



Physical Anthropology Section – 2004

H94 Preliminary Observations of Vertebral Centra Retraction and Its Relationship to Age

A. Midori Albert, BS, MA, PhD*, Anthropology Program, University of North Carolina at Wilmington, 601 South College Road, Wilmington, NC 28403-5907

After attending this presentation, attendees will understand the degenerative process of vertebral centra retraction, first described by Drukier et al. (2003), and how it relates to aging as well as its consideration for use in age estimation, particularly if key skeletal age markers such as pubic symphyses and or sternal ends of right fourth ribs are absent or damaged.

This presentation will impact the forensic community by sharing preliminary findings and reporting on the continued development of a new age estimation for unknown skeletons

The goal of this beginning study was to explore the relationship between a recently observed degenerative phenomenon of the vertebral centra with age at death from a known sample for purposes of assessing the efficacy of its future use as an age estimation method for unknown skeletons.

Specifically, the degenerative phenomenon, first described by Drukier et al. (2003) as a “sucking in” of the superior and inferior vertebral centra, occurs in adults after vertebral centra maturation is complete (i.e., after epiphyses of the superior and inferior vertebral centra—the “ring” epiphyses—are fully fused to the centra). The “sucking in” occurrence takes place when the central portion of the surface of the vertebral body begins to pull away or retract from the perimeter, where what was once the vertebral ring epiphysis has fused to the centrum, and sinks inferiorly, leaving a “sucked in,” concave appearance that we refer to as “retraction.” Drukier et al. (2003) have hypothesized a possible link between vertebral centra retraction and age at death, based on observations and skeletal analyses of decedents from recently exhumed mass graves in Europe.

To test Drukier et al.’s (2003) hypothesis, the retraction phenomenon and its relationship to known age at death was studied using a sample from the Robert J. Terry Skeletal Collection, housed at the Smithsonian Institution in Washington, DC. Superior and inferior centra of the thoracic vertebrae (T1-T12) and the first two lumbar vertebrae (L1-L2) of 63 known individuals (16 black females, 9 white females, 19 black males, 19 white males), ranging in age at death from 23 years to 78 years, were examined.

Gross morphological observations of vertebral centra retraction were documented using a newly developed numerical scoring system based on progressive stages of retraction observed. Stages of retraction were coded as 4, 5, 6 or 7 for each centrum, inferior and superior, of each vertebra used in the study—T1 through T12, L1 and L2. Stage 4 was the least retracted, whereas Stage 7 was the most retracted. Stages of retraction were designated as 4 through 7 to represent that this process occurs after epiphyseal union of the superior and inferior centra is complete (Stages 0-3, according to the Albert and Maples method, 1995). Thus, similar numbers for the stages between the two methods (i.e., 0-3 for both epiphyseal union and retraction) would not be confused between the two differing processes—one a maturation process (epiphyseal union), the other a degenerative process (retraction).

Descriptions of vertebral centra retraction in Stages 4 through 7 are as follows: Vertebral centra showing no retraction or a slight, beginning depression or concavity in the center of the centrum, with no separation along the perimeter, were designated as Stage 4. Stage 5 comprised either of two scenarios: 1) slight to moderate depression or concavity in the center of the centrum, or 2) retraction occurring along the perimeter of the centrum, or along the anterior border where what was once the epiphyseal ring separated or retracted from the centrum, where the centrum was depressed at these loci. In this case, the center of the centrum appeared slightly convex relative to the periphery of the centrum. Retraction in Stage 6 was moderate to advanced, occurring both at the center of the centrum radiating outward, as well as along a greater area of the perimeter of the centrum, where what was once the epiphysis was further separated (retracted) from the centrum along the anterior, lateral, and posteriolateral borders (with the posterior aspect of the perimeter of the centrum the last to retract, during Stage 7. Separation or retraction during this stage encompassed a greater surface area of the centrum, which was sunken in. The perimeter of the area retracted sloped inward, declining slightly, forming somewhat of a “V” shape. In the last stage, Stage 7, vertebral centra retraction was advanced, appearing noticeably more depressed or concave than in previous stages. The perimeter of the area retracted no longer sloped inward at an angle (“V” shape); rather, there was a vertical drop along the entire perimeter of the centrum (i.e., anterior, lateral, posteriolateral, and posterior aspects), forming somewhat of a “U” shape. Retraction was extensive over the surface of the centrum, where the centrum was clearly concave relative to the perimeter, which appeared to “wall in” or “rim” the central portion of the centrum. How these stages best relate to chronological age will be discussed.

Gross observation results of vertebral centra retraction revealed a distinct and predictable pattern in its progression as related to increasing age. Retraction along the perimeter of the centrum begins posteriolaterally and progresses anteriorly, with the posterior aspect the last portion to retract. Further, the centra of the middle thoracic (T5-T8) and the first two lumbar vertebrae (L1-L2) frequently showed more advanced retraction than the centra of the superior (T1-T4) and inferior (T9-T12) thoracic vertebrae.



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Quantitative analyses involved calculating a mean value for vertebral centra retraction for each individual in the sample, which represented the overall extent of the retraction phenomena for each person. Results of preliminary statistical analyses showed no significant correlation between overall mean retraction values and age. There were no statistically significant differences between overall mean retraction values of the superior vertebral centra when compared to the inferior vertebral centra. Mean values for vertebral centra retraction were also calculated separately for superior thoracic vertebrae (T1-T4), middle thoracic and first two lumbar vertebrae (T5-T8, L1-L2), and inferior thoracic vertebrae (T9-T12); these values showed no statistically significant correlation with age. When the data were analyzed separately by sex and ancestry, however, some interesting findings emerged. F-tests for the variance between the superior thoracic, middle thoracic and lumbar, and inferior thoracic vertebral centra retraction mean values showed that the superior thoracic retraction mean values differed significantly from the inferior thoracic retraction mean values ($p < 0.02$). There were no statistically significant differences between middle thoracic and first two lumbar retraction mean values compared to either superior or inferior thoracic retraction mean values for females, males, or whites when tested separately; however, results for blacks were significant ($p = 0.00$). Further, F-tests for the variance in retraction means when vertebrae were separated into the three groups (superior, middle and lumbar, and inferior) showed that superior thoracic retraction mean values significantly differed from inferior thoracic retraction mean values for females (ancestry combined; $p < 0.006$) and whites (sexes combined; $p < 0.01$) but not for males (ancestry combined) or blacks (sexes combined).

Sample size effects and or the challenge of quantitatively measuring patterns of degenerative change observed grossly may very well have influenced the results of statistical analyses. Thus, it may be more useful to consider qualitative assessments when using vertebral centra retraction as an aid in estimating age. Information regarding how the appearance and pattern of retraction of vertebral centra may be useful as a corroborative, supplemental method for the estimation of adult age of unknown skeletons will be addressed. As this research was a seed project surveying the relationship of vertebral centra retraction and age, future research on this topic will test the accuracy of the use of the stages of vertebral centra retraction to estimate age at death.

Drukier P, Sarajlic N, Klonowski EE. Age-related changes in the adult male vertebral column. *Proceedings of the American Academy of Forensic Sciences*; 2003 Feb. 17-22; Chicago. H21: 249-250.

Vertebral Centra Retraction, Age Estimation, Degenerative Changes