Fracture Healing in Unintentional and Abuse-Related Fractures in Children: Considerations of Identity in the Context of Physical Abuse

Diana L. Messer, PhD1,2,6; Brent H. Adler, MD3; Farah W. Brink, MD4; Henry Xiang, MD, MPH, PhD5; Amanda M. Agnew, PhD6

1Division of Anatomy, College of Medicine, The Ohio State University; 2SNAr International in support of DPAA Hawai’i; 3Department of Radiology, Nationwide Children’s Hospital; 4Center for Family Safety and Healing, Nationwide Children’s Hospital; 5Center for Pediatric Trauma Research & Center for Injury Research and Policy, Nationwide Children’s Hospital; 6Skeletal Biology Research Lab, School of Health and Rehabilitation Sciences, The Ohio State University

PURPOSE

- Healing fractures are a common radiographic finding in cases of child physical abuse.
- Accurate time since injury estimation of healing fractures may provide an opportunity for identification and characterization of physical abuse, especially in young children unable to verbalize.
- Timelines of fracture healing are primarily derived from unintentional (accidental) fractures in otherwise healthy children and applied to children suffering physical abuse and other forms of maltreatment.
- Potential differences in fracture healing between abused and healthy children has been largely unexplored (Messer et al. 2020).

This study examines the relationship of abuse status to fracture healing in a modern sample of children less than two years old.

MATERIALS + METHODS

- Retrospective study of humeral fractures in children less than two years old conducted at a large pediatric tertiary care center (Figs 1–3, Table 1).
- Abuse status was determined by a child abuse assessment team.
- IRB approval through Nationwide Children’s Hospital, Columbus, Ohio (IRB16-00241).
- Exclusion criteria included: 1) casted radiographic exams, if the fracture was obscured on all views, 2) unknown date of injury, 3) individuals with comorbidities or disorders affecting bone, and/or 4) fractures requiring internal fixation.
- Features of fracture healing (subperiosteal new bone formation [SPNBF] and callus formation) were evaluated and recorded (DLM) as present or absent on radiographs at initial and follow-up visits.
- Kruskal-Wallis H tests were performed to determine if there were significant differences in fracture healing time between abuse-related and unintentional fractures. First observation was tested to ensure independence of observations.

RESULTS

- Significant differences in injury circumstances, characteristics, and outcomes between abuse-related and unintentional injuries have been described (Discala et al. 2000). Abused children are more likely to have a preinjury medical history including comorbidities such as malnutrition and multiple injuries that may affect fracture healing. In addition, fractures in abused children are caused by different mechanisms, namely battering and shaking, as opposed to unintentional fractures that primarily the result of accidental falls and motor vehicle accidents. Abused children are also more likely to have severe injuries that require longer hospitalization (Discala et al. 2000).
- Given the holistic differences in the identities and injuries between abused and healthy children, we should consider whether/how the identity of our study samples contributes to differences in the time and expression of fracture healing.
- The identity of abused children should be considered when estimating fracture age.

DISCUSSION

- Over half (58%) of children with abuse-related fractures had multiple fractures as opposed to 8% of children with unintentional fractures (Fig 2).
- Majority of children with abuse-related fractures were less than one year old and most abuse-related humeral fractures were complete and diaphyseal (Table 1).
- SPNBF and all levels of callus matrix occurred earlier in abuse-related, but only intermediate callus approached statistical significance (Figs 4–5, Tables 2–3).
- Each fracture healing variable examined occurred earlier in abuse-related fractures, but none reached statistical significance.

LIMITATIONS

- Low sample sizes limited interpretation of statistical tests.
- Only one fracture location observed.
- One observer and no inter-observer error.
- Data reflective of medical protocols (i.e., protocols for follow-up exams based on fracture location and type imply that certain fractures will have fewer or no follow-up exams performed during certain days/weeks).

Disclosures: This research was supported by the Center for Injury Research and Policy at Nationwide Children’s Hospital through Grant Number 1R49 CE002106 from the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention and the Center for Injury Research and Policy.