A141 Factors Affecting Bone Speed of Sound (SOS) in Infants

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Learning Overview: After attending this presentation, attendees will be able to identify characteristics of infant bone that affect tibial SOS measurements.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating that normal characteristics of growth and development influence measurements used to infer fracture susceptibility.

The assessment of bone fragility may be pivotal in the diagnosis or exclusion of non-accidental injury as the cause of trauma. However, there is no non-invasive, quantitative method for evaluating skeletal fragility in infants. Such a method could provide substantiated medical evidence of bone fragility or lack thereof in cases of suspected physical abuse. Quantitative Ultrasound (QUS) is marketed as a non-invasive, quantitative technique for evaluating bone quality and is considered a reliable technology for osteoporosis screening in adults.[1-6] Studies indicate SOS, a parameter of QUS, is correlated with bone characteristics related to bone quality.[7-16] Pediatric research suggests that QUS may also be used to evaluate the fragility of pediatric bone, but results are not definitive.[17-28] The purpose of this study is to evaluate the relationship between SOS and volumetric Bone Mineral Density (vBMD) and Bone Volume Fraction (BV/TV) measured by micro-computed tomography. It was hypothesized that SOS would be significantly related to age BMD.

The study sample consisted of 50 (41 term, 9 premature) infants between the ages of 30 weeks gestation (actual or corrected) at birth to one year postnatal at the time of death autopsied at the Harris County Institute of Forensic Sciences. Post autopsy, SOS (m/s) was measured on the anteromedial aspect of the left tibial midshaft using the Sunlight Omnisense 7000S. Subsequently, a Dremel® 4000 rotary tool with a diamond cutting wheel was used to cut a plank (~2mm x 10mm) from the tibial midshaft approximate to the SOS measurement site. Using a Scanco µCT 40 microCT scanner, tibial planks were imaged at 12-micron resolution at a voltage of 55kV and an intensity of 145µA. Analysis of vBMD and BV/TV were performed using the Scanco µCT version 6.1 analysis software with a threshold of 300 and a gauss of 0. One hundred consecutive slices were selected from the approximate center of each plank, and the cortical bone was contoured using a semi-automated method. During analysis, marked Subperiosteal New Bone Formation (SPNBF) was noted on the tibial surface of 23 bone planks.

Multiple linear regression and correlation analyses were used to examine the relationship between age, SOS, vBMD, and BV/TV. Regression results indicate a significant cubic relationship between age and SOS ($R_{adj.}^2$=.22, $F(3, 49)$=5.77, p=.002); SOS significantly decreased during the first three months of life (age^3 β=-2.43, p=.020), rebounding by 6-7 months of life (age^2 β=40.00, p=.013), and leveling off or decreasing thereafter (age β=-149.39, p=.026). Age also significantly correlated with vBMD (r_s=.51, p <.001) and BV/TV (r_s=.59, p <.001). A scatter plot indicated all samples with marked SPNBF were obtained from infants between 0-4 months or greater than 9 months of age. SOS was also significantly correlated with vBMD (r=.53, p <.001), BV/TV (r=.55, p <.001), and SPNBF (r=-.45, p=.001). A model predicting SOS from age^2, age, vBMD, and SPNBF accounted for 36% of the variance in SOS ($R_{adj.}^2$=.36, $F(4, 45)$=7.76, p <.001).

Results indicate that SOS is negatively affected by the presence of SPNBF on the infant tibia. SPNBF results from normal growth and development or a trauma response.[29,30] This study's findings suggest that the initial decrease in SOS during the first few months of life is likely due to the presence of SPNBF during this period of growth and development and not a result of decreased BMD. Additionally, results indicate that BMD has a positive effect on SOS. Other characteristics related to bone quality are also likely influencing SOS, as only a portion of the variance is explained by age, BMD, and SPNBF.

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Bone Mineral Density, Subperiosteal New Bone Formation, Quantitative Ultrasound