Evaluation of sexual dimorphism in maxillary and mandibular canine using mesiodistal, labiolingual dimensions, and crown height

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ABSTRACT

Context: Gender estimation is one of the most important parameters in forensic identification. Teeth being the central component of the masticatory apparatus of the skull is a good source of material for civil and medico-legal purpose. Gender estimation using dental features is primarily based on the comparison of tooth dimensions in male and female.

Aims: To analyze the presence of sexual dimorphism in maxillary and mandibular canine using mesiodistal (MD), labiolingual (LL), and height of crown.

Subjects and Methods: A total number of 100 subjects (50 males and 50 females) were included in the study between the age group of 20 and 25 years. Dimensions (MD, LL, height of crown) of maxillary and mandibular canine were recorded with a digital vernier calliper.

Statistical Analysis Used: The data obtained is subjected to statistical analysis using Student’s t-test and intra-reliability test.

Results: The present study revealed that male shows larger mean dimensions of teeth than female. Out of all the four canines, right maxillary canine shows highly consistent results for sexual dimorphism. Hence, by drawing the conclusion, it can be stated that right maxillary canine can be used as an adjunct along with other procedures for gender estimation.

Conclusion: The findings support the usefulness of employing odontometric analysis of the canine teeth in gender estimation. It is an easy, reproducible, and objective method.

Key words: Cuspid, forensic dentistry, maxillary forensic anthropology, sex determination analysis

Teeth, in the living as well as the dead, are the most useful objects in the field of anthropology and genetics also finding utility in odontologic and forensic investigations. The anthropological methods to estimate gender, age, height, and ethnicity give information on the individual that will guide police authorities when investigating cases of missing persons reported to the authorities. Teeth are extremely durable even at high temperatures and may be identified even when the rest of the body has undergone decomposition. They are thus invaluable as an additional tool to estimate gender from fragmentary adult skeletons.

Teeth provide resistance to damage in terms of bacterial decomposition and fire when rest of the body is damaged beyond recognition which makes them a valuable tool in forensic investigation. Although the dental morphology and structure are similar in both males and females, there are subtle differences. Variation in dental sizes can provide a clue about differences between the genders. Gender differentiation in the forensic investigation utilizes craniofacial morphology, tooth dimensions, and DNA analysis. It has been suggested that odontometrics play an important role in the determination of gender in young individuals where secondary sexual characteristics...
have not developed. In addition, the resistance of teeth to postmortem insults render them as an invaluable tool in the forensic investigation.[3] In forensic anthropology concerning gender estimation, especially in cases in which the positive and definitive identification of the individual, parts or bones is not viable, sexual dimorphism of teeth finds its significance.

Teeth of various species are known to exhibit sexual dimorphism. The dentition in males is larger than in females, and the former possess larger tooth crowns.[4] Canines are perhaps the most stable teeth in the oral cavity because of the labiobuccal (LL) thickness of the crown and the root anchorage in the alveolar process of the jaws. The crown portions of the canines are shaped in such a manner as to promote cleanliness. This self-cleansing quality and efficient anchorage in the jaws tend to preserve these teeth throughout life. Henceforth, they are being considered the “key teeth” for personal identification.[4]

Teeth measurements seem to be the most reliable method in the forensic investigations due to its advantages of being quick, less time consuming, noninvasive, and easy to perform.[5]

**SUBJECTS AND METHODS**

The study comprises 100 subjects (50 males and 50 females) randomly selected between the age group of 20 and 25 years [Pie Chart 1]. The study was approved by Institutional Research and Human Ethics Committee. Before starting the study, subjects were informed about the nature of the study and written informed consent were obtained.

Subjects with healthy gingiva and periodontium, caries-free teeth with normal occlusion (canine and molar relationship) were included in the study whereas, subjects having any developmental anomaly, spacing, restoration on canine, crown or bridge, attrited or missing canine, orthodontic treatment, or any history of trauma were excluded from the study.

The greatest mesiodistal (MD), LL diameter, and crown height (CH) of the maxillary and mandibular canine were recorded clinically on the subjects with the help of a Digital Vernier Caliper (measured between the anatomic points directly on the subject held parallel to the occlusal plane). All the measurements were taken thrice by a single examiner and if in case of any discrepancy the mean of three values were recorded.

All odontometric measurements of the four canine teeth and their related parameters, i.e., MD, LL dimensions and CH were entered into a Microsoft Excel spreadsheet with the corresponding age and gender of the subjects which was used for the statistical analysis of the provided data [Table 1].

**Statistical analysis**

The data sample was subjected to a computerized analysis using SPSS statistical program, version 20.0 USA, Echo Soft Corporation. In statistics, intra-rater reliability is the degree of agreement among repeated administrations of a diagnostic test performed by a single rater. Reliability test is applied here by the help of SPSS statistical program. R test is obtained as \( R = 1 - r^2 \). Significant level 95%. The level of significant is 5%.

![Pie Chart 1: Representation of Gender wise distribution of data with Pie chart](image)

| Gender wise distribution of data |
|---------------------------------|
| Gender | Frequency | Percentage |
|--------|-----------|------------|
| Male   | 50        | 50.0       |
| Female | 50        | 50.0       |
| Total  | 100       | 100.0      |

**Table 1: Descriptive Statistical analysis for comparing the varied parameters for all maxillary and mandibular canine**

| Parameter | Mean (n=50) | SD | Mean (n=50) | SD | 95% CI | t-test | SE | P |
|-----------|-------------|----|-------------|----|--------|--------|----|---|
| MD13      | 7.3932      | 0.6078 | 7.1424 | 0.4891 | 0.0318-0.4698 | 2.2730 | 0.110 | 0.0252 |
| LL13      | 6.0312      | 0.5630 | 5.3624 | 0.6074 | 0.4364-0.9012 | 5.7098 | 0.117 | 0.0001 |
| CH13      | 9.2486      | 0.6697 | 8.3392 | 0.5354 | 0.6688-1.1500 | 7.4996 | 0.121 | 0.0001 |
| MD23      | 7.3594      | 0.5268 | 6.8502 | 0.5974 | 0.2857-0.7327 | 4.5202 | 0.113 | 0.0001 |
| LL23      | 5.9460      | 0.6863 | 5.4588 | 0.8547 | 0.1796-0.7948 | 3.1428 | 0.155 | 0.0022 |
| CH23      | 9.0906      | 0.7180 | 8.5092 | 0.6266 | 0.3140-0.8488 | 4.3142 | 0.135 | 0.0001 |
| MD33      | 6.8540      | 0.5490 | 6.3100 | 0.4157 | 0.1507-0.5373 | 3.5323 | 0.097 | 0.0006 |
| LL33      | 5.7406      | 0.5818 | 5.1680 | 0.4575 | 0.3649-0.7803 | 5.4700 | 0.105 | 0.0001 |
| CH33      | 8.7070      | 0.5443 | 8.2026 | 0.6273 | 0.2713-0.7375 | 4.2946 | 0.117 | 0.0001 |
| MD43      | 7.0020      | 0.5815 | 6.2394 | 0.5935 | 0.5294-0.9958 | 6.4898 | 0.118 | 0.0001 |
| LL43      | 5.6024      | 0.5085 | 5.2088 | 0.4546 | 0.2022-0.5850 | 4.0807 | 0.096 | 0.0001 |
| CH43      | 8.8404      | 0.5295 | 8.3320 | 0.6707 | 0.2686-0.7482 | 4.2071 | 0.121 | 0.0001 |

MD=Mesiodistal, LL=Labiobuccal, CH=Crown height, SD=Standard deviation, SE=Standard error, CI=Confidence interval
RESULTS

The result drawn from the study is that the differences in the varied parameters, i.e., the MD, LL dimensions, and the CH of the maxillary and mandibular canines are statistically significant:

- The present study revealed that males show larger mean dimensions of teeth than females [Bar Chart 1]
- Out of all the four canines, right maxillary canine shows highly significant and consistent results for sexual dimorphism [Table 2 and Bar Chart 2]
- We can conclude that right maxillary canine can be used as an adjunct along with other procedures for gender estimation.

A correlative study based on crown lengths for male and female cases have presented in the following table. The CH23 only showed the significant association. The others are showed the insignificant association between sex. This is due to chance only.

An intra-rater reliability test value for MD is obtained as 0.6717, whereas the reliability test value for LL is 0.6189. The intra-rater reliability test value for CH is higher as compared to other two and is 0.6987. The calculated values show a significant amount of positive reliability between the data.

| Parameter | R       | P       | Analysis                                                                 |
|-----------|---------|---------|--------------------------------------------------------------------------|
| CH13      | 0.18714 | 0.19315 | The association between the male and female case for CH13 would not be considered statistically significant |
| CH23      | 0.29986 | 0.03438 | The association between the male and female case for CH23 would be considered statistically significant |
| CH33      | 0.17017 | 0.2374  | The association between the male and female case for CH33 would not be considered statistically significant |
| CH43      | −0.19082 | 0.18439 | The association between the male and female case for CH43 would not be considered statistically significant |

CH=Crown height

DISCUSSION

The present study was conducted on the maxillary and mandibular canines of 100 subjects (50 males, 50 females) between the age group of 20 and 25 years. Odontometric analysis was been conducted with the help of Vernier caliper directly on the subjects.

- Parikh et al. (2013) conducted a study on the maxillary and mandibular canines of sixty subjects (30 males, 30 females) between the age group of 16 and 25 years
- The odontometric measurements on study models using a Vernier caliper were preferred instead of a direct intraoral measurement according to the t-test formula. The results derived from the study being conducted was that males showed significantly greater mean dimensions of teeth than females and results were statistically significant
- Apart from the results stated above, according to the study, most sensitive predictors for gender determination were the mandibular intercanine distance and canine index. The final statement of the result was that mandibular canine teeth showed significant and consistent results of sexual dimorphism
- Omar and Azab conducted a study on dental casts of 220 adult persons and then these selected subjects were divided into two groups. (a) Examination of maxillary canine teeth which included 44 male and 66 female, (b) examination of mandibular canine teeth of 35 males and 75 females. In this study, all the stone casts were cut by cylindrical diamond bur at the areas of the lateral incisors and the first premolars. The proximal surfaces of the canine teeth were then carefully exposed using a knife. Vernier caliper and a divider with a fixing device were needed for the measurement. The results of a pilot study undertaken before this research were attempted revealed nonsignificant differences between measurements of the canines in right and left sides of the same subject. There was sexual dimorphism in both MD and LL diameters of canine teeth (maxillary and mandibular)
- The technique employed for the odontometric analysis
of canine teeth provided predictive equations useful for gender determination in a sample of Egyptian adult individuals.

- Ali Ahmed (2014) conducted an Iraqi study on mandibular canines on 200 subjects (100 males and 100 females) of age range between 17 and 23 years. The odontometric analysis was done with the help of study models and digital sliding caliper gauge. The maximum MD crown widths of mandibular canines were measured from the anatomical contact points using digital sliding caliper gauge. The inferences from the study were that MD widths of the mandibular canines were nonsignificantly slightly larger in males than females while the intercanine width was larger in males than females with a high significant difference.

- Boaz and Gupta (2013) also conducted their odontometric analysis on the dental casts of 100 subjects (50 males and 50 females) of a South Indian Population in the age group of 14–20 years with the help of Vernier calipers. The present study revealed that the mean values of LL and MD dimensions of the mandibular left canine were greater in female than in male in the given sample. The finding could be attributable to evolution resulting in a reduction in sexual dimorphism, causing an overlap of tooth dimensions in modern male and female.

- In another study by Khangura et al. (2011) the study was conducted on permanent maxillary incisors and canines on 100 subjects (50 males and 50 females) which hence revealed all greater mean value of MD dimensions of permanent maxillary incisors and canines in males compared to females but only canines were found statistically significant for sexual dimorphism.

- In this study, the odontometric analysis has been conducted with the help of Vernier calipers directly on the subjects rather than using cast models as using the latter procedure carried has some disadvantages, which could create errors in the odontometric analysis such as in the first step of model casts; multiple errors in impression making can be common, second air bubbles in pouring of dental stone in impression, and finally expansion of cast on setting can be observed. All these errors can create hindrance in measuring the dimensions of the required teeth and can hence give false results.

**SUMMARY AND CONCLUSION**

The present study revealed that males show larger mean dimensions than females in the study group. MD, LL dimensions, and CH are more sensitive indicators for gender estimation. According to the study, right maxillary canine shows highly consistent results for sexual dimorphism and hence it can be used as an adjunct along with other procedures for gender estimation.

The findings support the usefulness of employing odontometric analysis of the canine teeth in gender estimation.

Finally, odontometric analysis performed directly on the patient intraorally with the help of digital Vernier calipers leads to minimal errors in comparison to those odontometric measurements taken on study models.

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**Conflicts of interest**

There are no conflicts of interest.

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