



## Physical Anthropology Section – 2007

### H18 Progression of Intra-Epiphyseal Union and its Predictive Capability in Fragmented Remains

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The goal of this presentation is to document the progression of intra-epiphyseal union for the major long bones of the limbs. Statistical analysis will be used to support progression patterns for confidence in the forensic context.

This presentation will impact the forensic community and/or humanity by presenting a new and innovative method for the analysis and re-association of commingled and fragmented juvenile remains. Understanding the pattern by which union progresses in an epiphysis

offers the ability to reasonably predict the possible range of maturity of the entire epiphysis based on a recovered fragment. Once biological maturity of that epiphysis is assessed then re-association with similarly mature material is permitted.

Commingled and fragmentary remains pose specific problems in the analysis and description of human skeletal remains. The loss of key skeletal features commonly used to indicate sex, age, stature or race can hinder the ability to establish biological profiles and therefore the accurate reassembly of individuals. However, if a biological indicator is only partly missing, the part remaining may yet provide sufficient evidence to predict the condition of the missing fragments, thus still allowing some viable indication of biological identity.

Understanding the temporal sequence in which the various epiphyses of the body unite can be useful for re-associating bones from individuals of similar chronological age, but perhaps different maturity status (Schaefer, 2006). However, if only part of an epiphysis is present, the maturity assessment of the epiphysis as a whole may be skewed if the full pattern of fusion options is not fully understood. For example, if an epiphysis that is actively fusing becomes fragmented and the only fragment of bone that is recovered displays complete union, then the temptation will be to assume that the entire epiphysis has fused. This will inevitably lead to an over assessment of age and potentially incorrect biological profile and/or impede reassociation of parts. However if it is known that this is the first part of the epiphysis to commence union, then the range of possible ages can be extended to reflect the precocious nature of this feature. The fusion status of the fragment may provide useful ranges of potential maturity for the epiphysis as a whole if the sequence in which union progresses through the epiphysis is fully understood.

Progression of union was documented on a sample of 73 Bosnian males by recording the status of intra-epiphyseal union around the periphery of the bone. This was achieved by functionally dividing the epiphysis into segments in much the same way as a two dimensional map documents three-dimensional objects. The epiphysis was conceptually “unrolled” into a flattened continuous scale so that it was possible to visually record the location where peripheral union had, or had not, taken place.

Intra-epiphyseal progression was established for the epiphyses of the proximal humerus, ulna, femur and tibia, the distal radius, femur and tibia and the ischial tuberosity. Progressions patterns were first determined using observational analysis and were later confirmed through statistical analysis. Mathematical computations required that the visual data be transformed into a numerical format. Each segment of an epiphysis was assigned a score between zero and four depending on its degree of fusion (0 = no union, 1 = less than 1/3 union, 2 = around half union, 3 = more than 3/4 union, and 4 = complete union). A Kruskal-Wallis Analysis of Variances was then performed comparing each segment of an epiphysis to each of the other segments of that same epiphysis. If the mean scores between any of the two segments displayed a statistically significant difference then it could be inferred with some confidence that the union status of one segment was either in advance of, or retarded to, the other segment.

The results of this analysis show that the first and or last areas to unite on an epiphysis are frequently statistically different from the other segments of that epiphysis indicating that there is a predictive progression to intra-epiphyseal maturation which may be of sufficiently significant value to aid in the assessment and reassociation of fragmented remains.

#### Reference:

- 1 Schaefer M. Forensic application of epiphyseal sequencing. *Proceedings of the American Academy of Forensic Sciences*, 2006;24H.

#### Epiphyseal Union, Commingled Remains, Bosnia