ORIGINAL ARTICLE

Applicability of odontometric dimensions and indices in sexual dimorphism among Nalgonda population

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Abstract

Background: Teeth morphology varies among different population groups as they are exposed to various environmental conditions. Teeth being the most stable and hard tissue, human identification can be made when the other tissues are unavailable. Odontometric analysis can be considered for anthropological and forensic investigations. **Aim:** The aim of this study is to assess the reliability of odontometric mesiodistal (MD) width dimensions and indices in sexual dimorphism among Nalgonda population. **Materials and Methods:** A total of 180 ideal study dental models of patients between the age range of 18 and 25 years were collected from the Department of Orthodontics. Selection criteria include teeth with Class I molar and canine relation, free of anomalies, or caries. Maximum MD widths of all teeth and arch parameters (intercanine width, interpremolar width, and intermolar width) were measured and incisor index, canine index, premolar index, and molar index were calculated. Sexual dimorphism was calculated using Garn and Lewis equation. **Statistical Analysis:** The recorded data were subjected to statistical analysis using independent unpaired *t*-test. **Results and Conclusion:** Mandibular canines followed by maxillary canines showed greater sexual dimorphism among all teeth. Maxillary right canine index, mandibular left canine index, maxillary right incisor index, inter premolar and intermolar widths showed statistically significant difference between males and females ($P < 0.05$). The results of this study revealed significant sexual dimorphism with the use of odontometric dimensions, canine index, incisor index, and arch parameters. These parameters could be used as adjunctive aids by the forensic expertise in human identification.

Key words: Arch parameters, human identification, indices, individual tooth dimensions, odontometric analysis, sexual dimorphism

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Introduction

In 1970, Keiser–Neilsen defined Forensic odontology or forensic dentistry as "the branch of forensic medicine, which in the interest of justice deals with proper handling and examination of dental evidence, with proper evaluation and presentation of the dental findings."[1,2] Teeth are

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considered as the best records in certain mutilated conditions where the other methods cannot be proceeded. Teeth are not only the hardest and stable tissue, resistant to any chemical attacks; these can also be preserved and fossilized.[3] The preliminary thing for a trained forensic odontologist is the gender identification from whatever dental remains are presented as a specimen. "Sexual dimorphism" refers to the differences in size, stature, and appearance between males and females that can be to dental identification.[4] Among these dimorphic traits, odontometric data using tooth dimensions have been evaluated in various populations for its applicability in anthropologic and forensic investigations. A plethora of articles published in the literature reported that dimorphism is observed with respect to tooth size and arch dimensions in their respective population groups. Hence, the present study has been undertaken to assess the dimorphism of individual tooth dimensions, arch parameters and the applicability of incisor, canine, premolar, and molar indices in the Nalgonda population.

Materials and Methods

The study was conducted in the Department of Paediatric and Preventive Dentistry, Kamineni Institute of Dental Sciences, Narketpally, Nalgonda (Dt). A total of 180 ideal study dental models of patients (90 females and 90 males) between the age ranges of 18 and 25 years, which have met the inclusion criteria were collected from the Department of Orthodontics, Kamineni Institute of Dental Sciences. Selection criteria include the presence of all permanent teeth except third molars exhibiting Class I molar and canine relationship, teeth free of rotations, spacing or caries, and with normal overjet and overbite. Dental casts showing supernumerary teeth, partial anodontia, rotations, crowding, attrition, restorations, and malocclusions were excluded from the study. Individual tooth mesiodistal (MD) widths, arch parameters were measured on both maxillary and mandibular arches using digital Vernier calipers on the dental casts by single investigator [Figure 1]. A total of twenty study casts randomly selected from both males and females were re-measured by the observer to assess the intra-observer variability of these measurements.

Measurements/parameters recorded:

- Individual tooth dimensions: The greatest MD dimension was measured at the approximating surfaces of the crown using digital Vernier calipers to the nearest of 0.01 mm
- Intercanine width: The intercanine distance was measured from the cusp tip of one upper canine to the cusp tip of the opposite canine
- Interpremolar width: The width of the arch in the premolar region from the distal pit of one upper first premolar to the distal pit of the opposite first premolar was measured

Figure 1: Mesiodistal measurement of teeth on the cast

- Intermolar width: The width of the arch in the molar region from the mesial pit of one upper first molar to the mesial pit of the opposite first molar was measured.

Sum of the mandibular incisors

The MD widths of all four mandibular incisors were summed up.

Indices calculated:

$$\text{Incisor index}: \frac{\text{MD lateral incisor}}{\text{MD width of central incisor}} \times 100$$

$$\text{Canine index (CI)}: \frac{\text{MD width of the canine}}{\text{Inter canine distance}} \times 100$$

$$\text{Premolar index}: \frac{\text{Sum of the incisal widths}}{\text{Inter premolar width}} \times 100$$

$$\text{Molar index}: \frac{\text{Sum of the incisal widths}}{\text{Inter molar width}} \times 100$$

Standard mandibular and maxillary canine index (SCI):

$$\text{SCI} = \frac{\text{Mean CI of males} - \text{SD of males}}{2} - \frac{\text{Mean CI of females} - \text{SD of females}}{2}$$

Sexual dimorphism

Garn and Lewis's formula was followed to calculate sexual dimorphism.[5]

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

X_m = mean value of measurement for males

X_f = mean value of measurement for females.

All the measurements recorded were tabulated and the data were subjected to statistical analysis using (SPSS) version 20, using student's independent unpaired *t*-test.

Results

Table 1 shows the descriptive statistics of individual tooth dimensions of both males and females. The MD widths of incisors, canines, premolars, and molars were summed up and averaged separately. The mean MD widths of maxillary canines in males were 7.6 ± 0.4 and in females were 7.4 ± 0.4. The mean MD widths of mandibular canines in males were 6.7 ± 0.9 and in females were 6.4 ± 0.9. The MD widths of both maxillary and mandibular permanent canines showed a statistically significant difference between males and females ($P < 0.05$), and a greater sexual dimorphism followed by mandibular molars than the other teeth.

Table 1: Descriptive statistics of individual tooth dimensions

Group	*n*	Mean±SD	Significant (two-tailed)	Sexual dimorphism
16 and 26				
Male	90	9.8±1.0	0.491	0
Female	90	9.8±1.2		
15 and 25				
Male	90	6.4±0.9	0.221	1.2
Female	90	6.3±0.8		
14 and 24				
Male	90	6.8±0.8	0.430	0.7
Female	90	6.8±0.9		
13 and 23				
Male	90	7.6±0.4	0.001*	2.7
Female	90	7.4±0.4		
12 and 22				
Male	90	6.8±1.0	0.222	1.4
Female	90	6.7±1.1		
11 and 21				
Male	90	8.5±1.1	0.109	1.6
Female	90	8.3±1.1		
36 and 46				
Male	90	10.7±1.2	0.174	2.0
Female	90	10.5±1.4		
35 and 45				
Male	90	6.7±0.8	0.589	0.5
Female	90	6.7±0.9		
34 and 44				
Male	90	6.8±0.8	0.381	−2.8
Female	90	7.0±4.2		
33 and 43				
Male	90	6.7±0.9	0.001*	4.6
Female	90	6.4±0.9		
32 and 42				
Male	90	5.8±0.7	0.098	1.7
Female	90	5.7±0.8		
31 and 41				
Male	90	5.3±0.7	0.645	0.5
Female	90	5.2±0.7		

*Statistically significant. SD: Standard deviation

Table 2 shows the observed maxillary and mandibular right and left canine index. The mean maxillary right canine index in males and females was 22.2 ± 1.2 and 21.8 ± 1.4, and the mean maxillary left canine index in males and females was 22.3 ± 1.4 and 21.9 ± 1.9, respectively. The mean mandibular right canine index in males was 25.8 ± 1.9 and in females was 25.0 ± 2.2 and the mean mandibular left canine index was 25.8 ± 2.2 and 25.1 ± 2.2, respectively. Maxillary right canine index, mandibular left canine index showed a significant difference between males and females ($P < 0.05$) There was a significant difference between males and females ($P < 0.05$) with respect to maxillary right canine index and mandibular left canine index, but a greater sexual dimorphism was observed in mandibular right canine index followed by mandibular left canine index. The standard maxillary and mandibular canine index was 0.31 and 0.5, respectively [Table 3].

Table 4 shows the maxillary and mandibular incisor index values of both males and females. The mean maxillary right incisor index, left incisor index in males was 80.0 ± 5.6, 80.2 ± 5.7, and in females was 80.0 ± 5.9, 80.1 ± 5.6, respectively. The mean mandibular right incisor index, left incisor index in males was 110.4 ± 6.4, 110.0 ± 6.7 and in females was 108.5 ± 5.6, 108.5 ± 6.4, respectively. Mandibular right incisor index showed a significant difference between males and females with a sexual dimorphism of 1.7. No significant difference was observed in premolar and molar indices between males and females but with negative sexual dimorphism as females had slightly greater values than males [Table 5].

Table 6 shows the mean intercanine, interpremolar, and intermolar widths of both maxillary and mandibular arches of both males and females. The mean maxillary and mandibular intercanine width in males was 34.3 ± 2.0, 26.0 ± 2.11 and in females was 34.0 ± 1.8, 25.9 ± 1.6, respectively. The mean maxillary and mandibular interpremolar widths in males were 35.4 ± 1.8, 28.6 ± 1.8 and in females were 34.6 ± 1.9, 28.0 ± 1.6, respectively. The mean maxillary and mandibular intermolar widths in males were 46.6 ± 2.4, 3.8 ± 2.0 and in females were 45.3 ± 2.2, 38.9 ± 2.0, respectively. Both maxillary and mandibular interpremolar widths and maxillary intermolar width showed a significant difference between males and females, whereas no difference was found in both maxillary and mandibular intercanine width and mandibular intermolar widths. Sexual dimorphism was higher in maxillary intermolar width followed by maxillary inter-premolar width and then mandibular intermolar and inter-premolar widths.

Discussion

Odontometry has been considered as a valuable adjunctive tool for human identification in some situations where other tissues or body parts are not available either due

Table 2: Canine index

Group	*n*	Mean±SD	Significant (two-tailed)	Sexual dimorphism
Maxillary right canine index (13)				
Male	90	22.2±1.2	0.047*	1.8
Female	90	21.8±1.4		
Maxillary left canine index (23)				
Male	90	22.3±1.4	0.194	1.5
Female	90	21.9±1.9		
Mandibular right canine index (43)				
Male	90	25.8±1.9	0.468	3.2
Female	90	25.0±2.2		
Mandibular left canine index (33)				
Male	90	25.8±2.2	0.050*	2.7
Female	90	25.1±2.2		

*Statistically significant. SD: Standard deviation

Table 3: Standard maxillary and mandibular canine index

SCI	Index value
Standard maxillary canine index	0.31
Standard mandibular canine index	0.5

Table 4: Incisor index

Group	*N*	Mean±SD	Significant (two-tailed)	Sexual dimorphism
Maxillary right incisor (11)				
Male	90	80.0±5.6	0.990	0.01
Female	90	80.0±5.9		
Maxillary left incisor (21)				
Male	90	80.2±5.7	0.910	0.1
Female	90	80.1±5.6		
Mandibular right incisor (41)				
Male	90	110.4±6.4	0.042*	1.7
Female	90	108.5±5.6		
Mandibular left incisor (31)				
Male	90	110.0±6.7	0.127	1.3
Female	90	108.5±6.4		

*Statistically significant. SD: Standard deviation

to decomposition or in incidents of inferno or accidents. This method is a relatively simple, inexpensive, and easy to perform. As teeth dimensions and arch, parameters vary from individual to individual, determination of population-specific data would be an additional help to the forensic expertise in establishing the identity of a deceased or living individual. There is a paucity of literature on individual tooth dimensions, all arch parameters and the use of various tooth indices in determining the sexual dimorphism; hence, the present preliminary study has been undertaken. Ditch and Rose were the first to prove that teeth diameters can be successfully used in determining sex in poorly preserved and fragmentary skeletal remains in archaeology.[6] MD dimensions of maxillary and mandibular canines provide evidence of sexual dimorphism as these are the least frequently affected and extracted teeth and can survive air and hurricane disasters.[7]

Previously, only mandibular canine index and sexual dimorphism, *in vivo*, were reported in the Nalgonda group of population.[8] Hence, the present study has been undertaken to assess the applicability of odontometric data using individual tooth MD widths, arch parameters, and various indices in sexual dimorphism on ideal dental study models of the Nalgonda population as this study included many parameters. The individual tooth MD widths of maxillary and mandibular right and left canines showed a significant difference and sexual dimorphism with greater values in males than females. This is in accordance with various studies where mandibular canines exhibited the greatest sexual dimorphism in their MD width among all teeth.[9-16] On the contrary, reverse dimorphism was also reported.[17-19] Least variation was also reported with maxillary canines between males and females.[20] Maxillary central incisors and right and left canines showed a significant difference between males and females,[21-23] while Al-Rifaiy *et al*. reported no significant difference between males and females.[24]

In the current study, maxillary right canine index, mandibular left canine index showed a significant difference between males and females with greater dimensions in males. Mandibular right canine had shown a greater dimorphic value than mandibular left canine index. These results are in accordance with Vishwakarma and Paramkusam G *et al*., and Patil *et al*., who reported that mandibular right canine to be more dimorphic than mandibular left canine.[8,25,26] The left mandibular canine index was found to be significantly different in males and females.[15,25,27]

When incisor index was statistically analyzed, mandibular right incisor index showed a significantly greater value in males than females. These findings are contradicting the studies reported where maxillary central incisors showed a significant difference between males and females.[21,22,28] When arch parameters were analyzed, interpremolar, and intermolar widths showed a significant difference between males and females. However, no significant difference was observed in relation to intercanine width.[25]

Conclusion

Within the limitations of the present study, it can be concluded that the odontometric data using individual tooth dimensions, canine index, and incisor index, and sexual dimorphism are useful, adjunctive, and inexpensive tools for human identification. In the current study, maxillary and mandibular canine MD widths, mandibular left canine index, maxillary right canine index, maxillary right incisor

Table 5: Intercanine, interpremolar, and intermolar widths

Group	*n*	Mean±SD	Significant (two-tailed)	Sexual dimorphism
Maxillary inter canine width				
Male	90	34.3±2.0	0.275	0.8
Female	90	34.0±1.8		
Mandibular intercanine width				
Male	90	26.0±2.1	0.839	0.3
Female	90	25.9±1.6		
Maxillary inter premolar width				
Male	90	35.4±1.8	0.003*	2.3
Female	90	34.6±1.9		
Mandibular inter premolar width				
Male	90	28.6±1.8	0.022*	2.1
Female	90	28.0±1.6		
Maxillary intermolar width				
Male	90	46.6±2.4	0.001*	2.8
Female	90	45.3±2.2		
Mandibular intermolar width				
Male	90	39.8±2.0	0.006	2.1
Female	90	38.9±2.0		

*Statistically significant. SD: Standard deviation

Table 6: Premolar and molar indices

Group	*n*	Mean±SD	Significant (two-tailed)	Sexual dimorphism
Maxillary premolar index				
Male	90	86.8±5.5	0.595	−0.5
Female	90	87.3±6.3		
Mandibular premolar index				
Male	90	77.8±6.0	0.190	−1.3
Female	90	78.9±5.6		
Maxillary molar index				
Male	90	66.1±4.0	0.315	−0.8
Female	90	66.7±4.5		
Mandibular molar index				
Male	90	56.1±4.0	0.820	−0.3
Female	90	56.3±7.5		

SD: Standard deviation

index, interpremolar and intermolar widths were proved to be significantly greater in males than females. Mandibular canine MD width and mandibular right canine index were found to be more dimorphic than the other parameters. Hence, odontometric analysis and arch parameters can be considered as a valuable method in forensic investigations. However, a future study including large sample size with multiple examiners to rule out the individual errors would be of major help to reach a definitive conclusion.

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Conflicts of interest
There are no conflicts of interest.

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