



Physical Anthropology Section - 2014

H19 Quantification of Sex and Population Differences in Obturator Foramen Shape

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After attending this presentation, attendees will understand how the shape of the obturator foramen varies across sex and population groups.

This presentation will impact the forensic science community by quantitatively testing classic descriptions of sex differences in obturator foramen shape, thereby providing accuracy rates and an objective analysis of shape differences that can be utilized in future forensic methods.

The pelvis is known to be the most reliable skeletal element for sex estimation techniques. In particular, the pubic region has been shown to be highly diagnostic, with females displaying a relatively "stretched out" appearance compared to males (i.e., relatively longer and thinner pubic rami, broader pubic bodies, and greater subpubic concavity). Given that the obturator foramen is encompassed within the pubic bone, it is not surprising that traditional texts also describe sex differences in foramen shape. More specifically, females have been suggested to display a relatively more triangular obturator foramen shape compared to a more circular/ovoid appearance in males.¹ Despite the qualitative descriptions presented in texts and used by anthropologists in visual examinations, quantitative analyses statistically testing for sex differences in obturator foramen shape are generally lacking in the forensic literature. The aim of this study was to perform a geometric morphometric analysis on obturator foramen shape to quantitatively test for both sex and population differences and evaluate the reliability of this trait in forensic applications.

The sample consisted of 329 ossa coxae from adult females and males across five different population groups. These population groups included three modern samples (U.S. Whites, U.S. Blacks, and Portuguese) and two archaeological samples (medieval Nubian and plains Native Americans). Standardized photographs were taken of the medial surface of the obturator foramen with both pubic rami lying flat on a table surface. For each specimen, the outline of the obturator foramen was then extracted using Photoshop®, and an elliptical Fourier analysis and subsequent principal component analysis were performed using the SHAPE™ v1.3 software.² Multivariate Analysis of Variances (ANOVAs) were then conducted to test for sex and population differences in the shape components.

Results indicate that the majority of shape variation exhibited by the obturator foramen is in relative height (PC1, 42% of variation). PC2 (20%) reflects the position of the inferior angle of the foramen, while PC3 (10%) captures the traditional "triangular" versus "ovoid" shape changes. When samples were pooled, significant sex differences were revealed in all three components ($p < 0.001$). In general, females display a relatively taller and more triangular obturator foramen with a more medially placed inferior angle than males. These results support the written qualitative descriptions provided in traditional texts. When all PCs were analyzed in a Discriminant Function Analysis (DFA), a correct sex classification rate of 76% was obtained using a leave-one-out cross-validation method. Within-population accuracy rates ranged from 69-83%, cross-validated. Using only PC3, representing the "triangular" versus "ovoid" shape changes, accuracy rates dropped to 60%. Even within-population DFA results displayed low correct sex classification rates (54-66%). Significant population differences were also observed on PC1 and PC3. Overall, the archaeological samples displayed relatively taller obturator foramina than the modern samples ($p < 0.001$), and the U.S. Black sample displayed significantly more triangular foramina than all other groups ($p < 0.001$).

These results suggest that although there are significant sex differences in obturator foramen shape that are consistent with previous descriptions (females display more triangular obturator foramina than males), the accuracy rates for this particular shape trait alone are not acceptable for forensic analyses. In order to obtain moderately high classification rates, other aspects of the obturator foramen shape must be included in the analysis (e.g., relative foramen height). Furthermore, significant population differences were observed, indicating that any potential sex estimation methods using the obturator foramen should include population-specific standards.

References:

1. Krogman WM, Iscan MY. The human skeleton in forensic medicine. Charles C. Thomas, Springfield, IL: 1986.
2. Iwata H, Ukai Y. SHAPE: A computer program package for quantitative evaluation of biological shapes based on elliptic Fourier descriptors. *J Hered* 2002;93:384-85.

Sex Estimation, Obturator Foramen, Geometric Morphometric

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