



Cervico-Incisor measurements of Incisors, Cuspids, and Molars for Gender Estimation: A Pilot Study in Western Uttar Pradesh

Sidra Aslam¹, Anshul Aggarwal², Juhi Gupta³, Masood Hasan Khan⁴, Pradhuman Verma⁵, Sahla Batool⁶

¹ PG second year, Department of Oral Medicine & Radiology, Dr Ziauddin Ahmad Dental College and Hospital, AMU, Aligarh, UP, India

² Department of Oral Medicine & Radiology, Dr Ziauddin Ahmad Dental College and Hospital, AMU, Aligarh, UP, India.

³ Department of Oral Medicine & Radiology, Dr Ziauddin Ahmad Dental College and Hospital, AMU, Aligarh, UP, India.

⁴ Department of Oral Medicine & Radiology, Dr Ziauddin Ahmad Dental College and Hospital, AMU, Aligarh, UP, India.

⁵ Department of Oral Medicine & Radiology, Dr Ziauddin Ahmad Dental College and Hospital, AMU, Aligarh, UP, India.

⁶ PG first year, Department of Oral Medicine & Radiology, Dr Ziauddin Ahmad Dental College and Hospital, AMU, Aligarh, UP, India.

ABSTRACT-

Background

Dental forensic anthropology is a specialized field within forensic dentistry that focuses on examining the variations in dental morphology and measurements of human teeth across different time periods (both prehistoric and modern) and geographical regions (including ethnic influences).

Objectives

To check whether there is sexual dimorphism in cervico-incisor dimensions of incisors, cuspids and molars.

Methods

Cross sectional study conducted in 60 patients, aged 25-60 years from daily hospital OPD at Aligarh. Impressions of both the maxillary and mandibular arches were taken using irreversible hydrocolloid-alginate material. To prevent any distortion, the impressions were promptly cast with type IV dental plaster. The resulting study models were then measured using a digital Vernier caliper (resolution 0.01 mm) (Aerospace) to ensure precise data collection on study casts. The data thus obtained was tabulated and subjected for further statistical analysis using SPSS 20.0 (Microsoft Corporation Inc., Chicago, IL, USA).

Results

The left mandibular first molar with SDI of 134.5%, and potentially other mandibular measurements, could be highly reliable markers for sex determination in forensic investigations.

Conclusion The present data underscores that male dentitions are consistently larger than female dentitions, with the mandibular teeth especially left mandibular first molar demonstrating the most significant differences.

Introduction

Dental forensic anthropology is a specialized field within forensic dentistry that focuses on examining the variations in dental morphology and measurements of human teeth across different time periods (both prehistoric and modern) and geographical regions (including ethnic influences). This branch of study explores how these variations relate to the processes of adaptation and dietary changes that have contributed to the evolution of the dental system and, ultimately, the human species.¹ Determining the identity of an injured individual poses significant challenges for forensic experts, particularly when the body is dismembered or mutilated. Among the various parameters, identifying the sex of the individual is a key factor in establishing their uniqueness. Accurate sex identification of human remains can significantly narrow down the search to a specific sex,

providing valuable direction to the on-going forensic investigation.²

Sexual dimorphism encompasses the distinct differences in size, stature, and appearance between males and females. These differences can be leveraged for dental identification,

Address for Correspondence:

Dr Sidra Aslam

PG Student,

Department of Oral Medicine & Radiology

Dr Ziauddin Ahmad Dental College and Hospital,

AMU, Aligarh, UP, India pin- 202002

Email: drsidraaslam09@gmail.com

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as no two mouths are identical. By analyzing these variations, forensic experts can effectively determine an individual's sex, making dental identification a powerful tool in forensic investigations.^{1,3}

Teeth are resilient structures capable of withstanding high temperatures and resisting bacterial decomposition. Measurements taken from teeth, known as odontometrics, can be valuable in estimating gender, especially when other skeletal indicators are missing due to fragmentation or loss.⁴ The hypothesis behind this pilot study is that among the different traits that exhibit sexual dimorphism, odontometric data such as tooth dimensions have been extensively evaluated across various populations for their usefulness in anthropological and forensic investigations. Numerous published studies have demonstrated that tooth size shows significant dimorphism within their respective population groups, making it a valuable parameter for identifying sex and aiding forensic experts in their investigations. With this background present pilot study has been undertaken to assess the sexual dimorphism in individual tooth dimensions among western Uttar Pradesh population.

Material and Methods

The present study was carried out at our institution, involving a total of randomly selected fifty patients who met the inclusion criteria specified below. The sample size was calculated by using the coefficient of variation (20%), coefficient interval (95%) with power design of the study (90%). The sample size of the study was calculated to be a minimum of 26, but it was increased to 60 for the present study. The informed and written consent in both local and English language was taken for each subject. The institutional ethical committee clearance was obtained for the conduct of the study the focus was on the permanent dentition of individuals aged 20 to 50 years from daily OPD of Oral Medicine and Radiology, Aligarh. The selected participants were evenly split by gender, comprising 30 males and 30 females. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The Institutional ethical clearance (IEC/JNMC/ 1715 dated 4/11/2024) was obtained before the start of study.

Inclusion Criteria

1. Patient having fully erupted central incisors, cuspids and molars (I and II) of both jaws.
2. Patient devoid of any dento-alveolar and maxillofacial

fractures.

3. Only those subjects who were residing in Western UP for 10 years.

Exclusion Criteria

1. Psychotic patients
2. Patients having Syndromes/systemic illnesses/metabolic diseases & endocrinopathies
3. Teeth having developmental anomaly.
4. Restored / missing teeth

Impressions of both the maxillary and mandibular arches were taken using irreversible hydrocolloid-alginate material. To prevent any distortion, the impressions were promptly cast with type IV dental plaster. The resulting study models were then measured using a digital Vernier caliper (resolution 0.01 mm) (Aerospace) to ensure precise data collection on study casts. [figure 1]

The measurement was defined as CI length is the portion of the enamel from the cervical line to the incisal edge. [Figure 2]⁵ All the measurements were performed by two observers to assess the reliability of the measurements and to remove the inter-observer error. The mean of the two values was considered and rounded to two decimal places.



Figure 1: Armamentarium for Clinical examination: (1) Kidney tray with mouth mirror, explorer, probe and tweezers; (2) Hand gloves; (3) Mouth mask (4) Cotton holder with cotton pellets (5) digital Vernier caliper (resolution 0.01 mm) (Aerospace).



Figure 2: Dental casts for measurements of CI dimensions



Sexual dimorphism

Garn and Lewis's formula was followed to calculate sexual dimorphism.⁶

$$([X_m/X_f] - 1 \times 100)$$

X_m = mean value of measurement for males

X_f = mean value of measurement for females

The data thus obtained was tabulated and subjected for further statistical analysis using SPSS 20.0 (Microsoft Corporation Inc., Chicago, IL, USA). The unpaired t-test was applied to compare the dimensions measured for males and females on dental casts. The value of $P \leq 0.05$ was considered statistically significant.

Results

The mean values of cervico-incisal dimensions of tooth are given separately for males and females. [Table 1, 2]

The mandibular arch demonstrates a higher degree of sexual dimorphism compared to the maxilla. This suggests that differences in tooth dimensions between males and females are more pronounced in the lower jaw.

The mean Sexual Dimorphism Index (SDI) values of about 110.8% suggest moderate dimorphism in the upper teeth, with male teeth being roughly 10.8% larger than their female counterparts. With a mean SDI of about 116.1%, the lower teeth exhibit more pronounced dimorphism, with males showing approximately 16.1% larger dimensions compared to females.

The mandibular tooth i.e left mandibular first molar stands out with an SDI of 134.5%, making it a particularly strong indicator of sexual dimorphism. This suggests that tooth left mandibular first molar, and potentially other mandibular measurements, could be highly reliable markers for sex determination in forensic investigations. [table 3]

Discussion

Sexual dimorphism in tooth size, a fascinating aspect of human biology, is attributed to several key factors. Moss proposed that the extended duration of amelogenesis in males results in thicker enamel, directly influencing tooth

Table 1: Mean of cervico-incisal dimensions in Females

Tooth	11	21	13	23	16	26
Mean	9.16	8.42	8.29	8.38	5.38	5.49
Tooth	31	41	33	43	36	46
Mean	7.15	7.23	8.41	8.13	5.80	6.52

Table 2: Mean of cervico-incisal dimensions in Males

Tooth	11	21	13	23	16	26
Mean	9.754	9.01	8.93	8.82	6.31	6.65
Tooth	31	41	33	43	36	46
Mean	8.46	8.35	9.11	9.88	7.80	7.22

Table 3: Sexual Dimorphism based on Garn and Lewis's formula

Tooth	Female mean (mm)	Male mean (mm)	SDI (%)
Maxillary			
11	9.16	9.754	106.4
21	8.42	9.01	107.1
13	8.29	8.93	107.7
23	8.38	8.82	105.2
16	5.38	6.31	117.3
26	5.49	6.65	121.1
Mandibular			
31	7.15	8.46	118.3
41	7.23	8.35	115.6
32	8.41	9.11	108.3
42	8.13	8.88	109.2
36	5.80	7.80	134.5
46	6.52	7.22	110.7

dimensions. Furthermore, sex chromosomes play a crucial role; the Y chromosome, in contrast to the X, modulates the pace and timing of body development, leading to a slower maturation process in males. These combined effects contribute to the observable differences in tooth size between sexes. Researchers have consistently observed that tooth size varies not only between genders but also across different racial and ethnic populations. This phenomenon highlights the complex interplay of biological and population-specific factors that influence dental morphology.⁷

A variety of dental indices can be employed for gender determination. These include measurements such as the width of the maxillary incisors and canines, the cervico-incisal dimensions of the maxillary and mandibular teeth, the width of the mandibular canines and molars, the diameter of molar cusps, as well as the combined width of all teeth.⁸ In this study we have taken maxillary and mandibular central incisors, canines and first molars with single measurement of CI dimension only.

Similar to our study, Iscan and Kedici⁹ in their research, demonstrated that mandibular teeth showed significantly higher sexual dimorphism compared to maxillary teeth. Acharya and Mainali (2007)¹⁰ conducted a study on Nepalese dentition and found that male central incisors, canines, and molars exhibited significant sexual dimorphism, with SDI values ranging from 105% to 120%. This aligns closely with the present study, where maxillary teeth showed an SDI of approximately 110.8%, while mandibular teeth exhibited even greater dimorphism (116.1%).

Garn and Lewis (1965)¹¹ were among the first to establish



that male teeth are generally larger than female teeth across different populations. Using their formula, they found that the crown dimensions of maxillary and mandibular teeth in males exceeded those of females by an average of 6–12%. This is in accordance with our study in which males have more CI dimensions than females. In molar odontometrics, the analysis revealed that the mean cervico-incisal length of tooth 36 differed significantly between males and females ($p < 0.001$), emphasizing its strong potential as a discriminative marker for gender determination.

Soundarya et al.¹² concluded in their study that CI dimension of mandibular first molar as reliable indicators for gender determination than mandibular canine, maxillary and mandibular central incisors and maxillary first molar dimensions. This also went well with our study in which CI of molars showed maximum sexual dimensions.

Because of paucity of research involving CI dimensions in predicting sexual dimorphism there is limited data for comparison. Hence, more researches are required to check precision.

Limitations

Being a pilot study the inbuilt limitations include a small, potentially non-representative sample, measurement variability, and lack of standardized calibration. Variations in tooth wear, age, and genetic background may significantly confound results. The cross-sectional design limits causal inference, and findings might not generalize to diverse populations or account for intra-individual morphological differences.

Conclusion

Odontometry plays a pivotal role in exploring the dimorphism among tooth dimensions.

The present data underscores the following important findings-

- Mean cervico-incisal dimensions of teeth are separately recorded for males and females, indicating measurable sexual differences.
- The mandibular arch exhibits more pronounced sexual dimorphism compared to the maxillary arch, highlighting greater differences in the lower jaw.
- The left mandibular first molar, could serve as a particularly reliable marker for sex determination, making mandibular measurements valuable in forensic investigations.

This reinforces the use of precise odontometric measurements in forensic odontology for effective sex

determination. Although more studies that are population specific, with large sample size are required for checking the reliability and accuracy of results. Maintaining the large database of study will further aid in gender identification in forensic anthropology.

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CONFLICT OF INTEREST: NIL

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