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Original Research Paper

Radiology

CBCT EVALUATION OF GENDER DIMORPHISM USING MAXILLARY SINUS IN A SMALL SUBPOPULATION IN RIYADH

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ABSTRACT

Introduction: Multiple fatalities in incidents like explosions, mass disasters, illegal immigration and criminal cases etc invokes the importance of identification of gender. Since skeletal bones are often damaged, gender estimations are done using structures that are most commonly recovered such as the maxillary sinus. This study utilized the use of Cone Beam Computed Tomography (CBCT) for evaluating gender through maxillary sinus.

Research Methodology: Maxillary sinus dimensions of 30 consecutive patients with 60 sinuses [left and right bilateral maxillary sinuses], were evaluated out of 100 retrospective cases. The width, depth and height of the sinus was assessed and data was subjected to descriptive analysis, independent t-test and discriminant function analysis.

Results and Conclusion: The female group showed statistically significant lower sinus parameters values than males with the sinus height being a relatively better predictor to study sexual dimorphism. Within the limitations of this study, gender prediction through sinus width, height and depth showed low prediction values.

KEYWORDS :

INTRODUCTION

Kingdom of Saudi Arabia has an estimated population of 31 million and gathers around 3 million people annually over a short time during Haj season which raises the risk of multiple fatalities. Opportunities, investments, wealth and religious worship invites people from different parts of the world legally in majority or with some minority illegally. There are also many numbers of unregistered birth in the kingdom. All of these factors including explosions, mass disasters, illegal immigration and criminal cases etc necessitate the establishing precise identity of the individual, gender and age estimation. (Alqahtani, S., Alshahrani, Y., & Alqahtani, A. (2017)). Since skeletal bones are often damaged or fragmented, the focus has been diverted to the use of structures that are most commonly recovered without much destruction such as the maxillary sinus, which calls in for the role of forensic odontology. (Teke, H. Y., Duran, S., Canturk, N., & Canturk, G. (2006)). Thus, the dimensions of the maxillary sinuses as reliable gender predictors have been a topic of great research h interest worldwide.

The maxillary sinus is a bilateral pyramidal shaped pneumatic space having the greatest volume in comparison to other sinuses. It is located in the maxilla and it drains to open in the middle nasal meatus of the lateral wall of the nose (Rani, S. U., et al,(2017)). The primitive maxillary sinus starts to develop from the inferior margin of the infundibulum by the end of 16th week of intrauterine life (Lee KJ (2003)). It is pea-sized at birth and expands after eruption of primary teeth. It continues to enlarge and pneumatize until the maxillary third molars have formed and erupted. The maxillary sinus varies in its shape, size, position and person to person and in the same individual, subjective by age. (Rani, S. U., et al,(2017)). This variation is vital for utilization of maxillary sinus in gender determination (Bangi, B. B., Ginjupally, U., Nadendla, L. K., & Vadla, B. (2017)).

Imaging of the maxillary sinus has been widely used for determination of gender. The advent of 3d imaging such as CT, MRI and CBCT offer excellent imaging and accurate assessment of the sinuses and craniofacial bones including the extent of pneumatisation as compared to standand 2d radiographs (Kanthem, R. K., Guttikonda, V. R., Yeluri, S., & Kumari, G. (2015); White PS1, Robinson JM, Stewart IA, Doyle T. (1990)). Cone Beam Computed Tomography (CBCT) being an advanced imaging technology in dentistry allows measurement of the maxillary sinus with reduced radiation dose compared to CT and lower cost in comparison to MRI.(Shah, N., Bansal, N., & Logani, A. (2014)).

Sexual dimorphism implies to the variation and difference in the form (either in shape or size) between different gender in the same species (Khangura, R. K., Sircar, K., Singh, S., & Rastogi, V. (2011)). The maxillary sinus in males is larger than in females in contemporary human populations (Kanthem, R. K., Guttikonda, V. R., Yeluri, S., & Kumari, G. (2015)). On the basis of this background, the present study was done to evaluate whether the dimensional variation of the maxillary sinuses can be used for predicting gender.

MATERIALS AND METHODS

Retrospective data from 100 cases of full volume CBCT scans from Galileos CBCT were evaluated in Oral Radiology Section of OMFS & Diagnostic Sciences Department, Riyadh Elm University, An Namuthajiyah Campus, Riyadh with IRB approval no. RC/IRB/2016/431. Maxillary sinus dimensions of 30 consecutive patients with 60 sinuses [left and right bilateral maxillary sinuses], based on the following to the inclusion and exclusion criteria were retrieved and included in the study.

Inclusion Criteria

1) Images of patients of 20-60 years, 2) Clinically healthy maxillary sinuses and having permanent teeth 3)No radiographic imaging errors/distortions

Exclusion Criteria

1) Images with maxillary sinus pathology, 2) Nasal/maxillary complex surgery
2) Orthognathic surgery/fractures involving maxillary bone,
4) Documented craniofacial anomaly or previous orthognathic surgery.

Measurements were done in axial and coronal cross section views of CBCT scans. The three straight distances (height, width, and depth), was taken on the axial and coronal cross sections, where the longest distances could be measured. The width and depth distances was be measured on axial section while the height measured on coronal cross sectional views. All data were subjected to descriptive analysis, independent t-test and discriminant function analysis.

- The height was analyzed from the inner surface of the maxillary sinus as the longest distance from the lowest point of the sinus floor to the highest point of the sinus roof in the coronal view [Figure1].
- The width of maxillary sinus was analyzed as the longest distance perpendicular from the medial wall of the sinus to the most lateral wall of the lateral process of the maxillary sinus in the axial view [Figure 2].
- The depth was analyzed as the longest distance from the most anterior point to the most posterior point of the medial wall in the axial view [Figure 3].

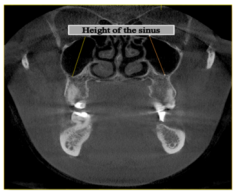

Figure 1: Height of the maxillary sinus

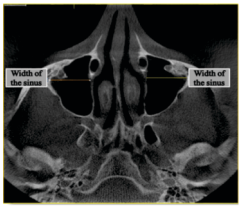

Figure 2: Width of the maxillary sinus

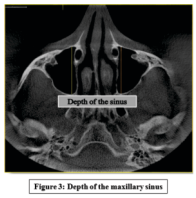

Figure 3: Depth of the maxillary sinus

RESULTS

In our study, the female group showed statistically significant lower sinus parameters values than males. The descriptive analysis of the parameters of the right and left maxillary sinuses in both genders are shown in Table 1. The quantitative data is calculated as Numbers (N), Mean, and Median Standard Deviation (SD). Significant differences were observed only among all the three parameters of the right sinuses (p value<0.05).

The Frequency and Percentage tables 2, 3 and 4 details the qualitative data procured. The cross validated classification of sinus parameters revealed that using the right height 68.8% of original grouped cases could be correctly classified as females and 50% of original grouped cases could be correctly classified as males (Table 2). The right width could correctly classify 87.5% and 37.5% of original grouped cases as females and males respectively (Table 3). In case of right sinus depth, could correctly classify 75% and 50% of original grouped cases as females and males respectively (Table 4). Using the left sinus height, height 68.8% of original grouped cases could be correctly classified as females and 71.4% of original grouped cases could be correctly classified as males (Table 2). The left width could correctly classify 75% and 42.9% of original grouped cases as females and males respectively (Table 3). In case of left sinus depth, could correctly classify 75% and 50% of original grouped cases as females and males respectively (Table 4).

Table 1. Comparison between females and males of right left maxillary sinuses parameters

Gender		right sinus width	left sinus width	right sinus depth	left sinus depth	right sinus height	left sinus height
Female	Mean	22.5112	23.5056	35.8288	35.6394	33.3306	33.1225
	N	16	16	16	16	16	16
	Std. Deviation	3.78634	4.62097	4.19009	4.25864	4.61062	4.93104
	Median	23.8000	24.0000	35.3050	35.6700	31.2100	32.0450
Male	Mean	28.3529	28.1164	40.5164	39.3986	39.2043	38.7750
	N	14	14	14	14	14	14
	Std. Deviation	4.64425	4.93995	2.96131	3.79778	4.85190	5.56311
	Median	27.3600	27.8650	40.8200	38.8450	40.2050	40.1400
Total	Mean Difference	5.84161	4.61080	4.68768	3.75920	5.87366	5.65250
	P-Value	.001*	.013*	.002*	.017*	.002*	.006*

Table 2.Classification results of discriminant functional analysis of right height[bc] and left height[de]

			Predicted group membership(right)		Predicted group membership(left)	
			Females	Males	Females	Males
Original	N	Females(16)	11	5	11	5
		Males (14)	7	7	4	10
	%	Females (100%)	68.8	31.3	68.8	31.3
		Males (100%)	50.0	50.0	28.6	71.4
Cross-validated a	N	Females (16)	11	5	10	6
		Males (14)	8	6	4	10
	%	Females (100%)	68.8	31.3	62.5	37.5
		Males (100%)	57.1	42.9	28.6	71.4

a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b.60.0% of original grouped cases correctly classified.

c.56.7% of cross-validated grouped cases correctly classified.

d.70.0% of original grouped cases correctly classified.

e.66.7% of cross-validated grouped cases correctly classified.

DISCUSSION

Gender determination from remnants of human skeletons is an important step in forensic profile for human identification. Gender estimation using the entire skeleton can yield an accuracy of 100% whereas pelvis and the skull can contribute to a total of 98% accuracy. (Uthman, A. T., Al-Rawi, N. H., & Al-Timimi, J. F. (2012)).

In the present study, the reliability of maxillary sinus parameters in predicting gender was analyzed. In our study, female group showed statistically significant lower sinus parameters values than males which is comparable with the previous study (Urooge, A., & Patil, B. A. (2017);Tambawala, S. S., Karjodkar, F. R., Sansare, K., & Prakash, N. (2016); Ravali CT (2017)).

Table 3.Classification results of discriminant functional analysis of right width[bc] and left width[de]

			Predicted group membership(right)		Predicted group membership(left)	
			Females	Males	Females	Males
Original	N	Females(16)	14	2	12	4
		Males (14)	9	5	8	6
	%	Females (100%)	87.5	12.5	75.0	25.0
		Males (100%)	64.3	35.7	57.1	42.9
Cross-validateda	N	Females (16)	14	2	12	4
		Males (14)	10	4	8	6

	%	Females (100%)	87.5	12.5	75.0	25.0
		Males (100%)	71.4	28.6	57.1	42.9
a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.						
b63.3% of original grouped cases correctly classified.						
c60.0% of cross-validated grouped cases correctly classified.						
d60.0% of original grouped cases correctly classified.						
e60.0% of cross-validated grouped cases correctly classified.						

The maxillary sinus height showed relatively better discrimination that could be used to study sexual dimorphism and is in consensus with other studies (Tambawala, S. S., Karjodkar, F. R., Sansare, K., & Prakash, N. (2016); Ravali CT (2017); Paknahad, M., Shahidi, S., & Zarei, Z. (2016); Kumar P, Pachipulusu B, Govindaraju P (2018); Uthman, A. T., Al-Rawi, N. H., Al-Naaimi, A. S., & Al-Timimi, J. F. (2011)).

Table 4.Classification results of discriminant functional analysis of right depth[bc] and left depth[de]

			Predicted group membership(right)		Predicted group membership(left)	
			Females	Males	Females	Males
Original	N	Females(16)	12	4	12	4
		Males (14)	7	7	7	7
	%	Females (100%)	75.0	25.0	75.0	25.0
		Males (100%)	50.0	50.0	50.0	50.0
Cross-validateda	N	Females (16)	12	4	12	4
		Males (14)	7	7	7	7
	%	Females (100%)	75.0	25.0	75.0	25.0
		Males (100%)	50.0	50.0	50.0	50.0
a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.						
b. 63.3% of original grouped cases correctly classified.						
c. 63.3% of cross-validated grouped cases correctly classified.						
d. 63.3% of original grouped cases correctly classified.						
e. 63.3% of cross-validated grouped cases correctly classified.						

In our study, gender prediction through sinus width, height and depth showed low prediction values. The dimensions of maxillary Sinus of males were found narrower than female in Zululand and wider in males than females in Europe (Teke, H. Y., Duran, S., Canturk, N., & Canturk, G. (2006); Lee Fernandes C(2004)) in contrast to the study by Bangi, B. B., Ginjupally, U., Nadendla, L. K., & Vadla, B. (2017), where maxillary sinuses are significantly larger in males than in females. Most of the studies done on maxillary sinus in gender determination have reported significant differences in the sinus metric parameters between males and females (Teke, H. Y., Duran, S., Canturk, N., & Canturk, G. (2006); Tambawala, S. S., Karjodkar, F. R., Sansare, K., & Prakash, N. (2016); Amin, M. F., & Hassan, E. I. (2012); Prabhat, M., Rai, S., Kaur, M., Prabhat, K., Bhatnagar, P., & Panjwani, S. (2016)). On the contrary, Saccucci M et al.(2015), reported no such differences. The findings of this morphometric analysis of maxillary sinus using CBCT suggest that Maxillary sinus may assist in gender determination when other methods used in the field of forensics seem to be indecisive (Tambawala, S. S., Karjodkar, F. R., Sansare, K., & Prakash, N. (2016); Ravali CT (2017); Paknahad, M., Shahidi, S., & Zarei, Z. (2016); Kumar P, Pachipulusu B, Govindaraju P (2018); Uthman, A. T., Al-Rawi, N. H., Al-Naaimi, A. S., & Al-Timimi, J. F. (2011)).

CONCLUSION:

Within the limitations of this study performed with small sample size owing to the stringent inclusive and exclusive criteria, gender prediction through sinus width, height and depth showed low prediction values. This being a preliminary study in Saudi sub population, further studies on large samples are required to make it as a conclusive gender predicting tool and for attaining standardization.

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CONFLICTS OF INTEREST

No conflict of interest declared

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