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Morphometric Assessment of Occipital Condyle in Gender & Age Determination: A Cross Sectional Forensic CBCT Study

Saraswathi K Gopal[1], Poongodi V [2], N Alice Josephine Rani[3]

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Abstract

Aim & Objectives: To assess the dimensions of Occipital Condyle (OC) in three different age groups and to gender.

Materials and Method: 60 CBCT volumes acquired from the dental archives were used. Using Planmeca Romexis software, Height of OC: Longest line drawn ascending from Condylar cartilage to the hypoglossal canal on the coronal section. Condylar Sagittal angle: long axis of the Condyle & the sagittal midline on the coronal section. Width of OC: Widest line drawn to the mid-point of the long axis of the OC on the axial section. Length of OC: Longest axis of the OC on the sagittal section.

Results: The collected data were analysed with IBM SPSS Statistics for Windows, Version 23.0. (Armonk, NY: IBM Corp). The parameters of height, width, length of OC and Condylar sagittal angle had a statistically significant 'p' value which was a boon to the present study.

Conclusion: The morphometric variables such as height, width, length of OC & Condylar-Sagittal angle could serve as reliable tool in gender and age determination in Forensics.

Keywords: CBCT; Occipital Condyles; Condyle; Occipital bone; Forensics.

INTRODUCTION

The Occipital Condyle (OC), the distinctive bony structure linking the skull and the vertebral column & are present on each side of the foramen magnum.[1] The stability of Craniovertebral junction depends largely on the morphometric parameters of the occipital condyles.[2] The integrity of occipital condyles is of vital importance for the stability of the cranio-vertebral junction.[3] Between the occipital condyle and atlas, there is no intervertebral disk as in other joints of the spinal axis.[1] The OC partly covers the fringe of the foramen magnum anteriorly and forms an articulation with the superior articular facets on the lateral masses of the atlas inferiorly. Each OC is oval in shape and oriented obliquely is traversed by hypoglossal canal.[4] Deep to each condyle traverses the hypoglossal canal (HC) which transmits the hypoglossal nerve and a meningeal branch of ascending pharyngeal artery.[5]

The morphology of the occipital condyles with their facets is clinically very important. The cranium floor is the template on that the face is established and thus finds eminent place in the face reconstruction approach.[6] Skull base variations may also be part of a pathological process (tumours, aneurysms, congenital or acquired

Author's Affiliations: [1]Professor and Head, [2]Associate Professor, [3]Post Graduate, Department of Oral Medicine and Radiology, Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research Institute, Chennai 600095, Tamil Nadu, India.

Corresponding Author: N Alice Josephine Rani, Post Graduate student, Department of Oral Medicine and Radiology, Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research Institute, Chennai 600095, Tamil Nadu, India.

E-mail: alice.nevis@yahoo.com

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malformations and trauma and their surgical approach is technically demanding and requires the profound knowledge of anatomy.[7] Knowing the anatomy and analysing the morphometric aspects of occipital condyles is extremely important as it will help the neurosurgeon in the planning of surgical intervention involving the skull base safe and easier due to the increasing trends for transcondylar approach.[3]

3D cone beam computed tomography (CBCT) is becoming a routine diagnostic imaging modality in maxillofacial applications due to its wide array of diagnostic capabilities and minimizing radiation dose to the patient.[8] Previous literature shows the developed accuracy and reliability of cone beam computed tomography (CBCT) over conventional imaging modalities.[9]

Hence, the current cross-sectional study aims to evaluate the utility of the dimensions of Occipital Condyle in gender and age determination.

MATERIALS AND METHOD

Study Design: A Retrospective study.

Study Population

60 CBCT volumes acquired from the dental archives that were generated using Planmeca Promax 3D MID Proface CBCT machine and assessed with Romexis software. CBCT full skull images of the individuals between 2018 and 2021 from the dental archives of department of oral medicine and radiology will be collected for the study purpose.

Sample size Determination

Sample size calculation was done using IBM SPSS Statistics for Windows, Version 23.0. (Armonk, NY: IBM Corp). Samples were divided into 3 age groups and each group comprised of 20 samples with 10 males and 10 females in each group.

Group I – Age 20 - 35 years.

Group II – Age 36 – 50 years.

Group III – Age above 50 years.

Inclusion criteria

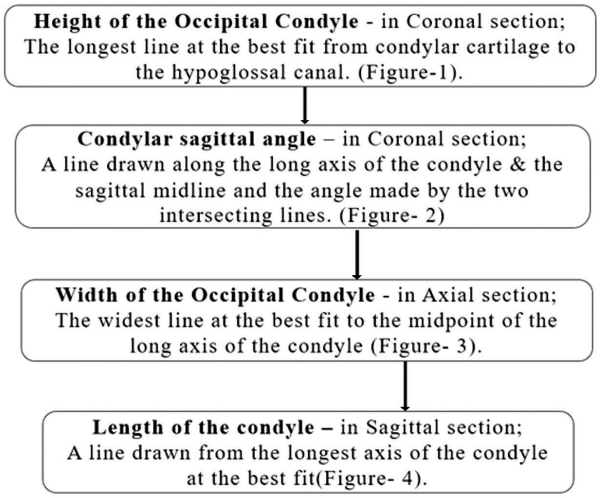
- Images with good contrast, resolution and pixel depth.
- Presence of Occipital condyles & cervical vertebral region.

Exclusion criteria

- Images with artefacts.
- Incomplete scans of OCs and the cervical vertebral region.

Method

Using Planmeca Romexis software,



RESULTS

The collected data were analysed with IBM SPSS Statistics for Windows, Version 23.0. (Armonk, NY: IBM Corp). To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To determine the significant difference between the bivariate samples in Independent groups the Unpaired sample t-test was used. For the multivariate analysis the one way ANOVA with Tukey's Post-Hoc test was used. To evaluate the significance in categorical data Chi-Square test was used. In all the above statistical tools the probability value .05 is considered as significant level.

DISCUSSION

Forensics is a novel science in the field of Medicine and Dentistry and it attributed to numerous fact values in Ante & post-mortem subjects that aided numerous research and invention in the modern science. Forensic odontologists and Dentist can define their role of forensic medical specialists by providing more precise valuable dental records. Skeletal structures are more resistant to external environmental stimuli and are more reliable in the field of Forensic medicine. Age, gender and facial

type determination are paramount in forensic science in identification of deceased individuals.

Morphometrics of Occipital condyles play a vital role in the integrity of the Cranio-Vertebral complex and it is our responsibility as maxillofacial radiologist to detect and find the anatomical and pathological variation in the given field of view. Morphometric measurements vary with gender, age, ethnics & race. In Chennai population of our current study had a significant gender variation in height, width, length of Occipital Condyle & Condylar-Sagittal angle with males having increased size than females which was in consensus with the study done by ***Ismail et al.***, in 2019 among the Turkish population.[1] Additionally in our study we had a significant variation of morphometrics with increasing age which was a negative correlation with the study by ***Ismail et al.***[1] As the age increased the height, width & length of OC decreased; this could be attributed due to the reduced bone remodelling, reduced osteoblastic activity & reduced vascular supply to the bones with advancing age.[10] Where as the study conducted by ***Lyrtzis et al*** in the year 2016 with 141 Greek skulls had a positive correlation with our study with decreased height, width & length of the occipital condyles with advancing age.[11] In 2014, study done by ***Kalthur et al.*** with 71 skulls 2 and ***Anil kumar et al.*** with 50 skulls 3 enumerated the significant results with variation in gender and not in age which was in disagreement with our study. In the present study the condylar-sagittal angle had significant variation with gender which was in agreement with the studies conducted by ***Saluja et al.*** in 2016 with 114 skulls 4, ***Cheruiyot et al.*** in 2018 with 52 skulls 5 & ***Agarwal et al.*** in 2019 with 96 skulls 6; the condylar-sagittal angle decreased with increasing age which was in contrast with the study conducted by ***Saluja et al.*** in 2016 with 114 skulls, which revealed the increased condylar-sagittal angle with advancing age.[4] As previous literature reveals symmetry of the right and left OC, one of the main characteristic features for Cranio-vertebral stability. Whereas in our present study had alternative results as among the right and left OC, right condyle was highly significant when compared to the left condyle, this may be attributed due to the variation in positioning of the patient during the exposure.

Therefore, there is an inverse relationship between Morphometrics of occipital condyles and age; As the age increases there is a decreased height, width & length of OC and decreased Condylar-sagittal angle. There exists always a variation in size with male and female bones wherein the Occipital Condyles follow the same.

Table: 1 T-Test table shows the equal distribution of age wise samples for all parameters.

Parameters	N	SD
H1	60	5.1
H2	60	5.0
W1	60	2.8
W2	60	2.8
L1	60	3.3
L2	60	3.2
A1	60	6.2
A2	60	6.8
Height	60	5.0
Width	60	2.8
Length	60	3.2
Intercondyar angle	60	6.4

Table: 2 shows the equal distribution of samples for Gender

Gender		N	SD
Height	Male	30	5.0
	Female	30	4.4
Width	Male	30	2.9
	Female	30	2.4
Length	Male	30	2.8
	Female	30	3.3
Intercondyar angle	Male	30	6.5
	Female	30	6.3

Table: 3 Post Hoc Turkey test is summarized in this table revealing a significant P value for all age groups of all parameters.

Parameters between groups	p-value	
H1	Between Groups	.0005
H2	Between Groups	.0005
W1	Between Groups	.0005
W2	Between Groups	.0005
L1	Between Groups	.0005
L2	Between Groups	.0005
A1	Between Groups	.0005
A2	Between Groups	.0005

Table: 4 This table shows Intergroup relation of all samples with significant P value.

Dependent Variable			p-value
H1	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
H2	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
W1	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
W2	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
L1	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
L2	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
A1	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005
A2	20 - 35 years	36 - 50 years	.0005
		Above 50 years	.0005
	36 - 50 years	Above 50 years	.0005

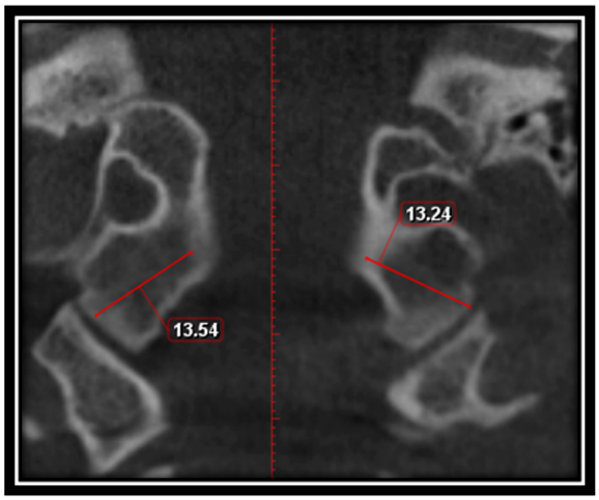


Fig. 1:

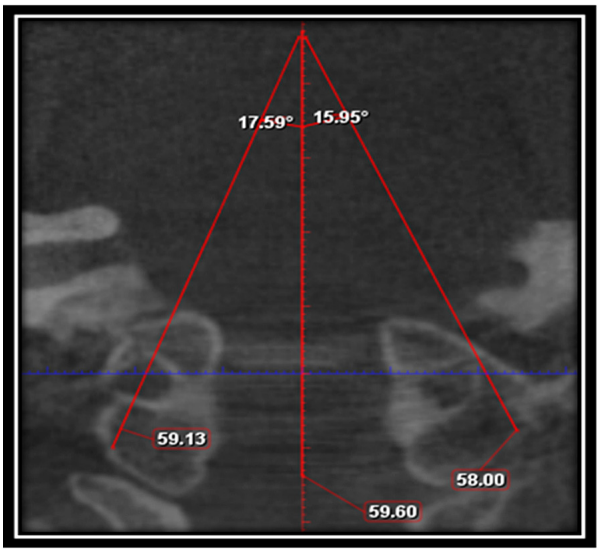


Fig. 2:

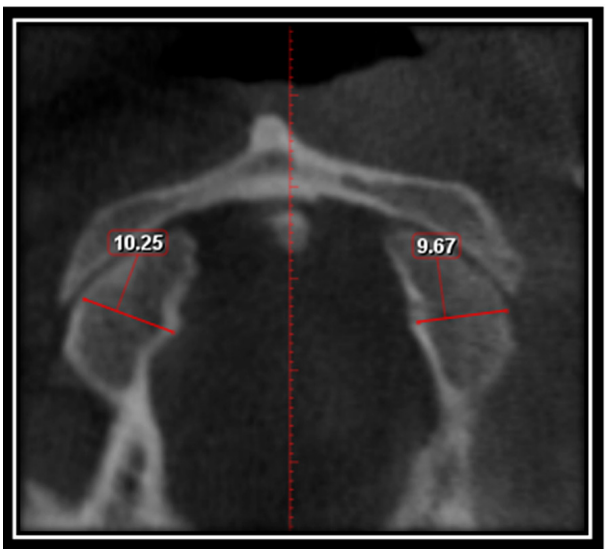


Fig. 3:

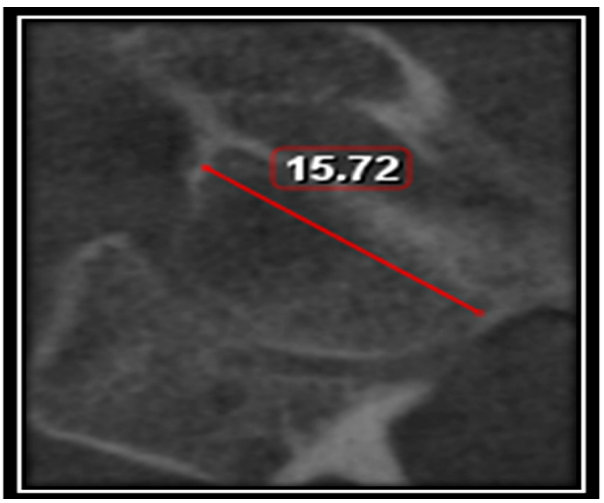


Fig. 4:

Strength of the study

- Most of the studies in the past are done using skull, whereas in our study 3-Dimensional images are being used.
- In our study, digital measurements are done which can be more reliable than the manual measurements.

Limitations of the study

- It's a preliminary study and it has to be studied with larger samples for better reliability and to be used as routine tool in the forensic science.

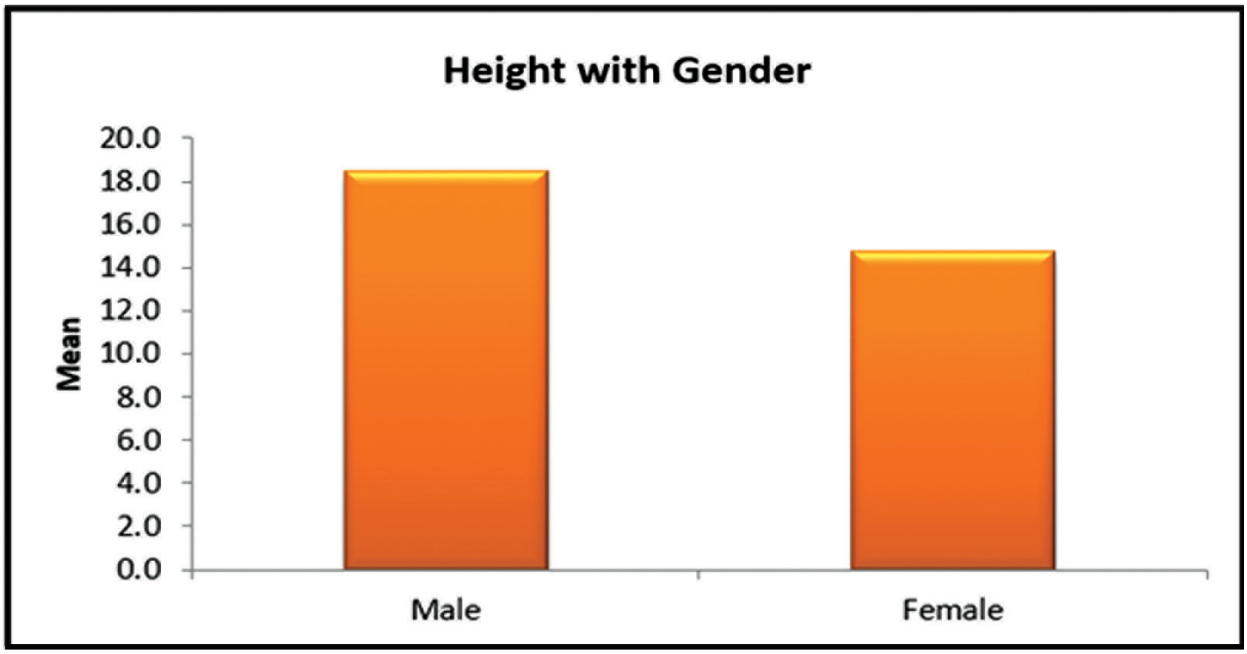


Fig. 5: Height with gender

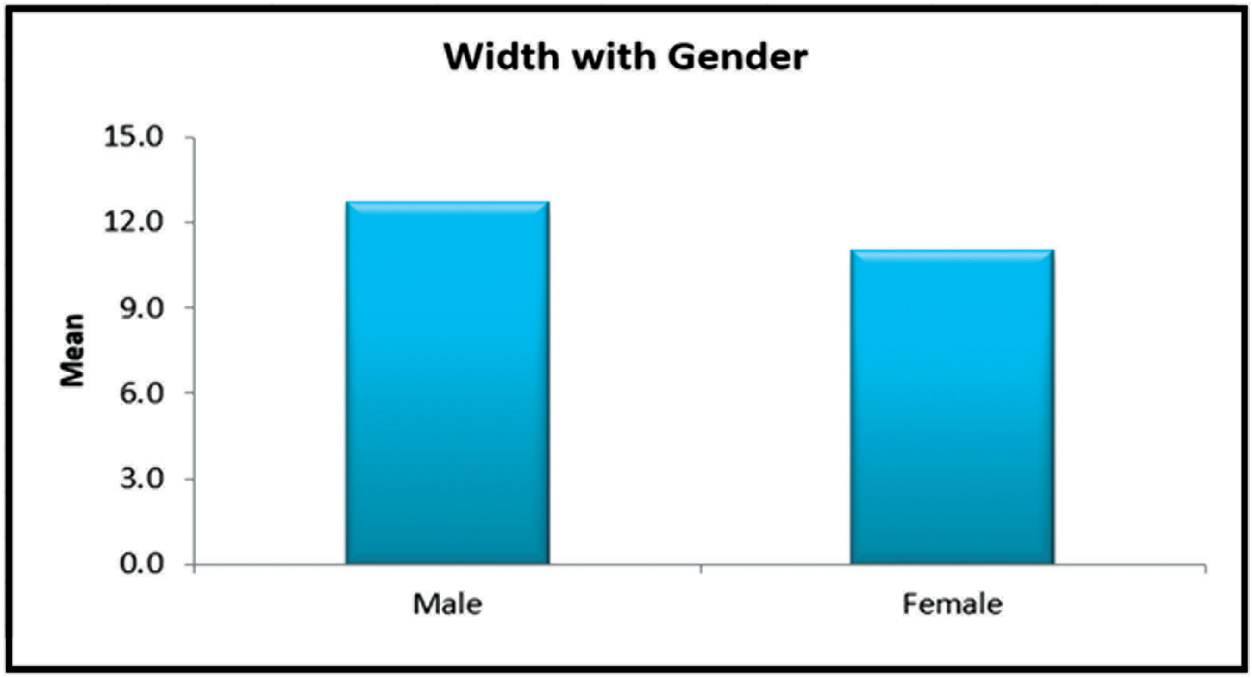


Fig. 6: Width with gender

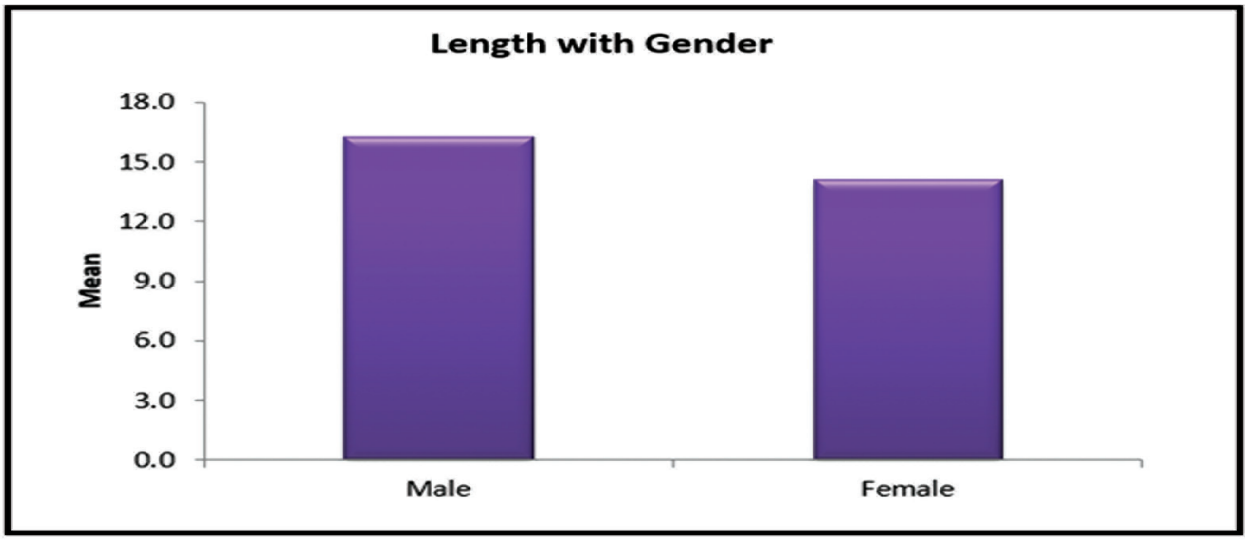


Fig. 7: Length with gender

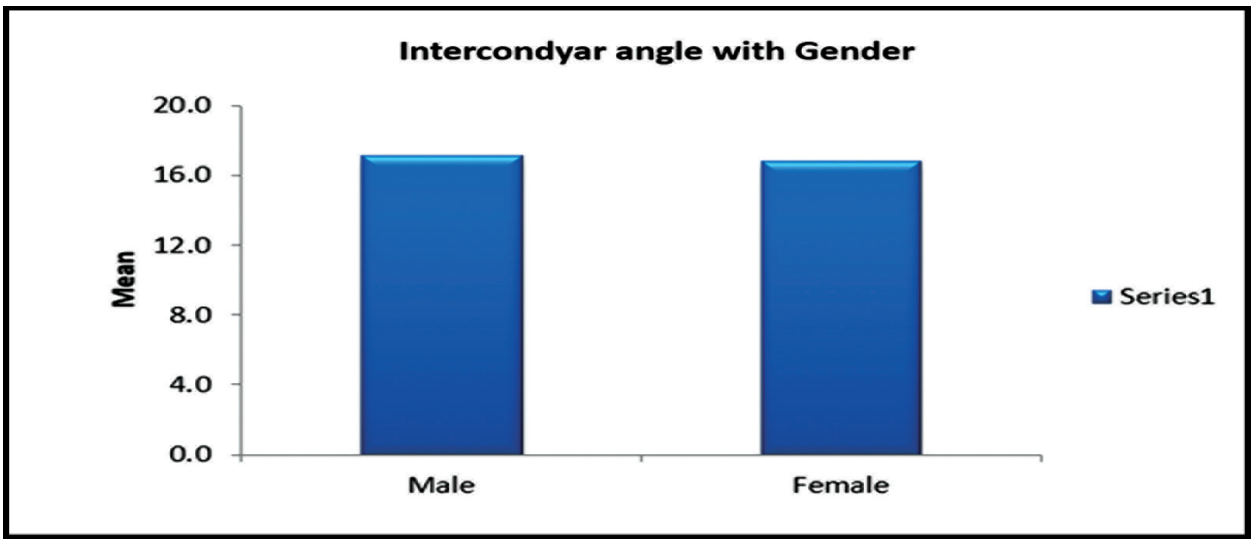


Fig. 8: Intercondyar angle with gender

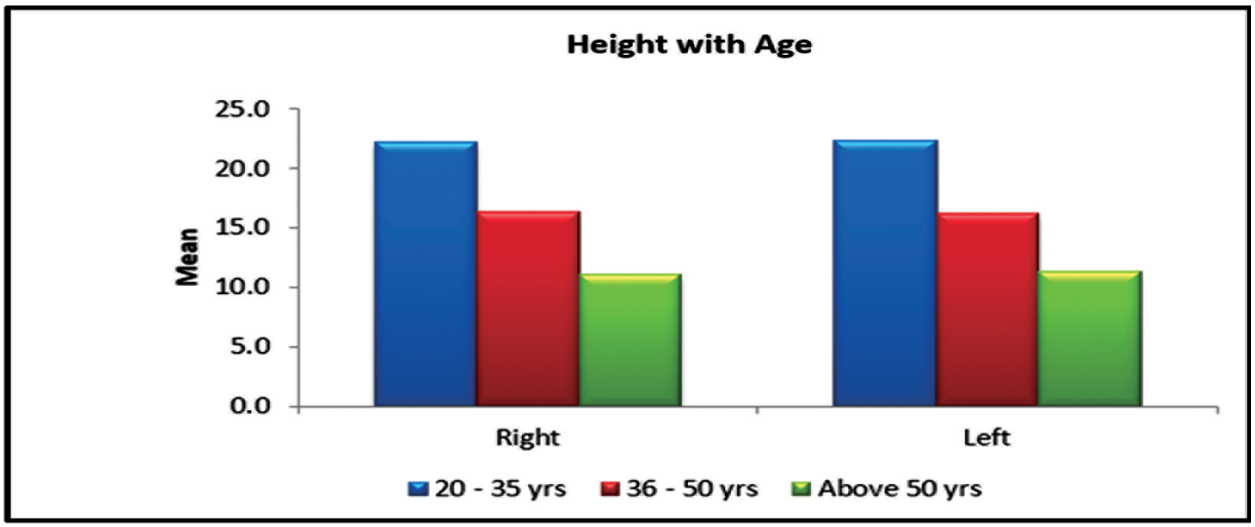


Fig. 9: Height with gender

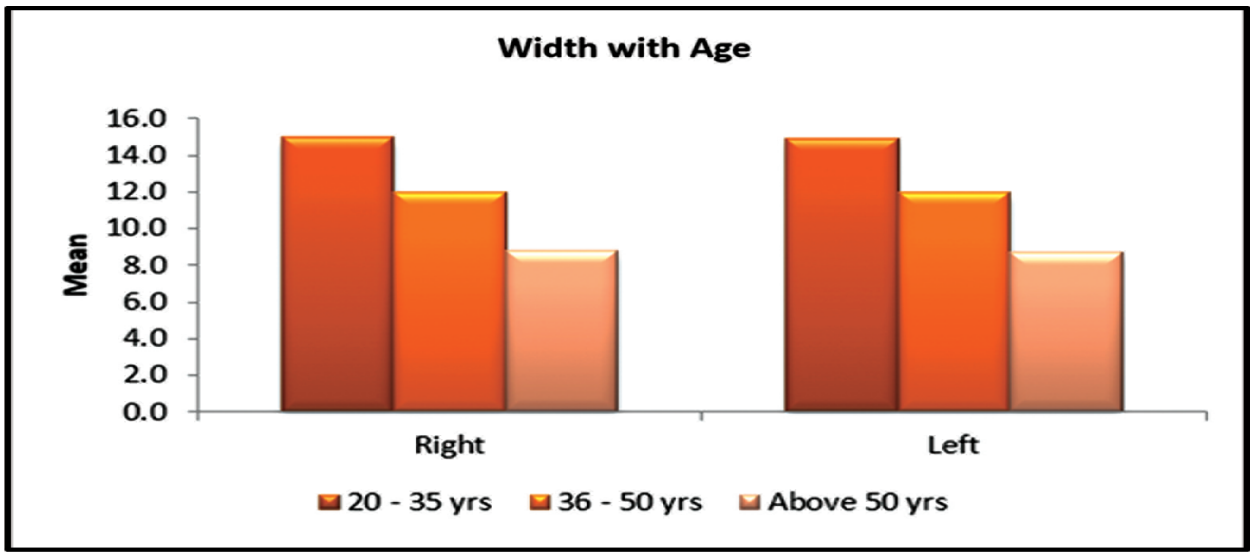


Fig. 10: Width with age

Future Scope

Artificial intelligence frameworks using convoluted neural networks could be developed utilising the morphometric cut-off values determined from the current study for gender and age determination. These AI frameworks could serve as a remarkable supplementary tool in forensics.

CONCLUSION

In the light of the results of our current study, we can conclude:

- Height, Width & Length of the Occipital Condyle & Condylar sagittal angle vary with advancing age and with gender.
- There exists an inverse relationship between morphometrics of OC & Age.

Hence, it can be concluded that the morphometric variables such as height, width, length of occipital Condyle & Condylar-Sagittal angle could serve as reliable tool in gender and age determination in Forensics.

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