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Mesiodistal Width of Permanent Anterior Teeth: A Tool for Sex Determination

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Abstract

Background: Metric and non-metric analysis of the human dentition have played an important role in human biological research and have formed a central focus in the field of dental anthropology for over a century. This study intends assess the degree of sexual dimorphism in permanent anterior teeth in south Indian origin student population. *Aim:* The purpose of this study is to analyze the mesiodistal crown width of permanent anterior teeth and assess the degree of sexual dimorphism in permanent anterior teeth in south Indian origin student population. *Materials and methods:* Materials for this cross-sectional study consisted of 210 students belonging to various parts of South India (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, and; union territories of Lakshadweep and Pondicherry) comprising of 100 males and 110 females in the age group of 18–25 years studying at A. J. Institute of Medical Sciences and Research Centre, Mangalore, Karnataka who are willing to participate in the study. Methods for the study consisted of measuring the maxillary and mandibular incisor and canine widths of these students using a digital caliper with a resolution of 0.01mm with the provision to fix it in position to the desired position so as to avoid any errors in recording the exact measurements of canines. *Results:* 100 males and 110 female students in the age group of 18–25 years, from various parts of South India were examined to predict the sex from the mesiodistal widths of permanent anterior teeth for both the arches. The mean mesiodistal width of mandibular central incisor was greater in males (Right: 5.55 ± 0.39 mm; Left: 5.59 ± 0.38 mm) than females (Right: 5.43 ± 0.34 mm; Left: 5.44 ± 0.34 mm). The mean Mesiodistal width of maxillary central incisor was greater in males (Right: 8.60 ± 0.52 mm; Left: 8.60 ± 0.58 mm) than females (Right: 8.29 ± 0.52 mm; Left: 8.24 ± 0.67 mm). The mean Mesiodistal width of mandibular lateral incisor was greater in males (Right: 6.07 ± 0.45 mm; Left: 6.10 ± 0.38 mm) than females (Right: 5.83 ± 0.41 mm; Left: 5.86 ± 0.37 mm). The mean Mesiodistal width of maxillary lateral incisor was greater in males (Right: 6.90 ± 0.62 mm; Left: 6.86 ± 0.63 mm) than females (Right: 6.58 ± 0.57 mm; Left: 6.59 ± 0.56 mm). The mean Mesiodistal width of mandibular canine was greater in males (Right: 6.62 ± 0.54 mm; Left: 6.78 ± 0.51 mm) than females (Right: 6.21 ± 0.54 mm; Left: 6.35 ± 0.47 mm). The mean Mesiodistal width of maxillary canine was greater in males (Right: 7.52 ± 0.58 mm; Left: 7.60 ± 0.54 mm) than females (Right: 7.33 ± 0.45 mm; Left: 7.28 ± 0.49 mm). *Conclusion:* This study shows that the Mesiodistal crown width of permanent anterior teeth can be used as tool for determining the sex.

Keywords: Dentition; Mesiodistal crown width; Metric and non-metric analysis; Permanent anterior teeth; Sexual dimorphism.

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Introduction

During legal investigations, especially in crimes resulting in fatalities or when unknown human remains are recovered by investigating agencies, the forensic pathologist is often required to give an opinion regarding personal identification of the deceased. Sex determination is considered as one of the parameters for personal identification and one of the 'big fours' of forensic anthropology. It is an important step in reconstructing the biological profile of unknown individuals from the forensic context. Assessment of sex differences from human remains will be of immense help to the investigating officer as it would narrow down his field of search to 50%.[1] The most commonly used techniques for sex determination are based on the assessment of the morphological characteristics of the pelvis and skull.[2] However, it is not uncommon to recover the pelvis and the skull in a fragmentary state in forensic settings. In this case, teeth can be used as an additional tool for sex determination. Their durability in the face of fire, trauma and bacterial decomposition makes them invaluable for identification.[3]

Metric and non-metric analysis of the human dentition have played an important role in human biological research and have formed a central focus in the field of dental anthropology for over a century.[4] Identification of humans using the unique features of teeth and jaws has been used since Roman times, because humans show dimorphism in jaw and teeth dimensions so also the dietary habits.[5,6] Whenever the jaws with the teeth, fragmented jaws with teeth or teeth alone are available at the crime scene or accident, then sex determination can be made using teeth alone. This identification of gender using odontometric techniques is of real interest in case of major catastrophes when bodies are often damaged beyond recognition.[7] As sexual dimorphism varies between different populations the collection of population specific data is of major importance. The purpose of this study is to analyze the mesiodistal crown width of permanent anterior teeth and assess the degree of sexual dimorphism in permanent anterior teeth in south Indian origin student population.

Materials and Methods

Materials for this cross-sectional study consisted of 210 students belonging to various parts of South India (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, and; union territories of Lakshadweep and Pondicherry) comprising of 100 males and 110 females in the age group of 18–25 years studying at A.J. Institute of Medical Sciences and Research Centre, Mangalore, Karnataka who are willing to participate in the study. The research conducted between September 2011 and August 2013. Due permission was taken from Institutional Ethics Committee of A.J. institute of Medical Sciences and Research Centre, Mangalore for the conduct of the study. This age group was selected as all the canines would have erupted by this age and attrition is expected to be minimal.[7] Methods for the study consisted of measuring the maxillary and mandibular incisor and canine widths of these students.

Written informed consent was taken prior to the recording of dental measurements, after detailed information given to the participants regarding the study. The measurements of anterior permanent teeth (incisors and canine) were taken intra orally on either side of the jaw using digital calipers with a resolution of 0.01 millimeter with the provision to fix it in position to the desired position so as to avoid any errors in recording the exact measurements. The maxillary and mandibular permanent anterior teeth measurement so collected in millimeter is recorded on a pre-structured proforma.

Mesiodistal crown width of mandibular and maxillary permanent anterior teeth, i.e., the greatest mesiodistal width of the crown between the contact points of the teeth on either side of the jaw was measured three times and the average of the three values were noted.[8]

Subject having fragmentary teeth, abnormal teeth alignment, missing anterior teeth, crowded or excessive spacing in the anterior teeth, abnormal overjet and overbite, caries teeth, subjects with bad/poor oral hygiene, anterior teeth with high degree of attrition, subjects with orthodontic treatment and any trauma to anterior teeth were excluded from the study.

Statistical analysis was carried out using IBM SPSS Statistics (IBM Inc., version 17 for Windows) software package.

In this study the percentage of sexual dimorphism was used as an indicator to describe the differences between males and females. This index is calculated using the formula of Garn et al.[19]

$$\frac{\text{Male mean} - \text{Female mean}}{\text{Female mean}} \times 100$$

Results

This study comprises a total of 210 subjects, comprising of 100 males and 110 female students in the age group of 18–25 years. The agewise distribution of subjects is depicted in Table 1.

Table 1: Age wise distribution of subjects

Age group	Subjects	
	Males	Females
18–21 years	77 (36.67%)	103 (49.05%)
22–25 years	23 (10.95%)	7 (3.33%)
Total (n = 210)	100	110

Total 2520 anterior teeth of which 1200 teeth were that of males and 1320 teeth were that of females: 840 central incisors of which 400 were that of males and 440 were that of females, 840 lateral incisors of which 400 were that of males and 440 were that of females and 840 canines of which 400 were that of males and 440 were that of females. The measurements included Mesiodistal crown width of central incisors, lateral incisors and canines in the respective arches.

It was observed that the mean value of the mesiodistal crown width of right mandibular central incisor was 5.55 ± 0.39 mm in males and 5.43 ± 0.34 mm in females, while the mean value of the mesiodistal crown width of left mandibular central incisor was 5.59 ± 0.38 mm in males and 5.44 ± 0.34 mm in females as depicted in Table 2. This value was statistically highly significant (p < 0.01).

Table 2: Mesiodistal crown width of mandibular central incisor

Mesiodistal width (mm)	Sex	Mean	± S.D.
Right central incisor	Male (n = 100)	5.55	0.39
	Female (n = 110)	5.43	0.34
Left central incisor	Male (n = 100)	5.59	0.38
	Female (n = 110)	5.44	0.34

The mean value of mesiodistal crown width of right maxillary central incisor was 8.60 ± 0.52 mm in males and 8.29 ± 0.52 mm in females and the mean value of mesiodistal crown width of left maxillary central incisor was 8.60 ± 0.58 mm in males and was 8.24 ± 0.67 mm in females as depicted in Table 3. This value was statistically very highly significant (p <0.001).

Table 3: Mesiodistal crown width of maxillary central incisor

Mesiodistal width (mm)	Sex	Mean	± S.D.
Right central incisor	Male (n = 100)	8.60	0.52
	Female (n = 110)	8.29	0.52
Left central incisor	Male (n = 100)	8.60	0.58
	Female (n = 110)	8.24	0.67

It was observed that the mean value of the Mesiodistal crown width of right mandibular lateral incisor was 6.07 ± 0.45 mm in males and 5.83 ± 0.41 mm in females, while the mean value of the Mesiodistal crown width of left mandibular lateral incisor was 6.10 ± 0.38 mm in males and 5.86 ± 0.37 mm in females as depicted in Table 4. This value was statistically very highly significant (p <0.001).

Table 4: Mesiodistal crown width of mandibular lateral incisor

Mesiodistal width (mm)	Sex	Mean	± S.D.
Right lateral incisor	Male (n = 100)	6.07	0.45
	Female (n = 110)	5.83	0.41
Left lateral incisor	Male (n = 100)	6.10	0.38
	Female (n = 110)	5.86	0.37

The mean value of Mesiodistal crown width of right maxillary lateral incisor was 6.90 ± 0.62 mm in males and 6.58 ± 0.57 mm in females and the mean value of Mesiodistal crown width of left maxillary lateral incisor was 6.86 ± 0.63 mm in males and was 6.59 ± 0.56 mm in females as depicted in Table 5. This value was statistically highly significant (p <0.01).

Table 5: Mesiodistal crown width of maxillary lateral incisor

Mesiodistal width (mm)	Sex	Mean	± S.D.
Right lateral incisor	Male (n = 100)	6.90	0.62
	Female (n = 110)	6.58	0.57
Left lateral incisor	Male (n = 100)	6.86	0.63
	Female (n = 110)	6.59	0.56

It was observed that the mean value of the Mesiodistal crown width of right mandibular canine was 6.62 ± 0.54 mm in males and 6.21 ± 0.54 mm in females, while the mean value of the Mesiodistal crown width of left mandibular canine was 6.78 ± 0.51 mm in males and 6.35 ± 0.47 mm in females as depicted in Table 6. This value was statistically very highly significant (p < 0.001).

Table 6: Mesiodistal crown width of mandibular canines

Mesiodistal width (mm)	Sex	Mean	± S.D.
Right canine	Male (n = 100)	6.62	0.54
	Female (n = 110)	6.21	0.54
Left canine	Male (n = 100)	6.78	0.51
	Female (n = 110)	6.35	0.47

The mean value of Mesiodistal crown width of right maxillary canine was 7.52 ± 0.58 mm in males and 7.33 ± 0.45 mm in females and the mean value of Mesiodistal crown width of left maxillary canine was 7.60 ± 0.54 mm in males and was 7.28 ± 0.49 mm in females as depicted in Table 7. This value was statistically highly significant (p < 0.01).

Table 7: Mesiodistal crown width of maxillary canines

Mesiodistal width (mm)	Sex	Mean	± S.D.
Right canine	Male (*n* = 100)	7.52	0.58
	Female (*n* = 110)	7.33	0.45
Left canine	Male (*n* = 100)	7.60	0.54
	Female (*n* = 110)	7.28	0.49

The sexual dimorphism, from Mesiodistal crown width of canine tooth was calculated by the formula Xm / Xf -1 X100; Xm is the mean Mesiodistal width of canines in males and Xf is the mean Mesiodistal width of canines in females. The sexual dimorphism was 2.27% for right mandibular central incisor and 2.79% for left mandibular central incisor as shown in Table 8.

Table 8: Sexual dimorphism — Mandibular central incisor

Mandibular tooth	Sexual dimorphism
Right central incisor	2.27%
Left central incisor	2.79%

The sexual dimorphism of right maxillary central incisor was 3.81% and that of left maxillary central incisor was 4.28% as shown in Table 9.

Table 9: Sexual dimorphism — Maxillary central incisor

Maxillary tooth	Sexual dimorphism
Right central incisor	3.81%
Left central incisor	4.28%

The sexual dimorphism was 3.99% for right mandibular lateral incisor and 4.06% for left mandibular lateral incisor as shown in Table 10.

Table 10: Sexual dimorphism — Mandibular lateral incisor

Mandibular tooth	Sexual dimorphism
Right lateral incisor	3.99%
Left lateral incisor	4.06%

The sexual dimorphism of right maxillary lateral incisor was 4.86% and that of left maxillary central incisor was 4.18% as shown in Table 11.

Table 11: Sexual dimorphism — Maxillary lateral incisor

Maxillary tooth	Sexual dimorphism
Right lateral incisor	4.86%
Left lateral incisor	4.18%

The sexual dimorphism was 6.53% for right mandibular canine and 6.78% for left mandibular canine as shown in Table 12.

Table 12: Sexual dimorphism — Mandibular canine

Mandibular tooth	Sexual dimorphism
Right canine	6.53%
Left canine	6.78%

The sexual dimorphism of right maxillary canine was 2.58% and that of left maxillary canine was 4.29% as shown in Table 13.

Table 13: Sexual dimorphism — Maxillary canine

Maxillary tooth	Sexual dimorphism
Right canine	2.58%
Left canine	4.29%

Discussion

Dental identification is the most common and reliable method of human identification especially for identifying burnt, decomposed, skeletonized and fragmented remains. Since teeth survive prolonged immersion, decomposition, desiccation, extensive trauma and direct heat in excess of 1000°F.[10]

Teeth can help us to determine age, ancestry, gender, and habits, past and present systemic disease, occupation, country or area of origin or residence and socio economic status. This study makes an attempt to establish gender of an individual by using Mesiodistal crown width of permanent anterior teeth and to assess the degree of sexual dimorphism in south Indian student population.

In our study, there were no significant differences between the Mesiodistal crown width of right and left, mandibular and maxillary central incisors, lateral incisors and canines among males. Similar observations were made amongst the female counterparts. The difference between the mean Mesiodistal dimension of any individual tooth on the right and left hand side were very small and ranged from 0.01 mm to 0.16 mm. These findings were in agreement with the studies conducted in the different parts of the world.[7,11-16] Lundstrom found a definite significant difference between left and right tooth measurements.[17] These findings indicate that right or left side measurements, for both sexes, could be taken to represent Mesiodistal crown dimension in this population. Harper provides evidence that the right-left differences between homologous teeth are smaller than the differences between the teeth of monozygotic twins, suggesting that the side differences can be attributed to environmental influences.[18] According to Garn, intra-individual variations in crown size and similarities between isomers and antimeres might be derived from specific intrauterine events during odontogenesis and less from genetic effects.[19]

The mean Mesiodistal crown dimensions of the anterior permanent teeth of males were larger than that of females in the maxillary and mandibular arches. The mean Mesiodistal crown dimensions of the anterior permanent teeth of maxillary arch were larger than that of mandibular arches in both the genders. These findings were in agreement with the similar studies conducted on South Indian population, North Indian population and Nepalee population.[7,20,21] But in contrast with the study on Bangladeshi population where there was no significant difference between males and females.[16] The larger dimensions of Mesiodistal width of tooth in males can be attributed to 'Y chromosome' which controls the thickness of dentine, which in turn determines the width of a tooth. Whereas the X chromosome, which was considered to be the chromosome responsible, is only concerned with the thickness of enamel.[2,12,22,,23]

In our study, among anterior permanent teeth, the greatest percentage of sexual dimorphism is demonstrated by left mandibular canine (6.78%) and lowest percentage of sexual dimorphism is by right mandibular central incisor (2.27%). The mandibular canines showed greatest percentage of sexual dimorphism amongst all teeth in their Mesiodistal width in our study in concurrence with the similar studies conducted on Tristanite, Ohio Caucasians, Australian aborigines, Pima Indians, South Indian and North Indian population.[7,12,24] The greatest percentage of sexual dimorphism demonstrated by mandibular teeth amongst all teeth in their Mesiodistal width is in agreement with the studies conducted globally. [7,12,25]

Conclusion

100 males and 110 female students in the age group of 18–25 years, from various parts of South India (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, and; union territories of Lakshadweep and Pondicherry) were examined to predict the sex from the Mesiodistal widths of permanent anterior teeth for both the arches. It is evident from our study that the Mesiodistal crown width of permanent anterior teeth can be used as tool for determining the sex.

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