Evaluation of Sexual Dimorphism using Permanent Maxillary First Molar in Sri Ganganagar Population

Abstract

Aim of Study: The aim is to evaluate existence of sexual dimorphism by variation in right and left permanent maxillary molars using buccolingual width (BLW) and mesio-distal width (MDW) measured intraorally and on study casts among Sri Ganganagar population.

Materials and Methods: Fifty patients (25 males and 25 females) with 17–25 years of age were selected. Impressions of maxillary arch were taken and the BLW and MDW were measured using digital Vernier calipers on study casts and intraorally. Results: Highly significant correlation was found between MDW and BLW of both the maxillary permanent first molars for both genders (P < 0.05) intraorally. The MDW and BLW on study cast of both sides in both gender were more on left side in males while on right side in females. Conclusion: Left maxillary permanent first molar showed minimum mean difference of measurements on study cast and introrally than right, thus better predictor for gender dimorphism in forensics.

Keywords: Buccolingual, maxillary first molar, mesio-distal, sexual dimorphism, tooth dimensions

Introduction

Dental forensic anthropology is a branch of forensic dentistry concerned with the study of dental morphological variations and metrics of human dentition over time (prehistoric and modern) and space (ethnic influences) and their relation with the processes of adaptation and dietary changes that led to the evolution of the dental system and the human race.[1] The human identification is the recognition of an individual based on the physical characteristics unique to the individual. The main four attributes of biological identity that the forensic dental anthropologists may wish to determine are the gender, age, stature, and ethnic or racial background of the individual.[2] The gender determination is usually the first step in personal identification process as it not only cut the number of possible matches to half but also subsequent methods for age and stature estimation are often gender dependent.[2] Although many bones like pelvis and skull give most reliable results of sexual dimorphism by morphological and metric analysis, rarely, the only evidence available for gender determination may be teeth, as they are more resistant to taphonomic degradation than bones. Furthermore, the degree to which they resist damage from bacterial decomposition, fire, and fracture makes them very important in forensic investigation and research.[2]

The sexual dimorphism refers to those differences in size, stature, and appearance between male and female that can be applied to dental identification as no two mouths are alike.[1,3] The sexual dimorphism in tooth size has been carried out focusing on linear dimensions as buccolingual and mesiodistal dimensions or diagonal measurements of tooth crowns and dental indices.[3] The tooth size variations are influenced by both genetic and environmental factors hence it is only useful if relative to a population.[3] The coronal dimensions of the teeth are important for identification of sex when skeletons are found, especially when anatomical parameters are not reliable for identifying the subject.[4] Many studies established that permanent mandibular canines exhibit greater sexual dimorphism but permanent maxillary first molars erupt early in the oral cavity at the mean age of 6–7 years and are less commonly impacted as compared to canines.[1] Moreover, in young children where cranial growth is not complete, the odontometric features of...
permanent maxillary first molars that erupted at an early age can be of immense use in gender determination.\textsuperscript{[1,5]} The human maxillary first molar provides information regarding evolution and is functionally important. With this background, the present study evaluates the existence of sexual dimorphism and variation in right and left maxillary molars using buccolingual and mesio-distal dimensions measured both intraorally and on study casts among the semi-urban population of Sri Ganganagar, Rajasthan.

Materials and Methods

The present study comprised of randomly selected fifty subjects (25 males and 25 females) of an age group ranging from 17 to 25 years (mean age of males 22.16 years and females 21.56 years), from the daily outpatient department of Surendera Dental College, Sri Ganganagar, Rajasthan. 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 50 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 inclusion criteria taken into consideration were: Presence of fully erupted bilateral caries, attrition, abrasion free permanent maxillary first molars, healthy periodontium, intact contact area and only those subjects who were residing in Sri Ganganagar for 5 years. The exclusion criteria included: Syndromic patients, any pathology or anomaly affecting maxillary permanent first molars, any dent-alveolar or maxillofacial fracture, mal aligned teeth, any restoration in maxillary permanent first molars. The subjects fulfilling the inclusion criteria were subjected to impression making of the maxillary arch with irreversible hydrocolloid (alginate) material and casts poured immediately in type II dental stone to minimize dimensional change [Figure 1].

The buccolingual (BL) and mesiodistal (MD) width of both the maxillary first molars were measured using digital Vernier calipers (resolution 0.01 mm) both intra-orally and on study casts following procedures described by Moorrees and Reed [Figure 2].\textsuperscript{[6]} The MD width of the permanent maxillary first molar crowns was measured as the greatest MD dimensions (in mm) between the contact points with the second premolars and second molars. The BL width of the crown of maxillary first permanent molars was measured as the greatest distance (in mm) between the facial and palatal surface of the crowns parallel to the long axis of the tooth. All the measurements were performed by one observer twice to assess the reliability of the measurements and to remove the intra-observer error. As before the study, the examiner participated in a training program which included intra-examiner calibration exercise where the minimum and maximum kappa values were agreed (0.81 and 0.86, respectively) for the examiner. The mean of the two values was considered and rounded to two decimal places. 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 of permanent maxillary first molar measured for males and females and between intraoral and dental casts. The value of $P \leq 0.05$ was considered statistically significant.

Results

The descriptive statistics for mean mesiodistal width (MDW) and buccolingual width (BLW) of maxillary first molar intraorally of both sides in both genders showed that the MDW was more for males on the left side while it was more for female patients on right side. The BLW was noted more on left side in both genders. A highly significant correlation was found between MD and BL dimensions of both the maxillary permanent first molars for both the genders ($P < 0.05$) [Table 1].

The mean MDW and BLW of a maxillary first molar on study cast of both sides in both genders showed that both MDW and BLW were more on left side in males while they

![Figure 1: Armamentarium used for study](image1)

![Figure 2: Measurements performed on maxillary first molars. (a) Intraoral bucco-lingual, (b) intraoral mesio-distal, (c) bucco-lingual on study cast, (d) mesio-distal on study cast](image2)
were more on right side in females. A highly significant correlation was found between MD and BL dimensions of both the maxillary first molars for both the genders when measured on study cast (P < 0.05) [Table 2].

The comparison of MDW and BLW of both genders measured intraorally, and on a study cast showed that a highly significant correlation (P < 0.05) was found on intraoral measurements and measurements [Table 3].

Concerning the validity of measurement to predict dimension, the mean difference was considered to find which tooth is better for forensics. The mean difference for 26 is the minimum on comparing cast dimensions with intraoral dimensions for both MD and BL measurements. Hence, statistically left maxillary permanent first molar showed the minimum mean difference, thus it is a better predictor for gender dimorphism [Table 4].

Discussion

There are differences in odontometric features in different populations, also noticed in the same population in historical and evolution context, and hence, we have chosen the Sri Ganganagar population in our study. In the present study, the age of 17–25 years was chosen as according to Doris et al.[7] the early permanent dentitions proved to be the best sample for tooth size measurement because of less mutilation and less attrition in early adulthood dentition.

The mean BLW and MDW of permanent maxillary first molars measured intraorally were found to be higher in males than females. These findings were in accordance with Garn et al. and Garn et al.,[8,9] Eboh[2] Agnihotri and Sikri[10] studies this may be due to the combination of environmental factors and genetics that controls the MD and BL dimensions of upper first molars.[2] The Y chromosome is now known to contribute most to the size of teeth by controlling the thickness of dentine, whereas the X chromosome seems to be responsible for modulating thickness of enamel. The sexual dimorphism in tooth morphology is attributed to the presence of relatively more dentine in the crown of male teeth.[2,5] The significant correlation was found between both genders regarding MDW and BLW measurements of both permanent maxillary first molars, and similar finding were found by Macaluso[11] Vito and Saunders[12] Metgud et al.[13] Dempsey and Townsend[14] in their studies.

| Table 1: Dimensions of mesio-distal and bucco-lingual parameters of 16 and 26 of both the genders measured intraorally |
|-----------------|-----------------|-----------------|-----------------|
| **Gender**       | **Parameters**   | **Statistical analysis** |
|                  | **Mesio-distal** |                  | **Bucco-lingual** |                  |
|                  | 16 | 26 | 16 | 26 |                  |
| Male             | 9.54 | 9.62 | 10.92 | 11.00 |                  |
| Female           | 9.42 | 9.39 | 10.54 | 10.73 |                  |
| Mean±SD          | 9.48±0.085 | 9.50±0.163 | 10.73±0.269 | 10.87±0.191 |                  |
| Statistical analysis                  |                  |
|                  | Pearson correlation (r) | P | n |
|                  | 0.996 | 0.004* | 4 |
| df               | 1 | 1 | 1 | 1 |
| Significance (P) | 0.004* | 0.008* | 0.011* | 0.008* |
| 95% CI           |                  |
| Lower            | 8.718 | 8.044 | 8.316 | 9.149 |
| Upper            | 10.242 | 10.966 | 13.144 | 12.580 |

*P<0.01 is highly significant. CI=Confidence interval, SD=Standard deviation

| Table 2: Dimensions of mesio-distal and buccolingual parameters of both genders measured on study casts |
|-----------------|-----------------|-----------------|-----------------|
| **Gender**       | **Parameters**   | **Statistical analysis** |
|                  | **Mesio-distal** |                  | **Bucco-lingual** |                  |
|                  | 16 | 26 | 16 | 26 |                  |
| Male             | 10.14 | 10.22 | 11.40 | 11.47 |                  |
| Female           | 10.28 | 9.94 | 11.15 | 11.00 |                  |
| Mean±SD          | 10.21±0.098 | 10.08±0.197 | 11.28±0.176 | 11.24±0.332 |                  |
| Statistical analysis                  |                  |
|                  | Pearson correlation (r) | P | n |
|                  | 0.948 | 0.052** | 4 |
| df               | 1 | 1 | 1 | 1 |
| Significance (P) | 0.004* | 0.009* | 0.007* | 0.013* |
| 95% CI           |                  |
| Lower            | 9.320 | 8.301 | 9.687 | 8.249 |
| Upper            | 11.099 | 11.859 | 12.863 | 14.221 |

*P<0.01 is highly significant, **P<0.05 is significant. CI=Confidence interval, SD=Standard deviation
According to Townsend and Alvesalo, the difference in teeth size has been attributed to differently balanced hormonal production between the two sexes consequent to the differentiation of either male or female gonads during the 6th or 7th week of embryogenesis rather than any direct effect of sex chromosome themselves.[15]

The present study showed that three out of four linear measurements of maxillary first molars done intraorally and two out of four done on study cast were noted more on left side. The results were in agreement with the study done by Rai et al.,[16] Zarringhalam[17] who found that dimensions of all permanent teeth were greater on the left side than right side in the upper jaw while it was reverse in the lower jaw. The right and left differences may be attributed to dental asymmetry as perfectly bilateral body symmetry is a theoretical concept that seldom exists in living organisms.[3] Furthermore, most of the mastication is done from right side; hence, right posterior teeth are more prone to interproximal and occlusal wear than left leading to a difference in size.

In the present study on comparing the mean difference of MDW and BLW parameters of both genders intraorally and on study cast, permanent left upper first molar showed minimum mean difference, statistically suggestive of a better predictor of sexual dimorphism. Similar results were found by Agnihotri and Sikri,[10] Kumar et al.,[5] Narang et al.[18] Suazo et al.[4] in their studies. According to Lakhanpal et al.[19] MD dimensions were the most accurate method for gender determination, and better results were found when both the dimensions were taken together.

This pilot study provides normative morphologic data and establishes the existence of statistically significant gender dimorphism for the maxillary first molars among Sri Ganganagar population, but it is recommended to conduct similar studies on various populations taking greater sample size for further confirmation.

### Conclusion

The permanent left maxillary first molar showed minimum statistically significant mean difference of both measurements done intraorally and on study cast, hence suggestive of a better predictor of sexual dimorphism in Sri Ganganagar population.

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Nil.

**Conflicts of interest**

There are no conflicts of interest.
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