H29 Histological Abnormalities of the Costochondral Growth Plate in Infants and Young Children

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After attending this presentation, attendees will better understand the normal microscopic anatomy of the growth plate and the prevalence of growth plate abnormalities in ribs of infants and young children examined by the King County Medical Examiner's Office (KCMEO) in Seattle, WA.

This presentation will impact the forensic science community by contributing to the understanding of growth plate abnormalities of ribs in infants and young children that may indicate subclinical vitamin D deficiency and vulnerability to skeletal injuries or susceptibility to natural disease.

Previous studies have correlated abnormalities in the growth plate of infant ribs with subclinical vitamin D deficiency and suggested an increased vulnerability to skeletal fractures and sudden infant death. The anatomy of the normal growth plate is best appreciated as a sequence of transition from cartilage to bone, in which the critical features are most readily evident in the Hypertrophic Zone (HZ), where chondrocytes are large and arranged in columns, and in the Osteogenic Zone (OZ), where osteoblasts deposit osteoid on spicules of calcified cartilage matrix.

This study is a retrospective review of autopsies of infants and young children less than three years of age to evaluate histological abnormalities of the growth plate and their correlation with demographic and biological parameters. The costochondral junction of the ninth rib was sectioned perpendicularly to its long axis, decalcified in 10% formalin and 10% formic acid, processed by standard histological methods, and stained with hematoxylin and eosin. The slides were evaluated according to seven previously described criteria, as follows: (1) loss of columnar arrangement of cells in the HZ; (2) increased density of cells in the HZ; (3) increased thickness of the HZ; (4) irregularity of the boundary of the HZ and the OZ; (5) tongue-like projections of cartilage extending from the HZ into the OZ; (6) presence of thin-walled vessels traversing from the HZ into the OZ; and, (7) excess osteoid in the OZ. Cell density and thickness of the HZ were measured quantitatively using digital images with calibrated micrometer scales.

Altogether, the study included costochondral segments from 160 decedents, 138 of whom were 12 months of age or younger, including deaths due to natural disease (19), injuries (10), undetermined causes including Sudden Unexpected Death in Infancy (SUID) and Sudden Infant Death Syndrome (SIDS) (105), and other causes including asphyxia (26). In these 160 cases, abnormalities of the growth plate according to the seven criteria were identified as follows: arrangement of cells in the HZ was disorganized in 40%; height of the HZ was increased in 14%; cell density in the HZ was increased in 9%; an irregular boundary between the HZ and the OZ was identified in 11%; invasion of blood vessels in the HZ was identified in 1.2%; tongue-like projections of cartilage in the OZ were identified in 1.2%; and excess osteoid in the OZ was identified in 1.2%. Of the 160 cases, 59% had no abnormality in any of the seven criteria, 20% had abnormalities in one criterion, 11% showed abnormalities in two, 8% in three criteria, and 1.2% in four criteria. Two cases had abnormalities in all seven criteria and thus fulfilled the histological features of rickets.

Growth plate abnormalities were identified only in infants 12 months or younger. No differences were identified in any age group according to race or gender. No differences in growth plate abnormalities were associated with weight, but marginally significant differences were associated with height. Only two cases had histological changes of rickets. Unexplained fractures were not found.

The results indicated that the ribs of children under one year of age are more likely to manifest subtle growth plate abnormalities compared to older children. This finding may be related to breast feeding in infancy and lack of vitamin D supplementation. Additional prospective studies are needed to correlate histological changes of the growth plate with nutrition, vitamin D levels, and vulnerability to skeletal fractures.

Pediatric Bone Development, Growth Plate Abnormality, Vitamin D Deficiency

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