A7 The Relationship Between Soft Tissue Anatomy and Skeletal Sexual Dimorphism in the Cranium and Clavicle

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Learning Overview: After attending this presentation, attendees will understand the relationship between muscle, ligament, and skeletal enthesis size as it relates to human skeletal sexual dimorphism in both the cranium and clavicle.[1-3]

Impact on the Forensic Science Community: This presentation will impact the forensic science community by identifying how soft tissue affects the morphology of the underlying skeleton and how this relates to sexual dimorphism at three skeletal landmarks: the nuchal crest and the mastoid processes of the cranium, and the rhomboid fossa of the clavicle. Additionally, the forensic science community will have the opportunity to discuss future directions for establishing a metric sex estimation method from the dissection phase of this study, which will be the focus of this presentation.

The overall goal of this research is to explore ways of establishing accurate metric sex estimation methods from the cranium and clavicle, through the dissection of donated human cadaveric material and analysis of skeletal and soft tissue sexual dimorphism. In forensic anthropology, an absent pelvis requires sex estimation from other areas of the skeleton, and many morphological and metric methods are available.[1-4] However, morphological sex assessment can sometimes lack reliability due to the subjectivity and experience required for scoring skeletal morphology.[5-8] It is important to have accurate sex estimation methods to help with identification in modern forensic cases and to understand populations in archaeological settings. Metric methods can provide not only accuracy, but also limit the subjectivity and expertise that is required for morphological methods.[4] This is a multidisciplinary research project, which approaches a forensic anthropology question from an anatomical perspective.

This presentation focuses on the dissection phase of this project and the analysis of soft tissue associated with sexually dimorphic skeletal landmarks. Relevant soft tissue attaching to the nuchal crest includes the upper trapezius (distal limit at the clavicular attachment), semispinalis capitis, and the nuchal ligament. Muscles of interest for the mastoid processes are the sternocleidomastoid, splenius capitis, and longissimus capitis. Soft tissue related to the rhomboid fossa includes the clavicular head of the pectoralis major, sternohyoid, subclavius, and the costoclavicular ligament.

A total of 22 bequeathed cadavers from modern European New Zealand and Thai populations were dissected using standard dissection equipment. Right and left sides of each element, where available, were dissected for a total of 406 elements: 352 muscles and 54 ligaments. Muscles were dissected by individual fascicles, which were measured for length and weighed for mass (converted to volume, per muscle density constant: mass/1.0576g/cm^2). This was used to calculate the physiological cross-sectional area, or overall size, of the muscle (fascicle volume/length). Ligaments were measured for cross-sectional area (overall volume/length) and assessed separately from muscles.

Skin and fascia were removed to expose the relevant superficial muscles: the upper trapezius, sternocleidomastoid, and pectoralis major. Following their dissection, further muscles, such as the rhomboid major and minor, were removed to expose the deeper muscles: the splenius capitis, longissimus capitis, and semispinalis capitis. After the removal of each muscle, a grease pencil was used to outline all areas of attachment on the skeleton, providing the footprint of the entheses.

A 3D scan of the specimens was then taken, using a 3D scanning tablet attachment, to measure the total area of each enthesis as they related to the muscles and ligaments, as well as the skeletal landmarks with which they are associated. Following this, the sternum, clavicles, and partial first ribs were removed en bloc to access the sternohyoid, subclavius, and costoclavicular ligament for dissection. After all muscles and ligaments were dissected and recorded, the remaining elements were 3D scanned. Finally, the skull, vertebral column, clavicles, and sternum/manubrium were prepared for maceration for future analysis of the dry skeleton.

Preliminary results indicate that males show generally larger muscles than females, with some exceptions. Following standard methodology, the individuals are consistent with the male and female skeletal morphology.[1-3] Even muscularly robust females show standard female characteristics, skeletally. The implications for this muscular data can provide further insight into human sexual dimorphism in these well-understood skeletal landmarks, in addition to the lesser-understood sexual dimorphism of the neck muscles. Future development of a population-specific metric sex estimation method from these data will contribute to improving the accuracy of sex estimation from the cranium and clavicle.

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