



Physical Anthropology Section - 2013

H100 Patterns and Timing of Cervical Vertebral Ring Epiphyseal Union in Individuals Aged 10 – 30 Years at Death

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After attending this presentation, attendees will have garnered new information concerning the timing and progress of union of the superior and inferior cervical vertebral centra or “ring” epiphyses as it relates to age at death, and as it varies by sex and population. The goals of this presentation are to: (1) provide an understanding of the progress of union of the superior and inferior epiphyses of the centra of cervical vertebrae; (2) explain the correlation between cervical vertebral ring epiphyseal union and age at death; and, (3) report and discuss findings from tests of sex and population differences in cervical vertebral ring epiphyseal union

This presentation will impact the forensic science community by providing an understanding of the timing and progress of cervical vertebral ring epiphyseal union as it relates to age and may aid in the estimation of skeletal age of unknown individuals, an important aspect of human identification.

For this study, data were collected from a sample of 100 individuals (34 African American females, 19 European American females, 21 African American males, 26 European males), aged 10 to 30 years at the time of death, from the Hamann-Todd Skeletal Collection. Eleven sites of cervical vertebral ring union were observed: the inferior surface of the second cervical vertebra (C2) and the superior and inferior surfaces of C3 through C7. A modified five-stage scoring method was used: Stage 0, no union; Stage 1, beginning or progressing union; Stage 2, fully fused epiphyses but lacking in remodeling, thus revealing grooves throughout the centrum; Stage 3, full fusion with a groove in some areas and remodeling in other areas; and Stage 4, full fusion with complete remodeling throughout the centrum.

There was a strong correlation between mean values for vertebral ring union in the total sample ($r=0.78$). Females showed a higher correlation between vertebral ring union and age at death ($r=0.83$) compared to males ($r=0.73$). European females showed a slightly higher correlation between vertebral ring union and age at death ($r=0.89$) than African American females ($r=0.83$), while African American males showed a considerably higher correlation ($r=0.76$) compared to European American males ($r=0.49$). Student's t-test results indicated no statistically significant differences in mean epiphyseal union values between females and males with populations combined, or between African American and European American females; however, the difference between African American and European American males was significant ($p<0.05$).

Raw data observations showed that more cranially oriented epiphyses seemed more advanced in union than caudally oriented epiphyses. A student's t-test yielded a statistically significant difference between the inferior ring epiphysis of C2 and that of C7 ($p<0.01$), with C2 being more advanced than C7; yet, there was no statistically significant difference between C2 inferior and C7 superior. Epiphyses were divided by cervical vertebra type—mean epiphyseal union values for C2-C3 were compared to C4-C5 and C6-C7—and an Analysis of Covariance (ANOVA) test showed no statistically significant difference in the progress of union according to vertebra type. Further, age at death correlated similarly across vertebra types: the correlation between age and C2 – C3 epiphyseal union mean values was $r=0.74$, for age and C4 – C5 $r=0.76$, and for age and C6 – C7 $r=0.78$. Epiphyseal union mean values of the superior centra were compared to the inferior centra for each vertebra; results indicated no statistically significant differences.

Observational analyses of the raw data were as follows: in some females and males, aged 10 – 12 years, union had already begun (Stage 1). Stage 0, no union, was surpassed by 19 years in females and 21 years in males. Stage 1, union in progress, remained evident in some males at 23 years and 19 years in most females, except for one female aged 30 years, who was thought to be an outlier. Stage 2, complete union with grooves, was first evident at 13 – 14 years for females and 15 – 16 years for males. Stage 2 remained evident in males at 25 years and in what was believed to be an outlier female aged 30 years. Stage 3, complete union with both grooves and remodeling, was first seen at 15 – 16 for females and 17 – 18 for males. This stage remained evident in both females and males aged 30 years. Stage 4, complete union with complete remodeling (no grooves), was first seen in both females and males at ages 17 – 18 years.

No individuals in the sample displayed all Stage 4 union. This finding may reflect the difficulty in distinguishing a groove from a scar, a slight color demarcation not eradicated by remodeling. In conclusion, cervical vertebral ring epiphyseal union may serve as a useful guideline for age estimation in unknown skeletons.

Cervical Vertebra, Epiphyseal Union, Age Estimation