A73   Estimating Sex From the Innominate Utilizing New Measurements

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After attending this presentation, attendees will understand how the use of newly devised measurements, including maximum and minimum measurements of the innominate for sex estimation, can provide extremely high accuracy rates and reduce errors associated with differential interpretations of landmark locations in traditional measurements.

This presentation will impact the forensic science community by introducing novel measurements that circumvent errors introduced by differential interpretations of traditional landmark-based measurements, resulting in an improved rate of accuracy of sex estimation in human identification, along with reduction of intra-observer errors.

The innominate is commonly viewed as the best skeletal element used in the estimation of sex of an unknown individual and non-metric methods have dominated. However, metric methods can provide a more objective means of estimation. Previous metric studies cite accuracy rates in at least the 90% range, though many of these methods use measurements based on landmarks that are difficult to find and nearly impossible to replicate, leading to high inter-observer error rates. Most recently, Murail et al. defined a series of measurements through text and images and analyzed them using logistic discriminant analysis, in a computer program known as Diagnose Sexuelle Probabiliste (DSP).[1] Their study showed accuracy rates of at least 95% in diverse samples from around the world, apparently avoiding bias in sex classification due to ancestry. Though this study seems to provide highly accurate results, their DSP program does not provide the actual logistic regressions used, a necessity in the post-*Daubert* era.

In this study, measurements with clear landmarks or those involving a maximum or minimum were used as is or were modified from previously published definitions, some of which were rather unclear. A sample of 100 male and 100 female innominates from Whites and Blacks in the Hamann-Todd Collection were used for this study. The individuals used were of known age, ranging from 19 to 96 years old, with known sex and ancestry. Only innominates from the left side were used for consistency. On each innominate, 11 measurements were taken with a digital sliding caliper connected directly to a computer to record the measurements efficiently and reduce data input errors. The data were analyzed using FORDISC® 3.1 discriminant function analysis, using both stepwise and non-stepwise functions. All reported error rates were cross-validated.

Using stepwise discriminant function analysis, a combination of five variables were shown to provide classification accuracies of 96% in males and 99% in females, for a pooled-sex accuracy of 97.5%. The five measurements selected by the stepwise discriminant function analysis included minimum apex to symphysion, maximum innominate length, maximum ischial length, maximum innominate breadth, and maximum pubic length. These measurements are effectively able to capture dimorphism in the innominate, with the measurement of minimum apex to symphysion, which captures true pelvic morphology; maximum innominate length and maximum innominate breadth, which capture information on the ratio of height to width; and maximal ischial length and maximum pubic length, which capture the ratio of pubis to ischium. Some logistic regression and other classification methods produced similar or higher classification accuracies with little sign of classification bias for sex by ancestry. Forty individuals were measured a second time to calculate the technical error of measurement and coefficient of reliability for each measurement. The technical error of measurement showed differences between rounds of measurements to be less than 2mm, a mean of less than 3.5% for all measurements, signifying low intra-observer error rates. Additionally, for all but two of the measurements, the coefficient of reliability values were greater than or equal to 0.96, indicating an extremely high level of intra-observer consistency for those measurements.

The high levels of intra-observer agreement between rounds of measurements reveal the value of measurements with clear, unambiguous landmarks, or those that involve maxima and minima. This approach proves that current methods can be further improved upon to reduce measurement errors and increase classification accuracy.

Reference:

1. Murail, P., et al. (2005) DSP: A Tool for Probabilistic Sex Diagnosis Using Worldwide Variability in Hip-bone Measurements. *Bulletins et memoires de la Societe d'Anthropologie de Paris*. 17 (3-4).

Sex Estimation, Forensic Anthropology, Innominate

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