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Mastoid process as a forensic tool for sexual dimorphism: A Retrospective CBCT Study

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Abstract

Introduction: Gender determination is an important step in identification of human remains. Intact human skulls are rare to find in disasters site. In such cases mastoid can serve this purpose because of its compact structure and secure position in the skull.

Aim: To assess the dimension measurement of mastoid process in males and females using CBCT images.

Materials and Methods: This retrospective study composed of sample size 50 CBCT scans under 2 groups {25 males and 25 females} within age group 15-60 years. Mastoid Process Length, Width and Height were assessed in different sections (Coronal, Sagittal and Axial) of CBCT using I-cat CBCT machine analysed using software used was in-vivo 5. Statistical Analysis was done using SPSS version 25 with $p \leq 0.05$.

Results: There was statistical difference noted between width of males and females.

Conclusion: Present study proved statistically that the mastoid widths in males are more than in females.

Keywords: Mastoid Process, CBCT, Sexual Dimorphism

Introduction

Forensic is a path to find the unknown among the masses after any war, disaster or criminal scenes. The gender determination from human skeletal materials is always useful in Forensics. Most of the bones are thin and fragile and do not contribute much in this process. However, Mastoid bone in skull has a secure position and is relatively strong which can serve this purpose. Earlier other radiographic methods were used for the forensic purpose but CBCT (Cone Beam Computed Tomography) is very useful now-a-days and makes the work much easier, faster and precise.[1]

Aim and objectives of this study

To assess the dimension of mastoid process in males and females using CBCT images.

1. To compare the length of right and left mastoid process in males and females.
2. To compare the height of right and left mastoid process in males and females.
3. To compare the width of right and left mastoid process in males and females.

Materials and Methods

Inclusion Criteria

- Scans of both Males and Females
- Age group: 15 to 60 years

Exclusion Criteria

- Scans with gross artifacts.
- Scans that did not show any anatomic details.
- Scans with any pathological findings.

In this retrospective study, 50 CBCT scans of maxillofacial region were obtained from CBCT archives available in the department of Oral Medicine and Radiology to assess the dimension of mastoid process in terms of length, width and height. Length and Height was assessed in sagittal section and Width was assessed in axial section. Among 50 scans, 25 were male and 25 were female with the age group 15-60 years. The study was done using I-cat CBCT machine and radiographic analysis was done using in-vivo 5 software.

Mastoid Process

Length: Length: In the sagittal section, length is measured from the porion till the mastoid notch.(Fig [1])

Height: In the sagittal section, height is measured by drawing perpendicular line from centric point to the tip of mastoid process. (Fig 1)

Width: In the axial section, width is measured from the most prominent point on the lateral and medial aspect of the mastoid process. (Fig 2)

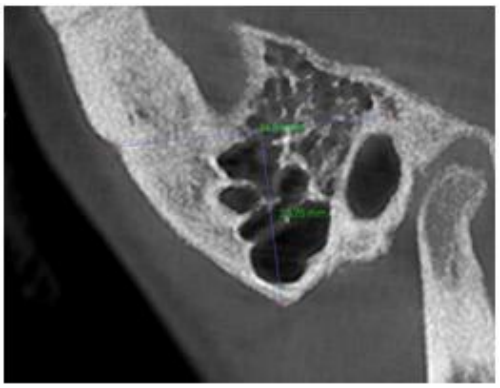


Fig.1: Length and Height of Mastoid Process

Fig.2: Width of the mastoid process

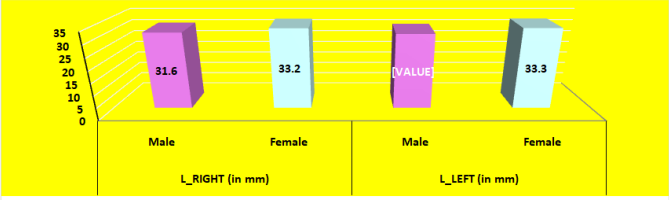
Statistical Analysis

The data was entered using MS Excel 2016 and analyzed using SPSS Statistical software version 25 using descriptive and inferential statistics. For the continuous

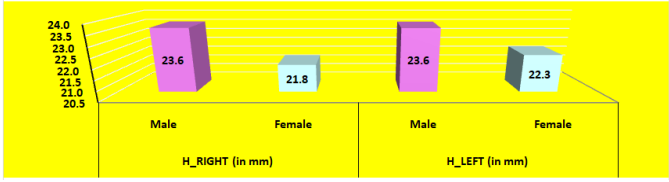
variables Mean and SD was calculated. Inferential statistics to compare between the groups was calculated using One-way ANOVA statistics. The statistical significance was kept at p value < 0.05.

Results

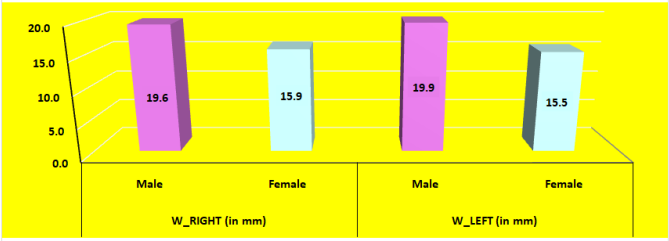
The length of mastoid process among females were more than the males however no statistically significant difference was noted. [Graph 1]. No statistically significant difference was noted between the genders for the left side for the gender groups. But for the right side, there was statistically difference noted. [Graph 2]. For the right and left side, a statistically significant difference was found in width between males and females. [Graph 3]



Graph 1: Length variation between the gender groups for right and left side



Graph 2: Height variation between the gender groups for right and left side



Graph 3: Width variation between the gender groups for right and left side there was a statistically significant difference between the genders.

Discussion

The current study aimed to study the sexual dimorphism based on dimensions of mastoid process in males and females. On comparing the mean length, width and height of different mastoid process among males and females, we found that the width of mastoid process was significantly greater in males than in females

Mondal B et al[1],conducted a similar study in which the mean value of all the parameters were found to be higher in males as compared to females.

Allam et al[2]conducted a study on mastoid process using multidetector computed tomography, they found that mastoid process served a purpose as forensic tool in sexual dimorphism as the dimensions in males. In their study all mastoid dimensions except mastoid angles were larger in malesthan in females. Few previous studies have been conducted on dry skulls and a significant difference was noted in males and female skulls.

According to Shah et al[3],mean values of male skulls were found significantly high on both sides in comparison to that of female sex.

Passeyet al[4], used porion- mastoid length, mastoid-asterion length, asterion- porion length, and area of mastoid triangle to differentiate between the males and females. All measured parameters were higher in the male group.

Mastoid bone is present at the base of the skull. It is relatively strong and well preserved bone. Radiographs play an important role in gender determination. With advanced imaging techniques line CBCT, the accuracy has increased to identify the unknown remains among dead bodies which have been lost in mass disasters. CBCT gives a 3-D view.

Gopal et al[5] conducted a study in which they had taken both the parameters mastoid and foramen magnum for comparing the genders and mastoid was found to be a better parameter as compared to foramen magnum.

In our study, width was found to be more significantly greater in males as compared to females. The reason can be attributed to the fact that different muscles Sternocleidomastoid, Digastric muscles, Splenius capitis, Longisssimuscapitis muscle act on the mastoid and in males this effect of muscles seems to be greater in males than females.

Chaudhary R K et al [6]conducted a study on 70 adult human skulls, and calculated the size of mastoid process using verniercallipers. They calculated the mastoid process size using a formula in which they multiplies mastoid length, mastoid antero-posterior diameter and mastoid breadth and divided it by 100. In their result they found that mean mastoid size was greater in males as compared to females. They concluded that the dimensions of mastoid process measured by anthropometric technique could be of great help in medicolegal investigations

Manivanan A et al[7]conducted a retrospective study using 100 CBCT scans to evaluate the length, height and width of mastoid process among males and females. The height and length was more in males as compared to females but the width was more in females as compared to males.

Inceoglu A et al [8] conducted a study to calculate the variation of mastoid process among males and females. In their study, they took few parameters like longest oblique coronal distance, distance between porion and mastoid notch and mastoid length which were similar o width, length and height respectively as per our study. However, they found all these parameters more in male as compared to females which were not in accordance with our study. Author further correlated this idea of mastoid size measurement with the risk of complications during surgical procedures especially in approaching the posterior fossa and the poster lateral cranial base.

Gaayathri D. et al [9] conducted a study to assess the role of mastoid process in gender determination using CBCT. They estimated the size of mastoid process using 3D volume rendering technique in CBCT. They took parameters like length, width and height of the mastoid processand found that all these parameters were greater in males as compared to females.

Manivan A et al [10] conducted a retrospective CBCT study to assess the dimension of mastoid process in males and females. In their study they found that length and height of the mastoid process were higher in males and width was greater in females. In our study ,length was higher in females.

Conclusion

In the present study, CBCT revealed that mean value of width of mastoid process was significantly higher in males than in females. Based on the results we concluded that mastoid process helps in predicting genders and can be a useful tool in forensic sciences.

Future prospects and limitations: In future, similar study can be conducted using larger sample sizes.

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