Sexual dimorphism of human occipital bone by craniometric analysis

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ABSTRACT

Introduction: Human skull is shown to exhibit varied sexually pleomorphism traits. The determination of sex from human skeletal remains is of basic importance in both medicolegal and bioarchaeological investigations. Estimation of sex could be a difficult task, particularly, once a region of bone is brought for investigation. This research was planned to judge the sexing potential of human occipital bone in forensic identification by craniometric analysis.

Materials and Methods: In the present study, a total of 30 dry human occipital bones of unknown sex and without any gross abnormality will be collected from the Department of Anatomy, Saveetha Dental College, Chennai, for evaluation. With the help of Vernier caliper, the diameter of occipital condyle (OC) was measured. Using a protractor, the measurements such as the superior angle, inferior angle, and right and left lateral angles were measured. The results obtained were analyzed, tabulated, and represented graphically.

Results: The diameter of the right and left OC in male was 1.63 cm and 1.74 cm, respectively. The diameter of the right and left OC in female was 1.48 cm and 1.52 cm, respectively. In male, the superior angle was 78.6, inferior angle was 47.5, right lateral angle was 45.3, and left lateral angle was 46.7. In female, the superior, inferior, right lateral, and left lateral angle were 79.3, 48.1, 47.4, and 48.2, respectively.

Conclusion: Human occipital bone exhibits a varied dimension in male and female. Thus, it can be used in forensics to distinguish the sex of an individual. Human occipital bone can be used to determine sexual dimorphism.

KEY WORDS: Craniometry, Forensic anthropology, Occipital bone, Sex determination, Sexual dimorphism

INTRODUCTION

Sex determination is a crucial step in biological identification from skeletal remains, particularly, in forensic circumstances because it will narrow down the chance of identification of 50% of sexes.[1,2] The ability to accurately predict sex is said to the completeness of the remains and also the degree of sexual dimorphism exhibited by the skeleton and also the population. The foremost correct results are obtained once the complete skeleton is accessible for study.[3] Estimation of the sex of the skeletal remains is a necessary part of any medicolegal investigation. Human skeleton shows sexually pleomorphism traits, and the estimation of sex of skeletal remains is so supported morphological and morphometric examination. Sexing accuracy of the human skeleton for the different bones and in several population groups has been done. Human bone is taken into account as one of the foremost reliable bones for sex determination.[4] Many studies on sex determination were supported biological variations between males and females. Males are usually a lot of larger in term of size and body proportion than females as a result of males have ordinarily a lot of muscle mass.[5,6]

During high impact and severe disruptive injuries, only fragments of bones could also be accessible for examination. Estimation of sex becomes difficult once only a part of bone is brought for examination and thus, a requirement to drive standards for sex estimation from completely different regions of the bone. The basal region of the membrane bone is probably going to survive the physical insults than the other parts of bone due to the plentiful soft tissue cover, bone thickness within the region, and its comparatively well-protected anatomical position. Thus, there is an enhanced chance of recovering the part of bone even just in case of severe trauma, and studies on the occipital bone could offer helpful clues in identification of considerably disrupted remains.[7]

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The adult human occipital bone offers opportunities to develop measurements that may aid within the identification of human remains, significantly because it tends to survive burial and physical insults more readily than several different bones of the skull. It is thus logical to look at the occipital region of the human skull for sex and quality variations. The occiput is found at the bottom of the cranium where it articulates with the first vertebra forming the atlanto-occipital joint. The cranial base encompasses a variety of anatomical features, a number of which have been evaluated for sex and ethnicity variations together with the bone condyles and the foramen.\(^\text{[8]}\) The superior angle of the occipital bone articulates with the occipital angles of the parietal bones and with the fetal bone, corresponds in position with the posterior orifice. The lateral angles are set at the extremities of the groove for the transverse sinuses: Each is received into the interval between the mastoid angle of the parietal bone and also the mastoid portion of the temporal bone. The inferior angle is united with the body of the sphenoid bone. The lateral angles are situated at the extremities of the grooves for the transverse sinuses: Both are received into the interval between the mastoid angle of the parietal and the mastoid part of the temporal bone.\(^\text{[9]}\) Each occipital condyle (OC) is oval in dimension and bound obliquely by hypoglossal canal. A condylar fossa is set simply posterior to the OC and might contain a posterior condylar canal for a vein from the sigmoid sinus. Laterally, the occipital bone connects with the petrous part of the temporal bone anteriorly and therefore, the mastoid process posteriorly.\(^\text{[10]}\)

During interventional operations, the direction, angle, and position of the nail might change in line with the OC morphometry, and therefore, the distinction in measurements might alter the surgical operation.\(^\text{[11]}\) Occipital plates are often utilized throughout occipitocervical fixation; however, the advanced anatomy of the craniocervical junction poses challenge throughout these procedures.\(^\text{[12]}\) This study aims to determine the sex of an individual by the craniometric analysis of human occipital bone.

**MATERIALS AND METHODS**

In the present study, a total of 50 dry human occipital bones with vault removed and showing the cranial cavity of unknown sex and without any gross breakage were collected from the Department of Anatomy, Saveetha Dental College and Hospitals, Chennai. The bones were subjected for morphological analysis visually, evaluated, and photographed.

**Exclusion Criterion**

Bones with gross defects such as deformities and pathological malformations were omitted.

The present study involved the examination of the right and left OC and the angles of the occipital bone in male as well as in females. With the help of Vernier caliper, the diameter of OCs was measured. Using a protractor, the measurements such as the superior angle (lambda), inferior angle (basion), right lateral angle (right mastoid angle), and left lateral angles (left mastoid angle) were measured [Figures 1 and 2]. The mean and standard deviation of the values were found and analyzed.

**RESULTS**

The diameter of the right and left OC in male was 1.63 cm and 1.74 cm, respectively. The diameter of the right and left OC in female was 1.48 cm and 1.52 cm, respectively. Thus, there is an increase in diameter of the right and left OC in male than in female.

**Figure 1:** External aspect of occipital bone showing the right and left occipital condyles in posteroinferior view

**Figure 2:** Internal aspect (cerebral surface) of occipital bone showing superior, inferior, right, and left lateral angles in anteroinferior view

**Inclusion Criterion**

The occipital bone which is totally ossified not broken and with no gross imperfections was taken into consideration.
In male, the superior angle was 78.6, inferior angle was 47.5, right lateral angle was 45.3, and left lateral angle was 46.7. In female, the superior, inferior, right lateral, and left lateral angle were 79.3, 48.1, 47.4, and 48.2, respectively. Thus, there is an increase in length of angle of the occipital bone in female than in male.

Figure 3 shows the diameter of the right and left OC in male and female. From the graph, it is very clear that the dimension of OC is larger in the left side than in the right and it also proves that males have larger OC than in females. Figure 4 shows the mean of superior angle, inferior angle, right lateral, and left lateral angle. The angles are higher in females than in males. Although the values are not of greater differences, they can be used as criteria for determining sex of an individual.

**DISCUSSION**

Fragmentary human remains compromised by differing kinds of burial or physical insults such as explosions, fires, and mutilations could frustrate the utilization of ancient morphogenetic sex determination strategies. The basicranium is protected by an outsized soft tissue mass comprising muscle, tendon, and ligaments. As such, the bone region could prove helpful for sex identification in cases of considerably fragmented remains. The aims of this paper are to assess sexual dimorphism in occipital
bone bases by manually recorded condylar length and breadth as well as intercondylar measurements and develop discriminant functions for sex determination for this cranial sample.\[13\]

The OC is the most cranial part of the spine and is the cephalic part of the atlanto-occipital joint. Several anatomical and surgical studies, students have focussed on partial or total excision of the OC through the acute lateral transcondylar approach for the management of varied clival pathologies.\[14-16\]

Holland discovered another important result from the pooled sample of early 20th century African-American and European-American crania. He demonstrated that measurements of the foramen magnum and OCs can correctly classify the sex of a person with 70%–85% accuracy using regression analysis.\[13\] During a subsequent study, Wescott et al.\[19\] tested the strategy developed by Holland on a sample drawn from the Terry collection as well as the Hamann-Todd collection, another 20th century American dead body series, and achieved an accuracy rate of 76% employing discriminant perform analysis.

Uysal et al. investigated sexual dimorphism among modern Turkish crania and obtained slightly higher results with a reported accuracy rate of chain 81% once using condylar measurements derived from three-dimensional computed tomography.\[19\] During an analysis of articles describing sexual dimorphism within the 18th and 19th century British sample from St Bride’s Church, using foramen magnum, occipital condyle and other standardized cranial measurements can be utilized for the determination of sex.\[20\] Gapert et al., demonstrated that significant dimorphism is present within the basicranium, even if the discriminant function analysis is slightly lower.\[21\]

Discriminant functions derived from measurements of both the foramen magnum and occipital condylar region yielded classification accuracy rates between 68 and 77% for this historical British population. The length and breadth of each condyle, as also two intercondylar dimensions displayed vital variations between males and females. The results of the above-mentioned studies, therefore, recommend that metric analysis of the basal region of the occipital bone might give a moderately effective methodology for the determination of sex in cases of considerably fragmented remains.

**CONCLUSION**

The dimension of OC is larger in male and the length of the superior angle, inferior angle, right lateral angle, and left lateral angle is larger in females than in males. All these parameters help us to distinguish female and male skull. Thus, the occipital bone helps in the determination of sex and is sexually dimorphic.

**REFERENCES**


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