sciences*, 68th Annual Scientific Meeting, Las Vegas, NV. 2016.
2. O'Conner J.F., Cohen J. Dating fractures. In: Kleinman P.K., ed. *Diagnostic imaging of child abuse, 2nd ed.* Baltimore, MD: Williams & Williams,1998:168-177.
3. Prosser I., Maguire S., Harrison S.K., Mann M., Sibert J.R., Kemp A.M. How old is this fracture? Radiologic dating of fractures in children: a systematic review. *Am J Roentgenol.* 2005:184:1282-1286.

Antemortem, Fracture, Database