RESEARCH ARTICLE

RELIABLITY OF CANINE MORPHOMETRIC ANALYSIS IN PREDICTION OF SEXUAL DIMORPHISM IN HIMACHALI POPULATION

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ARTICLE INFO	ABSTRACT
  Corresponding Author: *Dr. Shikha Thakur*	**Background:** Canines are considered to be the key teeth for personal identification as it exhibits greatest sexual dimorphism. The morphometric assesment provides the evidence of sex determination due to dimorphic nature of canine. Objectives: To evaluate the reliablity of canine morphometric analysis in prediction of sexual dimorphism in Himachali population. **Methods:** Total 70 subjects (35 males and 35 females) were randomly selected and study models were fabricated. The intercanine width and mesiodistal width of canine was measured using digital vernier caliper on the study models of both maxilla and mandible. Sexual dimorphism, Standard and observed canine index was calculated. All the measurements were statistically analysed using student t test. **Results:** On comparison the mean values were found to be larger in males than females and was statistically significant (p<0.05). **Conclusion:** The left canine was more dimorphic than the right canine in both maxilla and mandible and mandibular canine index was found to be more reliable than maxillary canine index in prediction of sexual dimorphism The value of the standard canine index was found to be 0.25 in maxilla and 0.28 in mandible in Himachali Population

INTRODUCTION

Teeth are the hardest and chemically most stable tissue in the body which can be selectively preserved and fossilized for providing the best record for evolutionary change. They play a vital role in anthropological, genetic, odontologic, and forensic investigations (Gandhi *et al.*,2017). Teeth are the most indestructible part of the body and can be identified even when the rest of body has undergone decomposition. So they act as an invaluable tool for identification and gender determination. Sexual dimorphism refers to those differences in size, stature, and appearance between males and females that can be applied to dental identification (Vijayan, 2019). Determination of gender is one of the most essential aspects for establishing identity in cases involving any legal certification and other forensic and crime investigations. The morphometric characteristic of almost all the teeth are used in identification ofsexual dimorphism of an individual. However, canines are the most common teeth which play a valuable role in odontometric sex assessment.

Canines are also most likely to survive in severe trauma such as air disasters and hurricanes. These findings include the one that they are most stable teeth in oral cavity because of the labiolingual thickness of the crown and the root anchorage in the alveolar process of jaws (Mahajan, 2020). Measurement of mesiodistal width of canines and intercanine distance provides good evidence of sex identification due to dimorphism. Therefore the aims and objectives of the present study were to evaluate the reliability of canine morphometric analysis in the prediction of sexual dimorphism in the Himachali population.

METHODS

The present study was conducted in the department of Orthodontics and Dentofacial Orthopaedics. Total 70 subjects (35 males and 35 females) were randomly selected from the patients visiting the department for seeking the orthodontic treatment.The subjects were included in the study on the basis of inclusion criteria- age group between 15 and 30 years, having all fully erupted teeth with no

spacing, periodontally healthy teeth, noncarious and nonattrited teeth, diastema or crowding and subjects with no clinical evidence of any restoration, orthodontic treatment, and trauma. The significant exclusion criteria for selection of the study sample were the presence of partially erupted/ectopically erupted teeth, patients with dental/occlusal abnormalities, teeth showing physiologic or pathologic wear and tear and patients with deleterious oral habits (like bruxism).

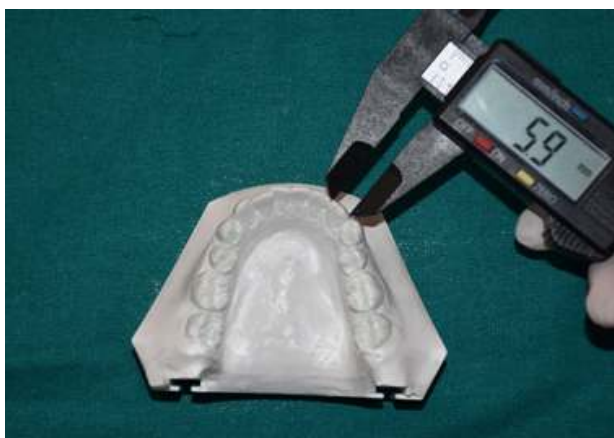**Figure 1. Measurement of mesio distal width of canine in Maxilla**

Figure 2. Measurement of mesio distal width of canine in Mandible

Figure 3. Measurement of inter canine distance in Maxilla

Mesiodistal width measurement: The subjects were seated on a dental chair and impressions were taken with Alginate impression materialand study models were fabricated.

Figure 4. Measurement of inter canine distance in Mandible

The mesiodistal width of the left and the right maxillary and mandibular canines in males and females were obtained by measurement on models with the help of digital Vernier calipers (accurate up to 0.01 mm) at the maximum mesiodistal width between the contact points of teeth on either side of the cast as shown in Figure 1.Each reading was taken 3 times and an average of three values was obtained to minimize the intraobserver error.

Intercanine distance measurement: The intercanine distance was measured using a digital vernier calliper by placing the two pointed ends of its jaws over the canine tip and values were noted. The observed canine index in Mandible denoted as $MnCI_o$ and observed canine index in Maxilla denoted as $MxCI_o$ calculated as follows[4]:

Canine index(CI)= Mesiodistal width of the canine/intercanine distance. The standard CI value was used as a cutoff point to differentiate males from females which is obtained by applying the following formula[5]:

Standard CI (CI_s) = (mean male CI − SD) + (mean female CI + SD)/2

If the CI value of study cast was less than or equal to the standard CI, the cast was considered to be of a female, and if CI value more than the standard CI, the cast was considered to be of a male subject. Calculation of sexual dimorphism was done according to the formula given by Garn *et al*[6].

Sexual dimorphism in mesiodistal width = $X_m/X_f \times 100$

X_m = Mean value of canine width in males; X_f= Mean value of canine width in females.

Statistical analysis: All the measurements were obtained and statistically analyzed using Statistical Package for Social Sciences (SPSS version 21). The mean value of the mandibular canine width in males and females were compared using student t-test. The statistical significance was set at p<0.05.

RESULTS

Table I and II showed the comparison of mean values of various parameters in maxillary and mandibular canine among males and females using student t test.

The results of the present study showed that the mean values were found to be higher in males than females and was found to be statistically significant (p<0.05) except the observed MxCI and MnCI.

Table I. Comparison of various parameters of maxillary canine index in males and females

PARAMETER	NUMBER OF SUBECTS	MEAN	SD	t	p
RIGHT CANINE WIDTH(mm)					
Male	35	7.80	0.75	2.88	0.005*
Female	35	7.29	0.67		
LEFT CANINE WIDTH(mm)					
Male	35	7.87	0.79	2.23	0.02*
Female	35	7.25	0.62		
MEAN CANINE WIDTH(mm)					
Male	35	7.75	0.75	2.95	0.004*
Female	35	7.23	0.60		
INTERCANINE WIDTH(mm)					
Male	35	32.0	2.98	2.03	0.04*
Female	35	30.8	1.81		
$MxCI_0$					
Male	35	0.25	0.02	1.32	0.19
Female	35	0.24	0.04		

*p<0.05=significant

Table II. Comarison Of Various Parameters of Mandibular Canine Index In Males And Females

PARAMETER	NUMBER OF SUBECTS	MEAN	SD	t	P
RIGHT CANINE WIDTH(mm)					
Male	35	6.82	0.65	2.66	**0.009***
Female	35	6.45	0.50		
LEFT CANINE WIDTH(mm)					
Male	35	6.98	0.64	2.78	**0.006***
Female	35	6.54	0.51		
MEAN CANINE WIDTH(mm)					
Male	35	6.95	0.64	3.89	**0.0002***
Female	35	6.42	0.49		
INTERCANINE WIDTH(mm)					
Male	35	27.9	2.50	4.54	**0.0001***
Female	35	25.6	1.65		
$MnCI_0$					
Male	35	0.29	0.03	1.64	0.10
Female	35	0.28	0.02		

*p<0.05=significant

Table III. Sexual Dimorphism In Maxillary And Manibular Canine

SEXUAL DIMORPHISM	PERCENTAGE %
MAXILLARY CANINE	
RIGHT CANINE	5.7%
LEFT CANINE	6.7%
MANDIBULAR CANINE	
RIGHT CANINE	6.9%
LEFT CANINE	7.5%

Table IV: Probability Of Gender Prediction Using Canine Width In Maxilla

GENDER	NUMBER OF SUBJECTS	NUMBER OF CASES WITH CORRECT GENDER PREDICTIONN USING MCI_S	PERCENTAGE ACCURACY
MALES	35	27	77%
FEMALES	35	29	82%
TOTAL	70	56	80%

STANDARD MxCI = 0.25

Table IV: Probability Of Gender Prediction Using Canine Width In Mandible

GENDER	NUMBER OF SUBJECTS	NUMBER OF CASES WITH CORRECT GENDER PREDICTIONN USING MCI_S	PERCENTAGE ACCURACY
MALES	35	29	82%
FEMALES	35	31	88%
TOTAL	70	60	85%

STANDARD MnCI = 0.28

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Table III showed the percentage of sexual dimorphism in maxillary and mandibular canine in Himachali population. The results of the present study showed that the left canine was found to be more dimorphic as compared to right canine in both maxilla and mandible. Table IV and V showed the probability of gender prediction using canine width in Maxilla and mandible. The results of the present study showed that the level of accuracy for sex determination in mandible was found to be 88% in females and 82% in males. Whereas in maxilla, level of accuracy for sex determination in mandible was found to be 82% in females and 77% in males.

DISCUSSION

Teeth provide an excellent source to study the relationship between ontogeny and phylogeny. This onto phylogenetic relationship makes human skeletal remains as most reliable source of gender identification. There are two extensively described methods of gender identificationi. e. metric and nonmetric. The objectivity of metric approach makes it more advantageous over the nonmetric approach. Moreover, it is highly reliable, less dependent on the previous observer experience and is more readily amenable to statistical analysis and thus helps comparisons within the sample and with other studies. Among the permanent teeth, canines are the most informative on the sexual dimorphism, not only through its metric trait such as crown dimensions but also by the nonmetric trait like the presence of a minor distal groove either on maxilla or on mandible. As canines are least exposed to periodontal disease, abrasion, or heavy occlusal loading and are one of the last teeth to be extracted with respect to age .Hence they are consideredthekey teeth for the purpose of personal identifications.Therefore the aims and objectives of our study was to evaluate the reliability of canine morphometric analysis in prediction of sexual dimorphism in Himachali population. The results of the present study showed that both maxillary and mandibular canine width was found to be more in males than females and was found to be statistically significant (p<0.05) in both right and left sides as shown in Table I and II. This suggests the variation in mesiodistal dimensions of canine in males and females as the size of teeth are larger in males than females.

According to Moss, it is because of the greater thickness of enamel in males due to the long period of amelogenesis as compared to females. However, in females the completion of calcification of crown occurs earlier in both deciduous and permanent dentition. According to Rani *et al*. (2009),sex chromosomes cause different effects on tooth size. The Y chromosome influences the timing and rate of body development, thus producing slower male maturation and acts additively to a greater extent than the X chromosomes. These findings were in accordance to the study done by Reddy *et al*. (2008) and Gandhi *et al*. (2017). Further the results of the present study showed that the maxillary and mandibular intercanine width in males was found to be more than females and was found to be statistically significant(p<0.05) as shown in Table I and II. This difference inintercanine width can be attributed to the fact that the bony ridges, crest, and alveolar processes are larger in males than females. Also, the strong musculature of males affects both maxillary and mandibular dimensions.

This was in accordance with the study done by Alia *et al*[9](2009), Rao *et al*[5] (1989), and Kaushal *et al*. (2004). Moreover, in the present study, it was found that the left maxillary (6.7%)and mandibular (7.5%) canine is more dimorphic than the right maxillary (5.7%) and mandibular (6.9%) canine as shown in Table III. This indicates that left mandibular canine is more dimorphic than right canine. This was in accordance to the study done by Reddy etal[8] (2008).Similar results were found for the north Indian population where the value came out to be 7.9% for the right canine and 8.89% for the left canine which was in accordance to the study by Kaushal *et al*. (2004). In the present study, the results showed that the probability of gender determination using canine width in mandible was found to be 82% in males and 88% in females whereas in maxilla, it was found to be 77% in males and 82% in females. This suggests that mandibular canine is sexually more dimorphic than maxillary canine. These results were in accordance to Rao *et al*. (1989), who found that the percentage accuracy of gender prediction was 84.3% of the males and 85.7% of the females in mandible. Similar study was conducted by Yadav *et al*. (2002) in south Indian population who estimated81% accuracy in females and 83.3% accuracy in males in mandible. Thus the present study signified that the mandibular canine has more predictability of gender determination than the maxillary canine by using mesiodistal width of canine and intercanine distance. But the method of sex determination via canine measurements has its own limitations. In the present study we measured only the linear dimensions which are not more accurate as more accuracy could only be obtained by the application of the Moire's topography and Fourier's analysis that require sophisticated equipment and the use of complex mathematical equations, respectively. On overall evaluation, the present study concluded that that the left mandibular canine has more reliability in prediction of gender than the right canine. Mandibular canine index is a valuable tool for sex determination as it is quick and easy method particularly when other methods for sex determination are not readily available. Thus the results of present study supports the usefulness of canine morphometric analysis in prediction of sexual dimorphism in Himachali population.

CONCLUSION

The conclusions drawn from the study were as follows:

- The mesiodistal width of the permanent maxillary and mandibular canine as well as the intercanine distance was found to be more in males than females of Himachali Population.
- The left canine was found to be more dimorphic than the rightcanine in both maxilla and mandible.
- The value of the standard MCIwas found to be 0.25 in maxilla and 0.28 in mandible for the population residing in Himachal Pradesh.
- The percentage accuracy for the sex determination in mandible was found to be 88% in females,82% in males and overall accuracy is 85%.
- Similarly in maxilla, the percentage accuracy was 82% in females, 77% in males and overall accuracy is 80%.
- Mandibular canine index was found to be more reliable than maxillary canine index in prediction of sexual dimorphism.

Hence the present study supports the usefulness of canine index for gender determination.

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