A16 Skeletal Asymmetry of the World War II (WWII) Battle of Tarawa Skeletal Assemblage: The Impact on the Resolution of Commingling

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Learning Overview: After attending this presentation, attendees will better understand the degree and prevalence of directional asymmetry within a commingled WWII battlefield population.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by highlighting the need to understand patterns of asymmetry to improve segregation and association of remains in a commingled assemblage.

Skeletal asymmetry has been identified by many researchers within human populations and is identified as a lack of symmetry between two paired elements. Directional asymmetry occurs when this difference is apparent on one side of the body. Previous researchers have found that there is a right-sided bias in the directional asymmetry of the upper limb bones, and to a much lesser extent, a left-sided bias in the lower limb bones.[1-3]

Understanding asymmetry in commingled assemblages is important for the re-assessment of prior analyses and to facilitate the association of related skeletal elements for forensic identification purposes. Visual pair matching of skeletal elements is commonly employed by anthropologists to associate antimeres. Hence, any asymmetry could impact the ability of forensic practitioners to correctly and accurately match these paired elements. Minimal differences affect the overall size, shape, and morphology, thus biasing visual assessment. During the preliminary analysis of the Battle of Tarawa assemblage, a WWII battlefield population recovered from the Tarawa Atoll, Republic of Kiribati, asymmetries were noted between skeletal elements. This pilot study examined the magnitude that visual and metric asymmetries have on this unique population.

The maximum long bone lengths in both upper and lower skeletal elements (humerus, radius, ulna, femur, tibia, and fibula), as well as the maximum length of the clavicle were examined to determine the effects of directional asymmetry. Skeletal measurements, including the maximum length of these bones, were recorded following standard procedure at the Defense POW/MIA Accounting Agency. These records were consulted and if left and right measurements for any of these bones differed by 3mm or more, they were reported in a separate table. Following the formula provided by Auerbach and Ruff, a calculation of directional asymmetry was computed for each bone: %DA=(right-left)/(average of left and right) X 100, where a negative value suggests a left-side asymmetry and a positive value suggests a right-side asymmetry.[2] Values for each bone category were then averaged to obtain the percentage of directional asymmetry.

These data follow the pattern seen by previous studies of a right-side bias in the upper limb (with the exception of the humerus) and a left-side bias in the lower limb (with the exception of the fibula). The clavicle also displayed a left-side bias within this skeletal population. The lack of left-sided bias in the fibula can be explained by the fact that it is not a weight-bearing bone and therefore is less sensitive to the pressures of differential loading and remodeling. However, the absence of right-sided bias in the humerus is confounding. Based on previous data, and the presence of a right-sided bias in the radius and ulna, a left-sided bias in the humerus is an unexpected result and may be a result of selective occupational stress or overuse.

Following asymmetry determination, paired *t*-tests were conducted on each bone group to determine significance of direction asymmetry within the samples. In each case, the difference was found to be non-significant ($p > 0.05$). This suggests that while asymmetry is present and affecting the skeletal measurements of some cases, the differences were not statistically significant across bone groups.

This study supports the need for both visual and statistical assessment when pair-matching elements. Even though some elements were deemed visually asymmetric, these observations did not correspond to overall differences between paired elements statistically. This is especially useful in dealing with the Battle of Tarawa assemblage, because it comprises a relatively homogenous population demographically, which limits the utility of some of the statistical pair-matching methods available.

The views of these authors do not necessarily reflect those of the Department of Defense or the Unites States government.

Reference(s):

1. Latimer, H.B. and Lowrance, E.W. (1965). Bilateral Asymmetry in Weight and in Length of Human Bones. *The Anatomical Record.* 152(2), 217-224.Auerbach, B.M. and Ruff, C.B. (2006). Limb Bone Bilateral Asymmetry: Variability and Commonality Among Modern Humans. *Journal of Human Evolution.* 50(2), 203-218.
2. Kujanová, M., Bigoni, L., Velemínská, J., and Velemínský, P. (2008). Limb Bones Asymmetry and Stress in Medieval and Recent Populations of Central Europe. *International Journal of Osteoarchaeology.* 18(5), 476-491.

Skeletal Asymmetry, Pair Matching, Commingling