A11 A Preliminary Study of Sex Determination Using the Alveolar Ridge in Korean Adults

Dong-Ho Eddie Kim, BSc, The Catholic University of Korea, Seoul 06591, SOUTH KOREA; U-Young Lee, MD, PhD, The Catholic University of Korea, Seoul 06591, SOUTH KOREA; Yi-suk Kim, MD, PhD, The Catholic University of Korea, Seoul 06578, SOUTH KOREA*

Learning Overview: After attending this presentation, attendees will understand the sexual dimorphism existing in the alveolar ridge and how the alveolar ridge can perform as an indicator of sex in cases where other sex determinants in the cranium are insufficient.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting an option to determine the sex of a skull without more conspicuous sexual indicators and enlarge the chance of collecting the information of an individual in a medicolegal investigation.

Non-metric traits of the skull, such as the ones suggested by Walker, have been a well-known method in sex determination.[1] The male skull tends to be larger and more robust than the female skull. The non-metric traits especially involve the occipital, temporal, frontal, and mandible as indicators of sexual dimorphism. In cases where those skeletal elements are unavailable or ambiguous, however, a researcher can opt for other parameters for sex determination.

The upper alveolar ridge consists of the maxillae's alveolar processes, and the lower alveolar ridge is a part of the mandible that contains the teeth. The average breadth of the dental arch (arrays of teeth) is larger in males than females, but few reports presented which part of the dental arch is more appropriate for sex estimation. Also, the dental arch is prone to be not intact; the teeth are often lost in burial cases because of the decaying of connecting tissue or intentionally damaged in criminal cases to hinder personal identification. Thus, researchers investigated the alveolar ridge instead of the dental arch since the alveolar ridge is a part of the maxilla and mandible, including the dental arch.

Sixty 3D models of Korean adult skulls were randomly selected from a collection of clinical computed tomography scans, with the same distribution of sex and age groups (30 females and 30 males). The five age groups were divided by decade of ages (the 20s, 30s, 40s, 50s, and 60s and above).

Using Mimics® ver. 14, landmarks were placed on the outer and inner surface of the alveolar ridges of the maxilla and mandible, between each neighboring tooth, and close to the root of the teeth. Then midpoints of outer landmarks and inner landmarks were calculated by their coordinates. Measurements were performed automatically by the program to figure out the relationships of those midpoints. Planes passing through neighboring two midpoints were created to measure the angular change of the alveolar ridge. For the lengths of the alveolar ridge in the anterior-to-posterior direction, planes passing through midpoints on each side were defined. Then the distance from the foremost midpoint to these planes were measured. Also, the breadths of the alveolar ridge between midpoints at the same level on each side were measured.

The accuracy rate of sex estimation by each measurement was calculated through a discriminant function analysis. Among maxillary measurements, breadth measurements at the premolar level showed an accuracy of over 70%. The demarcation point of Premolar1-Premolar2 (PM1PM2) breadth was 40.78mm, Premolar2-Molar1 (PM2M1) breadth was 45.83mm, and Molar1-Molar2 (M1M2) breadth was 49.92mm. The maxillary alveolar ridge's anterior-posterior length scored the highest accuracy of all maxillary measurements with an accuracy of 78.3%; the demarcation point was 48.90mm. The angle between Incisor1-Incisor2 (I1I2) right angle showed the highest accuracy among angle measurements with an accuracy of 71.7%; the demarcation point was 8.69 degrees ($p < 0.05$).

For the mandibular alveolar ridge, measurements of the posterior part showed higher accuracy. Breadth and length at the level in which the mandibular rami connected to the alveolar ridge (alveolar posterior, PA) showed an accuracy of 70.0% and 71.7%, respectively. The demarcation point for the breadth at the level of PA was 83.26mm, and the length at the level of PA was 38.02mm. Also, the change of the angle at the level of Molar2-Molar3 (M2M3) showed the highest accuracy among angular measurements with an accuracy of 80.0%; the demarcation point was 56.30 degrees ($p < 0.05$).

Overall, it was found that the alveolar ridge retains sexual dimorphism, which is valid for sex estimation. Especially, the part from the premolar to the molar in both alveolar ridges showed greater power of discrimination. Since the usage of 3D scanners and computed tomography is rising, applying alveolar ridge measurement to estimate the sex of a real skull would be available. However, a future study on this subject is required because there is a small number of studies dealing with the alveolar ridge for sex estimation, and extended data for various sample populations would be valuable for application in forensic anthropology.

Reference(s):

1. Walker P.L. Sexing skulls using discriminant function analysis of visually assessed traits. *Am J Phys Anthropol*. 2008 May;136(1):39-50. doi: 10.1002/ajpa.20776. PMID: 18324631.

Sex Determination, Alveolar Ridge, 3D analysis

*Presenting Author