MORPHOMETRIC EVALUATION OF PIRIFORM AND ORBITAL APERTURE IN SEX DISCRIMINATION BY USING COMPUTED TOMOGRAPHY IN EGYPTIAN POPULATION.

Reham Hassan El- Farouny [1], Shaimaa Abdelhamid Hassanein [2], Rasha Mamdoh Azab[1]

[1]Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine- Menoufia University, Egypt.

[2] Radiodiagnosis Department, Faculty of Medicine - Menoufia University, Egypt.

Corresponding author: Reham Hassan El- Farouny.

E-mail address:dr_reham2004@yahoo.com

Egypt J. Forensic Sci. Appli. Toxicol. Vol 21 (1)
Date of submission: 26 December 2020
Revised at: 3 February 2021
Accepted at: 8 February 2021

ABSTRACT

Human skeletal remains identification is crucial in forensic investigations, so the differentiation of the sex of a human bone is a significant initial stage for estimation of age and height of any unknown skeletal bone. **AIM**: The present study was designed to compare and evaluate the role of piriform and orbital aperture measurements in sex discrimination by using computed tomography in a sample of Egyptian population. **SUBJECTS AND METHODS:** This study was done by using 89 computed tomography (CT) images of the piriform and orbital bone obtained from the Radiology Department, Menoufia University Hospital for numbers of males' and females' patients (43 of them were for males and 46 were for females) aged from 20 to 70 years; where the morphometric measurements of piriform and orbital aperture were obtained. **RESULTS:** This study was conducted on 89 CT images; 43 of them were for males representing 48.3% with a mean age of 47.44± 16.54 years, while 46 cases were for females representing 51.7% with a mean age 44.52 ±15.56 years. A highly significant difference ($p<0.01$) was obvious between both sexes for left orbital width, right, and left orbital area with greater values in males. Measurements of piriform aperture (PA) in this study as length, width, and area showed that males presented with significantly greater mean values than females. Besides that, the Piriform area was the best sex discriminant measure as it had the highest sensitivity 93%, specificity by 85%, and accuracy of 88.7% at a cutoff equal to 64 mm or more suggesting males ($p<0.001$). **CONCLUSION:** Sex determination of human skeletons is important in forensic and anthropological research. The present study revealed that piriform and orbital aperture have sexual dimorphism and can be helpful in sex discrimination, especially the piriform area, which had the best accuracy in this study, as it had the highest sensitivity 93%, specificity 85%, and 88.7% accuracy.

Keywords: Morphometric, Orbit, Piriform, Sex, Discrimination, Egyptian

INTRODUCTION:

Human skeletal remains identification is crucial in forensic investigations, so the differentiation of the sex of a human bone is a significant initial stage for estimation of age and height of any unknown skeletal bone **(Ghorai et al., 2017).**

For sex determination, the forensic anthropologist must assess different regions of the skeleton, combine, and compare them **(Spradley and Jantz, 2011; Cabo et al., 2012; Garvin, 2012)** because parts of the same skeletal could have different grades of sexual properties **(Best et al., 2018).**

Morphological variations in the tissues of both sexes can be affected by the roles of each part of the body, biomechanical load, stress, and hormonal levels **(Best et al.,2018).**

Previous research concluded that cranium shape could be affected under extreme climatic conditions **(Evteev et al.,2018).** Some researchers have correlated osseous anatomy and degree of sexual dimorphism with human socio-economic status and diet, so a high degree of accuracy and precision can be obtained by integrating two or three of the cranium's morphological features for sex discrimination **(Williams and Rogers, 2006).**

The orbital aperture is an anatomical landmark in the cranium, and orbital measurements are one of the craniofacial variables that have been successfully used in anthropological studies for personal identification. Its morphological structure differs between races and ethnic groups from various geographical regions of the world (**Sarkar et al.,2018).**

The piriform is a pear-shaped anatomical structure; formed by some facial bones (frontal processes of the maxillary bones, the nasal bones, and the anterior nasal spine). Classical sex prediction; can be provided by the characteristic features of the pyriform aperture (PA) **(López et al., 2009).**

Radiographs have been used in the discovery of unknown skeletal bones since the 1900s. Because of their objectivity, specificity, and reliability, metric assessments of radiographs have greater importance. The measures of craniofacial structures are calculated by many methods and techniques **(Attia et al.,2018).**

Computer software undergoes significant development, as multiple segments imaging of the bone can be obtained automatically, late generation of CT scanners can view even minor differences in contrast. So, it can be used as an effective tool for anatomical measurement of a skeleton **(Khademi and Bayat., 2016).**

The present thesis was designed to determine the sexual difference between males and females with the help of a morphometric analysis of piriform and orbit aperture in a sample of Egyptian individuals.

METHODOLOGY:

This is a cross-sectional study done on 89 computed tomography (CT) images for the piriform and orbital bone obtained from the Radiology Department, Menoufia University Hospital for numbers of males' and females' patients (43 of them were for males and 46 were for females) aged from 20 to 70 years. Inclusion criteria: CT images of apparently healthy individuals; with no asymmetrical features of the skull or craniofacial trauma.

Radiological examination: CT images were done on the piriform and orbital aperture using a 128-MDCT scanner (SOMATOM perspective, Siemens, Germany). The image was taken while the patients were lying supine, head-first with the landmark 1cm superior to skull vertex. A scout was then performed Craniocaudal. A spiral scan was then performed using the following parameters: kVp: 130, mAs: 100, rotation time 1 second, slice thickness 0.6 mm. Axial volume was acquired and then transferred as a DICOM file. Post scan processing: the DICOM images were evaluated using a RadiAnt viewer system **(version 2020.2, 64-bit),** with 3D surface render volume (VR) analysis used to attain the orbital length (OL) and width (OW); where (OW) measured as the distance between the dacryon to the orbital tubercle, and (OL) is the distance between the upper and lower margin of the orbital bone and perpendicular to the OW, and the inter-orbital distance which is the least diameter measured in-between the two medial walls of the orbit, then right and left orbital index were calculated by dividing the orbital length to the orbital width and multiplying it by 100. Pyriform length (PL) and width (PW) were also measured; (PL) measured from the rhinion superiorly downward to the nasal spine; (PW) measured as the largest distance between the right and left lateral piriform ridges.

Multi-planar reconstruction (MPR) in the axial plane was used to assess the inter-zygomatic distance, and in the coronal plane to assess the orbital areas. Maximum intensity projection (MIP) was used to calculate the area of the pyriform aperture.

The measures were performed by a radiologist using the manual method for measurements, with the line used for measuring the straight lines and the closed polygon for measuring the areas.

Statistical analysis: The data collected were tabulated and statistically analyzed; using a personal computer with version 20 of the Statistical Package of Social Science (SPSS) **(Kirkpatrick and Feeney, 2013).** Kolmogorov-Smirnov test was used to check the normality of data, which presented as mean ± standard deviation (SD). We used a t-test at the 5% level to verify the significant difference at the parameter. The P-value; was found to be significant at 0.05 or less. The receiver operator curve (ROC); was implemented to evaluate the percentage of accuracy of the significant variables measured, and to establish ideal cutoff values, the area under the curve (AUC) reflects the measure's diagnostic efficiency, as more than 50 percent of the area shows appropriate prediction, while about 100 percent of the area is the best for discrimination. Then the significant parameters in sex discrimination; were analyzed by discrimination function analysis test as sectioning point, and sex equation was determined.

RESULTS:

This was a cross-sectional study done over 89 computed tomography (CT) images of the piriform and orbital bone; 43 of them were males representing 48.3% their mean age was 47.44± 16.54 years, while 46 cases were females representing 51.7% with a mean age of 44.52 ±15.56 years. **Table (1)** shows that there was a non-significant difference in age among the studied cases regarding their sex, where t- test= 0.856 and p > 0.05.

Table (2) reveals that there was no side difference between the left and right orbital values measured as regards the same sex.

Table (3) shows the statistical analysis of all orbital measures as regards the sex, where a highly significant difference (p <0.01) was obvious between both sexes for left orbital width, right, and left orbital area with greater values in males.

Measurements of PA in this study showed that males presented with significantly greater mean values than females in all measures of piriform as length, width, and area **(Table 4)**

Table (5) and fig (1) demonstrated the (ROC) analysis, which had been used to estimate the maximum values for sex discrimination. The optimum cutoff point, sensitivity, and specificity values were determined. It declared that the Piriform area was the most accurate measure for sex discrimination among all studied values, as it had the highest sensitivity percentage by 93%, plus 85% specificity, and an accuracy rate of 88.7% at a cutoff equal (64 mm) or more; suggesting males (p<0.001)**.**

By combining the orbit and piriform measures, the six significant variables were subjected to multivariate discrimination analysis, and sectioning point was obtained, with an 83.1% total accuracy rate, of which 88.9% in male and 79.2% in female were determined accurately **(Table 6).** And discriminant function (df) score = -16.587 + (Lt. orbital width * 0.082) + (Rt. orbital. Area * 0.084) + (Lt. orbital. area * 0.029) + (pyriform area *0.058) + (pyriform length *0.144) + (piriform width * -0.020). If the (df) score is more than or equal to the sectioning point, then the individual is considered male, while if (df) score is less than the sectioning point, then the individual is considered female.

Table (1): T-test statistical analysis of the relation between age and sex in the studied cases.

Age (years)	Male (n=43)	Female (n=46)	t-test	P-value
Mean ±SD	47.44± 16.54	44.52 ±15.56	0.856	0.395

n: number, SD: standard deviation.

Table (2): Comparison between the left and right-sided orbital measures as regards the sex.

Variables	Male (n=43)			Female (n=46)		
	Right side Mean ± SD. (mm)	Left side. Mean ± SD. (mm)	P-Value	Right side Mean ± SD. (mm)	Left side. Mean ± SD. (mm)	P-Value
Orbital width	36.79±1.34	37.03±1.37	0.772	37.39± 1.77	36.11± 1.34	0.090
Orbital length	34.92 ± 5.01	35.18 ± 1.73	0.72	35.08 ± 3.26	34.77 ± 3.25	0.076
Orbital area	111.96± 11.44	109.67±11.47	0.5	100.4 ±7.23	99.57± 6.14	0.66
Orbital index	0.935 ± 0.14	1.08 ± 0.8	0.240	0.92 ± 0.18	1.19 ± 1.11	0.108

n: number, SD: standard deviation, mm: millimeter

Table (3): T-test statistical analysis of the relation between the measured variables of orbital aperture (OA) and sex in the studied cases.

Variables	Male (n=43)	Female (n=46)	t-test	P-Value
Rt. Orbital width	36.79 ± 1.34	37.39 ± 1.77	-1.819	0.072
Lt. Orbital width	37.03±1.37	36.11 ±1.34	3.182	0.018*
Rt. Orbital length	34.92 ± 5.01	35.08 ± 3.26	-1.2343	0.22
Lt. Orbital length	35.18 ± 1.73	34.77 ± 3.25	0.738	0.463
Rt. Orbital area	111.964± 11.44	100.40±7.23	5.73	<0.001**
Lt. Orbital area	109.67±11.47	99.57± 6.14	5.226	<0.001**
Rt. Orbital index	0.935 ± 0.14	0.92 ± 0.18	-0.6467	0.52
Lt. Orbital index	1.08 ± 0.8	1.19 ± 1.11	-1.714	0.09
Inter orbital distance	23.53 ± 1.53	22.71 ± 3.16	1.5288	0.13
Inter zygomatic distance	98.68 ± 2.76	97.4 ± 3.86	1.7954	0.076

: Statistically significant at p ≤ 0.05.** *: Statistically highly significant at p ≤ 0.01.**

Table (4): T-test statistical analysis of the relation between the measured variables of piriform aperture (PA) and sex in the studied cases.

Variable	Male (n=43)	Female (n=46)	t- test	P-Value
Piriform _length	34.17 ± 4.4	28.51 ± 2.7	7.3641	<0.001**
Piriform _width	24.31 ± 1.52	22.78 ± 1.53	4.7503	<0.001**
Piriform _area	72.06± 10.51	58.83± 5.82	7.4078	<0.001**

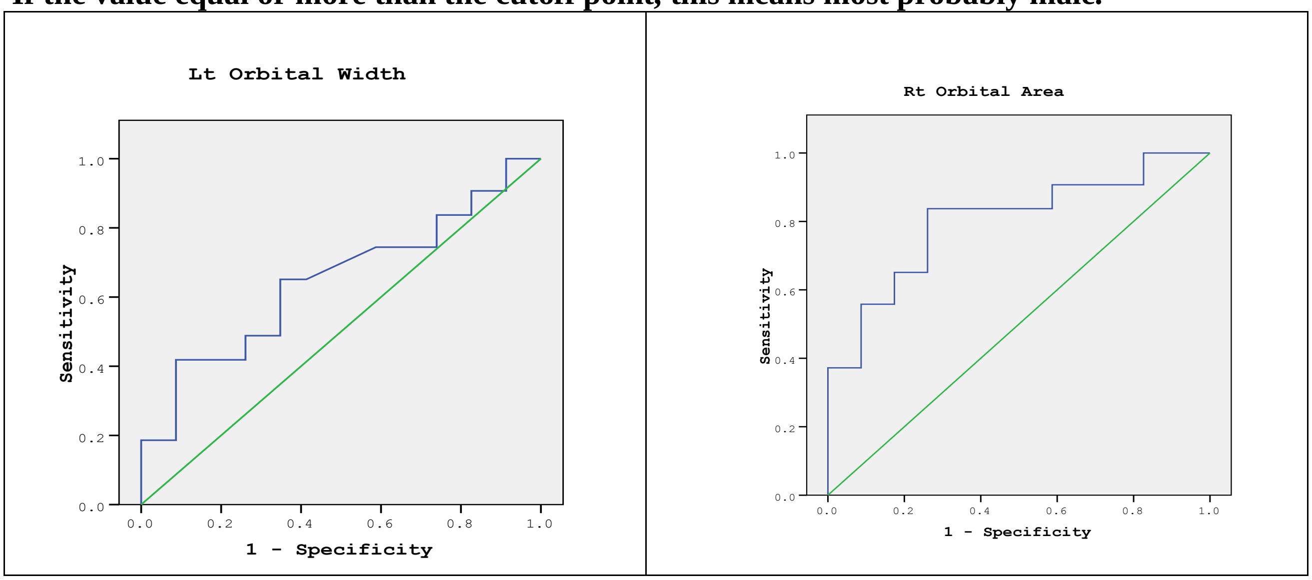
****: Statistically highly significant at p ≤ 0.01.**

Table (5): Sensitivity and specificity for the significant measured variables in the studied cases for sex discrimination.

	AUC	P-Value	95% C.I	Cutoff (mm)	Sensitivity	Specificity	PPV	NPV	Accuracy
Lt. Orbital width	0.646	<0.018*	0.53 - 0.76	≥36.25	65 %	65.2%	63.6	66.6	65.1%
Rt. Orbital area	0.801	<0.001*	0.70 - 0.89	≥106.25	84%	74%	83.7	73.9	78.6%
Lt. Orbital area	0.772	<0.001*	0.67 – 0.87	≥103.8	72.7%	75%	74.4	73.9	74.1%
Piriform length	0.886	<0.001*	0.80 - 0.96	≥30.6	81%	85%	81.4	84.8	83.1%
Piriform width	0.719	<0.001*	0.60 - 0.82	≥23.25	84%	67%	83.7	67.4	75%
Piriform area	0.911	<0.001*	0.85 - 0.96	≥64	93%	85%	93	84.8	88.7%

AUC: Area Under a Curve **CI**: Confidence interval
NPV: Negative predictive value **PPV**: Positive predictive value
**: Statistically highly significant at $p \leq 0.01$

If the value equal or more than the cutoff point, this means most probably male.



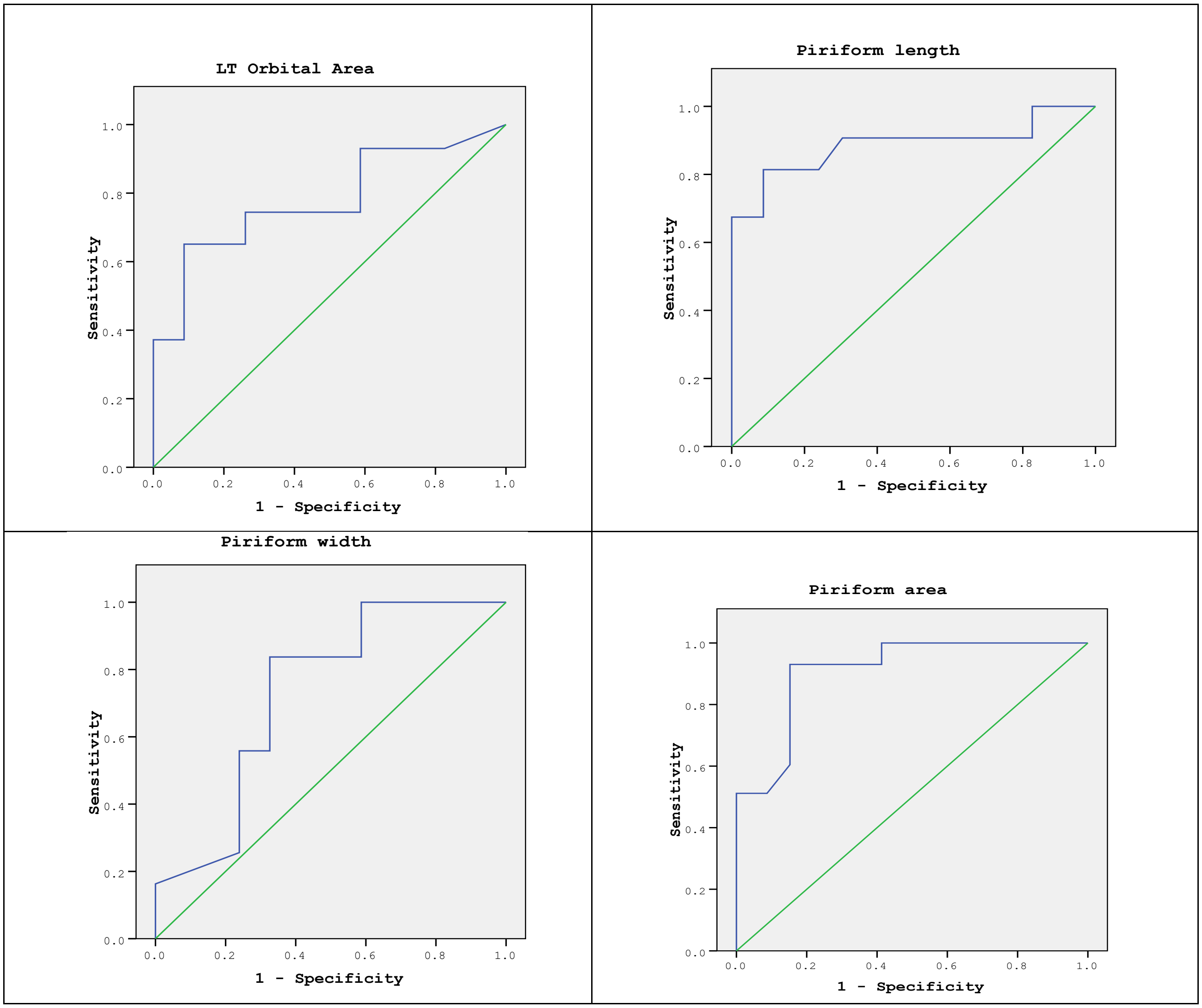


Figure (1): ROC curve analysis of the significant measured variables in sex discrimination.

Table (6): Multivariate discriminant function analysis of the measured significant variables of piriform and orbital aperture.

Variables	Constant	Coefficient	Sectioning point	Percent of accuracy		Accuracy %
				males	females	
Lt. Orbital width	-16.587	0.082	0.28	88.9%	79.2%	83.1
Rt. Orbital area		0.084				
Lt. Orbital area		0.029				
Piriform length		0.058				
Piriform width		0.144				
Piriform area		-0.020				

Discriminant function (df) score = -16.587 + (Lt. orbital width * 0.082) + (Rt. orbital. Area * 0.084) + (Lt. orbital. area * 0.029) + (pyriform area *0.058) + (pyriform length *0.144) + (piriform width * -0.020)

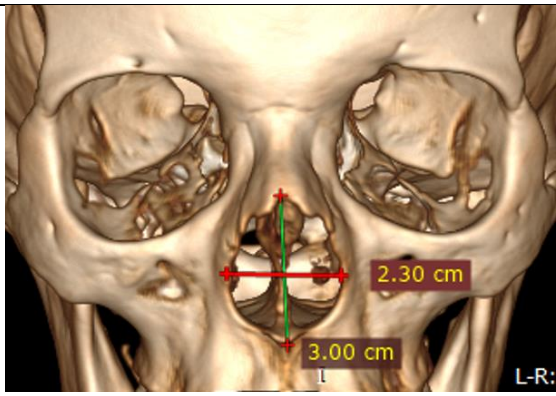


Figure (2): 3-dimentional CT scan of the Piriform Aperture (PA) shows maximal length of PA (green line), and maximal width (red line).

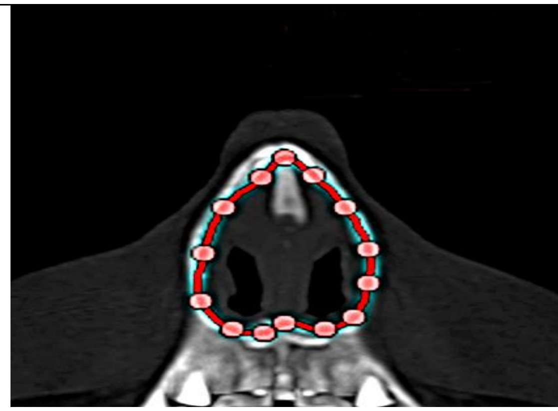


Figure (3): Coronal section CT scan showing the Piriform Aperture (PA) area

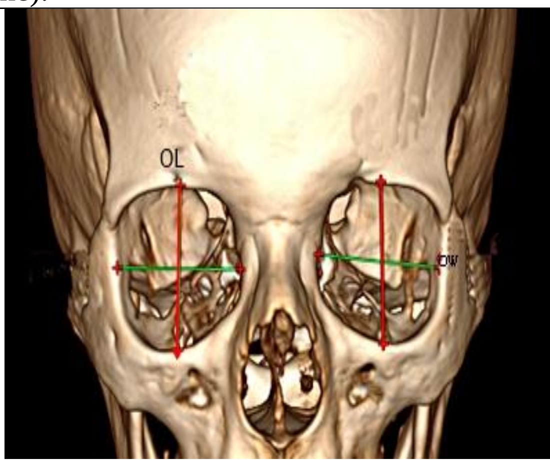


Figure (4): 3-dimentional CT scan of Orbital aperture (OA) shows maximal length of (OL) (red line), and maximal width (OW) (green line).

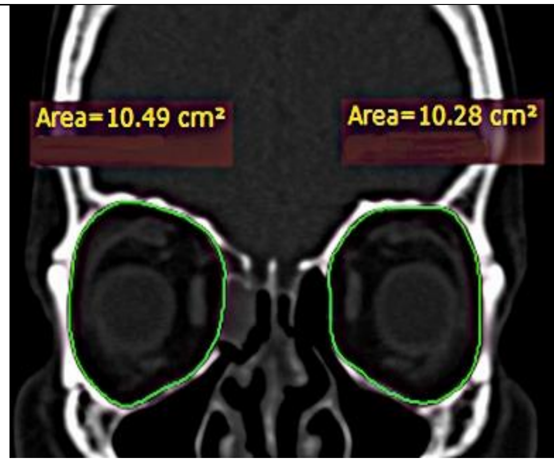


Figure (5): Coronal section CT scan of the Orbital aperture (OA) area

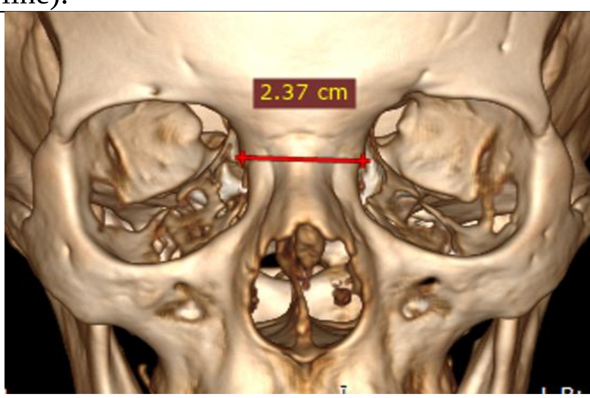


Figure (6): 3-dimentional CT scan showing the inter orbital distance (red line)

Figure (7): Axial section CT scan showing the inter zygomatic distance (red line)

DISCUSSION:

In a forensic background, the task of anthropology is to arrive at conclusions about age, sex, height, and racial origin from the unknown or decomposed remains. One of the major challenges raised while creating the biological profile is the determination of sex. The accuracy of skeleton sex discrimination depends on the bony part available, its validity, and the degree of sex differences; that present in such a population group **(Jain et al., 2016).** So, the purpose of the present research was to compare and assess the role of piriform and orbital aperture measurements in sex discrimination by using automated computed tomography imaging in a sample of Egyptian individuals.

This research was conducted on 89 computed tomography (CT) images of the piriform and orbital bone; 43 cases were males representing 48.3% their mean age was 47.44± 16.54 years, while 46 cases were females representing 51.7% their mean age was 44.52 ±15.56 years.

The present study revealed that there was no side difference was present between the left and right orbital indices as regards the same sex. Likewise, **Botwe et al. (2017)** and **Attia et al. (2018)** showed that the difference between the orbit length and width for either side was not significant statistically, which means that the orbital measurements on both sides have approximated dimensions. This was agreed with **Ezeuko and Om Iniabohs (2015); Mekala et al. (2015)** who reported similar results.

On the other hand, this result of our study was contradicted with that of **Gopalakrishna and Kashinatha (2015),** who declared in their study that the bilateral orbits showed a significant difference in the orbital index. They attributed this finding to the differential growth in the multiple bones forming the orbit.

This study reported that there was a highly significant difference ($p<0.01$) as regards left orbital width, right and left orbital areas between genders with higher male values, while other orbital indices were not significantly different between males and females. This was in line with **Cheng et al. (2008),** who stated that males owned considerably greater orbital measures than females. From the other side, in terms of orbital height, **Rossi et al. (2012)** found non-significant gender variations among Brazilian people.

Other studies on orbital dimensions as **Kaplanoglu et al. (2014)** stated that in males the orbital distance, height, orbital index, and interorbital widths were greater than in females. Also, **Attia et al. (2018),** who previously assessed sex determination from orbital aperture measures among the Egyptian population, concluded that there were obvious differences in the right orbital height regarding the gender where males got higher measures.

In contrast to the study of **Husmann et al. (2011)** had found that the orbital measures in females were higher than males, where the racial difference between the Egyptians included in the present study and the black races included in their study can be attributed to this outcome.

Out of the orbital measurements that were recorded in the current study, the left orbital area had the highest sensitivity by 75%, 74.4% specificity, and 74.1% accuracy. While **Dayal et al. (2008)** studied various measurements over more than one hundred skulls, found that the orbital width and orbital length had been assessed with 65.80% and 53.30% accuracy rate, respectively. **Attia et al. (2018)** published a near result on orbital measurement accuracy, as they reported that the orbital measurements provide up to 74.7 percent accuracy of right sex. However, the accuracy reported by **Saini et al. (2011)** was much lower as they studied orbital width and orbital length for gender classification and observed that the accuracies of their use in the prediction of sex were respectively 62.5% and 48.20%.

The discrepancy between the present findings and other studies concerning orbital measures validity in sex determination might be related to many factors including, the variation of age, ethnic group, the sample size of the studied population, and the applied method and tools used for obtaining the measurements.

Piriform aperture (PA) features had been interpreted as a classic sexual differentiation predictor; the piriform measures were chosen in this analysis to determine their role in sex discrimination **(Rogers, 2005).**

Hwang et al. (2005) proposed that heat and humidity in the air breathed by individuals specifically influence the measures of PA and the form of the nasal bone. For this reason, it is believed that the dimensions of PA and the shape of the nasal bone are adapted to the environmental and geographical variations.

Measurements of PA in this study showed that males presented with significantly greater mean values than females in all measures as length, width, and area. As male skulls are usually more rigid and larger, thus morphologically, it suggests that the anatomical features are larger in males than females. However, the degree of the discrepancy between them differs from one population to another.

Abdelaleem et al., (2016) analysis reported that in an Egyptian population sample, males displayed highly significant dominance over females in terms of height, width, and area of PA. The same finding was reported by **Prado et al. (2011);** who studied the role of the piriform aperture morphometry and nasal bone morphology in sex determination among the Brazilian population.

On the other hand, by comparing between piriform area and other studied orbital indices in sex determination, the ROC curve showed that the piriform area exhibited the highest accurate measure as it had 88.7% accuracy with sensitivity 93% and 85% specificity.

The current study represents a high accuracy of the piriform area in sex determination comparing to **Abdelaleem et al. (2016)** who recorded a high accuracy rate in sex prediction by using the width of the PA. Besides that, **Alves et al. (2018)** reported 74.2%, 67.8%, 77.6% accuracy, sensitivity, and specificity, respectively (0.764 AUC) for the piriform height. However, other studies as **Williams and Rogers (2006)** had thrown light on the shape of the PA, with an accuracy of 84%.

Hunnargi et al. (2009) suggested that the difference in the accuracy of the piriform variables for sex determination could be related to the different statistical approaches that had been used.

In the present research, the six significant variables of both the piriform and orbital aperture were subjected to discrimination functional analysis; where the sectioning point was reached and the following equation was obtained as, Discriminant function (df) score = -16.587 + (Lt. orbital width * 0.082) + (Rt. orbital. Area * 0.084) + (Lt. orbital. area * 0.029) + (pyriform area *0.058) + (pyriform length *0.144) + (piriform width * -0.020). Where if the (df) score equal to or more than the sectioning point, this predicting male, while if the (df) score less than the sectioning point, this predicting female. This equation showed a total accuracy rate of 83.1%, of which 88.9% in males and 79.2% in females were determined accurately.

The findings of many authors and the current study show that it is very important for sex determination to use various approaches in skeletal measurements, besides the combination of more than one bone to find out the sex in case of unknown bony remains **(Suazo et al., 2008).**

CONCLUSION & RECOMMENDATION

Sex determination of human skeletons is important in forensic and anthropological research. The present study revealed that piriform and orbital aperture had sexual dimorphism, so their measurements can be used for sex determination, especially the piriform area, which exhibited the highest accuracy for sex discrimination in this study.

Further research in this field are recommended on a wide scale of a larger sample of different races by using various age groups are recommended. Besides, using different statistical techniques for analysis of the measures of different anatomical structures to provide more accurate data that can be used as a baseline for morphometric data in forensic research.

REFERENCES:

Abdelaleem, S.A., Younis, R.H., and Kader, M.A., (2016): Sex determination from the piriform aperture using multi slice computed tomography: Discriminant function analysis of Egyptian population in Minia Governorate. Egyptian Journal of Forensic Sciences, 6(4), pp.429-434.

Alves, N., Deana, N.F., Ceballos, F., Hernandez, P. and Gonzalez, J., (2019): Sex prediction by metric and non-metric analysis of the hard palate and the pyriform aperture. Folia morphologica, 78(1), pp.137-144.

Attia, A.M., Ghoneim, M. and Elkhamary, S.M. (2018): Sex discrimination from orbital aperture dimensions using computed tomography: Sample of Egyptian population. Journal of Forensic Radiology and Imaging, 14, pp.32-38.

Best KC, Garvin HM, and Cabo LL. (2018): An Investigation into the Relationship between Human Cranial and Pelvic Sexual Dimorphism. J Forensic Sci; 63(4): 990–1000.

Botwe, B.O., Sule, D.S. and Ismael, A.M., (2017): Radiologic evaluation of orbital index among Ghanaians using CT scan. Journal of physiological anthropology, 36 (1), p.29.

Cabo, L. L., Brewster, C. P., and Luengo Azpiazu, J. (2012): Sexual dimorphism: interpreting sex markers. A companion to forensic anthropology, 248-286.

Cheng, A. C., Lucas, P. W., Yuen, H. K., Lam, D. S., and So, K. F. (2008): Surgical anatomy of the Chinese orbit. Ophthalmic Plastic & Reconstructive Surgery, 24(2), 136-141.

Dayal, M.R., Spocter, M.A., and Bidmos, M.A., (2008): An assessment of sex using the skull of black South Africans by discriminant function analysis. Homo, 59(3), pp.209-221.

Evteev, A., Cardini, A. L., Morozova, I., and O'Higgins, P. (2014): Extreme climate, rather than population history, explains mid-facial morphology of Northern Asians. American journal of physical anthropology, 153(3), 449-462.

Ezeuko, V.C. and Om Iniabohs, F.A., (2015): Radiologic evaluation of the orbital index among the Igbo Ethnic Group of Nigeria. Eur. J. Anat, pp.9-14.

Garvin H. (2012): Adult sex determination: methods and application. A Companion to Forensic Anthropology. 239–247.

Ghorai, L., Asha, M.L., Lekshmy, J., Rajarathnam, B.N. and Kumar, H.M., (2017): Orbital aperture morphometry in Indian population: A digital radiographic study. Journal of forensic dental sciences, 9 (2), p.61.

Gopalakrishna, K. and Kashinatha, M., (2015): The Craniometrical study orbital base of Indian Population and its applied importance. Scholars Academic Journal of Biosciences, 3(2), pp.618-623.

Hunnargi, S.A., Menezes, R.G., Kanchan, T., Lobo, S.W., Uysal, S., Herekar, N.G., et al, (2009): Sternal index: is it a reliable indicator of sex in the Maharashtrian population of India? Journal of forensic and legal medicine, 16(2), pp. 56-58.

Husmann, P.R., and Samson, D.R., (2011): In the eye of the beholder: sex and race estimation using the human orbital aperture. Journal of forensic sciences, 56 (6), pp.1424-1429.

Hwang, T.S., Song, J., Yoon, H., Cho, B.P. and Kang, H.S., (2005): Morphometry of the nasal bones and piriform apertures in Koreans. Annals of Anatomy-Anatomischer Anzeiger, 187(4), pp.411-414.

Jain, D., Jasuja, O.P. and Nath, S., (2016): An assessment of sex using craniofacial measurements of human crania by discriminant function analysis. Rom J Leg Med, 24 (4), pp.294-299.

Kaplanoglu, V., Kaplanoglu, H., Toprak, U., Parlak, I.S., Tatar, I.G., Deveer, M. and Hekimoglu, B., (2014): Anthropometric measurements of the orbit and gender prediction with three-dimensional computed tomography images. Folia Morphologica, 73 (2), pp.149-152.

Khademi, Z. and Bayat, P. (2016): Computed tomographic measurements of orbital entrance dimensions in relation to age and gender in a sample of healthy Iranian population. Journal of Current Ophthalmology, 28 (2), pp.81-84.

Kirkpatrick, L.A., and Feeney, B.C. (2013): A simple guide to IBM SPSS statistics for version 20.0. Student ed. Belmont, Calif.: Wadsworth, Cengage Learning.

López, M. C., Galdames, I. C. S., Matamala, D. A. Z., and Smith, R. L. (2009): Sexual Dimorphism Determination by Piriform Aperture Morphometric Analysis in Brazilian Human Skulls. International Journal of Morphology, 27(2): 327–331.

Mekala, D., Shubha, R. and Rohini, M., (2015): Orbital dimensions and orbital index: a measurement study on South Indian Dry Skull. Int J Anatomy Res, 3 (3), pp.1387-91.

Prado, F.B., Caldas, R.A., Rossi, A.C., Freire, A.R., Groppo, F.C., Caria, P.H.F., et al., (2011): Piriform aperture morphometry and nasal bones morphology in Brazilian population by postero-anterior Caldwell radiographys. Int. j. morphol, 29(2), pp.393-8.

Rogers, T.L., (2005): Determining the sex of human remains through cranial morphology. Journal of Forensic Science, 50(3), pp.1-8.

Rossi, A. C., de Souza Azevedo, F. H., Freire, A. R., Groppo, F. C., Júnior, E. D., Caria, P. H. F., and Prado, F. B. (2012): Orbital aperture morphometry in Brazilian population by postero-anterior Caldwell radiographs. Journal of forensic and legal medicine, 19(8), 470-473.

Saini, V., Srivastava, R., Rai, R.K., Shamal, S.N., Singh, T.B. and Tripathi, S.K., (2011): An osteometric study of northern Indian populations for sexual dimorphism in craniofacial region. Journal of forensic sciences, 56(3), pp.700-705.

Sarkar, N. and Mukhopadhyay, P.P. (2018): Determination of sex from the morphometry of orbits in adult skull of contemporary eastern Indian population. Egyptian Journal of Forensic Sciences, 8 (1), p.61.

Spradley MK and Jantz RL. (2011): Sex estimation in forensic anthropology: skull versus postcranial elements. J Forensic Sci.; 56 (2): 289–296.

Suazo, G., Galdames, I.S., Matamala, D.Z., Smith, R.L., Zavando, M., and Smith, R., (2008): Accuracy of palate shape as sex indicator in human skull with maxillary teeth loss. International Journal of Morphology, 26(4), pp.989-993.

Williams BA and Rogers T. (2006): Evaluating the accuracy and precision of cranial morphological traits for sex determination. J Forensic Sci. 2006; 51(4): 729–735.

الملخص العربى

التقييم المورفومتري للفتحة المدارية والكمثرية في التمييز بين الجنسين باستخدام التصوير المقطعي في السكان المصريين.

ريهام حسن الفرعونى [1] وشيماءعبد الحميد حسنين[2] ورشا ممدوح عزب[1]
1-قسم الطب الشرعي والسموم الإكلينيكية - كليه الطب - جامعه المنوفيه- جمهورية مصر العربية
2- قسم الأشعة التشخيصية كليه الطب جامعه المنوفية -جمهورية مصر العربية

مقدمة: يعد التعرف على بقايا الهيكل العظمي البشري أمرًا بالغ الأهمية في تحقيقات الطب الشرعي. علاوة على ذلك، يعد تحديد الجنس من الهيكل العظمي البشري خطوة أولية مهمة حيث أن تقدير العمر والعرق يعتمد بشكل كبير على نوع الجنس. **الهدف**: صممت الدراسة الحالية لمقارنة وتقييم دور قياسات الفتحات الكمثرية والمدارية في التمييز بين الجنسين باستخدام التصوير المقطعي المحوسب في عينة من المصريين. **الموضوعات والطرق**: أجريت هذه الدراسة باستخدام 89 صورة تصوير مقطعي محوسب (CT) للعظم الكمثري والعظم المداري تم الحصول عليها من قسم الأشعة بمستشفى جامعة المنوفية لعدد من المرضى الذكور والإناث (43 منهم للذكور و46 من الاناث) من سن 20 إلى 70 عامًا. حيث تم قياس عده قياسات للفتحة الكمثرية والمدارية وتم تحليل النتائج احصائيا والمقارنة بينهم. **النتائج**: أجريت هذه الدراسة على 89 صورة مقطعية. 43 منها كانت لذكور بنسبة 48.3٪ بمتوسط عمر 47.44 ± 16.54 سنة، و46 حالة للإناث بنسبة 51.7٪ بمتوسط عمر 44.52 ± 15.56 سنة. كان الفرق واضحًا للغاية بين الذكور والإناث في عرض المدار الأيسر، والمنطقة المدارية اليمنى واليسرى وكذلك قياسات الفتحه الكمثريه مع قيم أكبر عند الذكور. هذا وتعتبر المنطقة الكمثرية هي أفضل قياس للتمييز بين الجنسين حيث كانت لديها حساسية 93٪ وخصوصية 85٪ وبلغت الدقة 88.7٪.