H106 Upper Versus Lower Limb Pediatric Fracture Healing: A Radiographic Study of Time Since Injury (TSI)

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Learning Overview: After attending this presentation, attendees will understand the influence of fracture location on pediatric fracture healing and its potential impact, in both forensic and clinical contexts, for radiographic methods of TSI estimation, particularly in cases of child physical abuse.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by suggesting that not only should future TSI methods be specific to fracture location, but that the utility of methods derived from pooled bone samples may be inaccurate and inappropriate for use in a forensic or clinical setting. Improved TSI methods may lead to more accurate identification of child physical abuse that can inform decision-making regarding child protection.

The relationship of fracture location to healing is vastly understudied and its potential impact on TSI estimates remains largely unknown. As a result, timelines of pediatric fracture healing are often based on pooled samples of skeletal elements, which may not provide accurate results if healing rates differ significantly by location. Malone et al. suggest differences in healing between fractures of the radius and tibia, but whether this applies to all bones of the upper and lower limb remains unknown, and few, if any, existing methods take fracture location into account.[1]

This study assesses radiographic features of fracture healing in a modern pediatric sample of accidental fractures to evaluate whether fracture location (upper vs. lower limb) significantly influences rate of fracture healing.

Four hundred ninety-eight skeletal fractures (>1,355 radiographs) at Nationwide Children's Hospital in Columbus, OH, were evaluated for features of fracture healing, specifically fracture margin definition, Subperiosteal New Bone Formation (SPNBF), and callus formation. Features of SPNBF and callus were recorded for presence, thickness, matrix, and character based on modified parameters set by Walters et al.[2]

Independence and goodness of fit frequency tests were used to evaluate the relationship between fracture age and levels of SPNBF, callus formation, and fracture margin definition. Analysis of covariance tests were conducted to control for patient age, which has been demonstrated to affect fracture healing.[3]

Results of this study demonstrate that limb location significantly affects SPNBF thickness ($p<0.001$), with SPNBF occurring earlier in upper limb fractures. In addition, SPNBF thickness that was greater than 75% of the original bone shaft width only occurred in upper limb fractures. Limb location also significantly affects SPNBF character ($p<0.05$), with single-layered and multi-layered SPNBF occurring earlier in upper limb fractures. Further, limb location significantly affects callus thickness ($p=0.002$), with callus formation appearing thicker earlier, and lasting for a shorter duration, in upper limb fractures.

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Reference(s):

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2. Walters, M.M., Forbes, P.W., Buonomo, C., and Kleinman, P.K. 2014. Healing Patterns of Clavicular Birth Injuries as a Guide to Fracture Dating in Cases of Possible Infant Abuse. *Pediatric Radiology* 44 (2014):1224–1229.
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Fracture Healing, Child Abuse, Forensics