A90 Examining the Effectiveness of Mastoid Process Measurements in Estimating Sex

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After attending this presentation, attendees will understand the applicability of using mastoid process measurements to estimate sex of the fragmentary cranium.

This presentation will impact the forensic science community by examining the use of the "mastoid length" measurement, as described by Buikstra and Ubelaker, in determining sex of a fragmentary cranium using the mastoid process.[1] This presentation will also evaluate the inter-observer variability of the mastoid length measurement due to its wide use by forensic anthropologists.

Due to sexually dimorphic morphology, the skull is considered to be very useful when determining the sex of skeletal remains as part of the biological profile. The mastoid process is a feature typically cited as a good indicator of sex based on differences in length and volume between males and females. A system of scoring the mastoid process, and other cranial features, on a 1-to-5 scale has been developed to aid in sex estimation of cranial remains[1]. In addition, in recent years, attempts have been made to analyze the mastoid triangle region for sexual dimorphism with varying results; however, no attempt has been made to solely use the mastoid length measurement described by Buikstra and Ubelaker, which is likely the most common mastoid process measurement.[1] Nevertheless, there is a general consensus among forensic anthropologists that this measurement is difficult to take and inconsistent between analysts.

This research examines the usefulness of mastoid length and mastoid triangle area as an indicator of sex using a Southeast Asian sample. A total of 122 crania (47 female, 75 male) from the skeletal collection at Khon Kaen University in northeast Thailand were used in this study. Each mastoid process was scored on a 1-to-5 scale following Buikstra and Ubelaker, referred to as estimated sex, and the mastoid length measurement was taken.[1] Measurement of the mastoid triangle was conducted to obtain distances between porion, asterion, and mastoidale. The semi-perimeter of the triangle was computed and used to calculate the triangle's area using Heron's formula. Twenty crania were measured by a second researcher to test the level of inter-observer error.

Correlations between variables were measured using Pearson's correlation coefficient. As expected, significant correlations ($p < 0.05$) were observed for both males and females between estimated sex and mastoid length, estimated sex and area, and mastoid length and area. A significant correlation was observed between estimated sex and age in females, the only significant correlation between age and other variables in females. No significant correlation was identified in males between age and remaining variables.

Discriminant function analysis was performed using several different combinations of variables to test whether mastoid length alone can be useful in determining sex. When all six measurements were used to discriminate between sexes, leave-one-out cross-validation reached an accuracy of approximately 80%, the highest level of accuracy reached of any analysis. When only mastoid length was used to discriminate between sexes, cross-validation accuracy was approximately 77.6%. This suggests that when presented with a fragmentary temporal bone, a single mastoid length measurement can be used with significant accuracy to estimate sex.

Inter-observer error was examined for estimated sex and mastoid length. Cohen's kappa was used to measure the level of agreement between observers. A Cohen's kappa value of 0.100 ($p = 0.222$) suggests a low level of agreement between observers. The percentage of difference between 40 mastoid length measurements (both left and right sides) was calculated with an overall average of 4% difference. Interestingly, in 18 of the 26 cases in which estimated sex differed between observers, the observer that scored the mastoid process highest also had the larger mastoid length measurement. Given that estimated sex was assessed prior to taking the mastoid length measurement, this suggests the estimated sex score may bias the researcher's measurement of mastoid length.

The results of this analysis are promising for the applicability of using the mastoid length measurement as a method for estimating sex of fragmentary crania; however, further testing on non-Asian samples should be conducted to corroborate these results.

Reference(s):

1. Buikstra J.E., Ubelaker D.H. 1994. Standards for Data Collection from Human Skeletal Remains. *Arkansas Archeological Survey Research Series No. 44.* Fayetteville, AR.

Mastoid Process, Sex Estimation, Discriminant Function Analysis