Reliability of Mandibular Canines as Indicators for Sexual Dichotomy

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ABSTRACT

Introduction: Amongst the various calcified structures in the human body, teeth have gained lot of popularity in estimating the sex of an individual as they are highly resistant to destruction and decomposition. Using permanent mandibular canines many researchers have predicted a high level of accuracy in identifying the sex correctly. The purpose of our study was to gauge the effectiveness of mandibular canines in discerning sex.

Materials & Methods: Fifty dental casts each of males and females were utilized for the study. Mesio-distal dimension and inter-canine distance of mandibular right and left canine was recorded using digital vernier caliper and mandibular canine index was calculated.

Results: The mean value of mesio-distal dimensions of right and left mandibular canine was slightly greater in males compared to females. The mandibular canine index was equal in both sexes. Inter-canine distance was marginally higher in males compared to females. Despite of higher values in males none of the parameters were statistically significant.

Conclusion: The results herein bolster contemporary studies that mesio-distal dimensions of mandibular canines and mandibular canine index do not reflect sexual dimorphism and that its application should be discontinued in sex prediction among Indian populations.

Keywords: Sexual Dimorphism, Mandibular Canines, Mandibular Canine Width, Inter-canine Distance.

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Introduction

The four leading features of biological identity are sex, age, stature, and ancestry background. The forensic anthropologist wishes to authenticate these traits for an individual from their skeletal remains.[1] The recognition of a corpse may be prerequisite in cases of precipitous and unforeseen demise, fires, explosions, railway or aircraft accidents, mutilated or hidden decomposed bodies, or foul play, which often needs great medico-legal acumen.[2] The law enforcement community expects and compels that the forensic scientist report the identification of partial or complete remains of an individual to the best of his or her ability[3].

An important initial step in identification of the dismembered remains of mass disaster victims is the separation of sexes.[4] Sex assessment of skeletal remains is part of the archaeological and many medico-legal examinations.[5]

Assessment of sex has significant contribution in construction of a physical profile of the decedent along with other parameters like race, stature and age. Sex can be assessed with high precision using pelvic[6] and cranial bones[7]. But the demerit of using these bones is that

they easily get fragmented which may be major hindrance for assessment of sex. The dentition is considered as a useful adjunct in skeletal sex estmation, particularly since teeth are resistant to postmortem destruction and fragmentation.[8]

Tooth sexual dimorphism is often related to body size. In living people today, body size dimorphism averages 10%.[9] Human dental dimorphism is on the order of 2-6%.[9] Canines vary from other teeth with respect to survival and sex dichotomy. The differences in all probability are correlated to their function, which is different on an evolutionary basis from other teeth. In many animals, large canines are considered to be visual sexual signs of dominance and rank. In carnivores and in most primates, their chief function is related to threat of aggression and actual aggression.[10]

Mandibular canines show greatest dimensional differences with larger teeth in males than in females.[11]

Across populations, the tooth dimensions were consistently greater in males than in females. The average degree of sexual dimorphism was 1.96 percent for maxillary teeth and 0.68 percent for the mandibular teeth in Eurasians; the respective figures being 1.36 percent and 0.96 percent for Africans and 1.47 percent and 1.53 percent for East Asians. The average mesio-distal crown diameter appeared greater in Africans than in Eurasians, with that for East Asians being intermediate.[12]

In a study on the mesio-distal crown diameter of permanent teeth of aborigines, sex differences in tooth sizes were observed and the mandibular canines showed the most marked difference.[13]

However, other investigators have reported that in a Japanese population, the maxillary canine showed a higher degree of sexual dimorphism compared to the mandibular canine.[14] Similar findings were echoed in a study on Swedish population.[5]

When the relationship between all the teeth in deciduous and permanent dentition of the same individuals with respect to their mesio-distal crown widths was investigated, males were shown to exhibit larger mesio-distal tooth widths than females in both the deciduous and the permanent dentitions. The largest male to female tooth width difference in this study was found in the permanent canines.[11]

In recent times various studies have been done by several researchers to explore the validity of mandibular canine tooth size in sex detection, specifically the mandibular canine index (MCI), which is the ratio of the mesio-distal (MD) dimension of the lower canine and the inter-canine arch width.

A recent study done by Acharya et al suggests that the MCI has little utility in sex estimation and that its application should be restricted, if not discontinued altogether, in forensic and anthropological sex prediction.[15]

Our objective to carry out this study was to ratify if the mandibular canine index is indeed of limited value in sex estimation.

Materials & Methods

This study was carried out in the Department of Oral Pathology, Maratha Mandal's N.G.H. Institute of Dental Sciences & Research Centre, Belgaum after obtaining the institutional ethical clearance. The study was conducted using the dental casts available in the dental records section of the institute.

The mandibular casts having complete set of fully erupted, morphologically well-formed, non-carious, non-attrited, intact and satisfactorily aligned maxillary and mandibular anterior teeth with no history of orthodontic treatment and no evidence of crown restorations were included in the study.

The study involved only individuals of Indian origin.

The casts with missing or partially erupted, malformed, carious, fractured, attrited maxillary or mandibular anterior teeth and those with anterior teeth displaced, or with a history of orthodontic treatment and evidence of crown restorations were excluded from the study.

After meeting inclusion and exclusion criteria we selected 50 dental casts of each males and females aged between 15-21 years.

The following measurements were made directly on the study casts. All measurements were read by a single observer. The data obtained from various measurements was recorded on the proforma for that cast.

1. The greatest mesio-distal crown width of the mandibular permanent canines, measured between the contact points of the tooth on either side of the jaw, using digital calipers calibrated to 0.01mm (Mitutoyo, Japan) as shown in Fig. 1

Fig. 1: Photograph showing measurement of mesio-distal dimension of mandibular canine at contact point on dental cast using digital caliper.

2. Mandibular inter-canine arch width measured between the cusp tips of right and left canines, using digital calipers calibrated to 0.01mm (Mitutoyo, Japan) as shown in Fig. 2

Fig. 2: Photograph showing measurement of inter canine distance of mandibular arch using digital caliper.

on the premise that, any phenotype differences between them should be the result of environmental influences, or of interaction between identical genes and different environmental factors is one of the most effective methods available for investigating genetically determined variables in orthodontics as well as other medical fields, depending on the variance in the shape and the size of the skull and teeth. Twins are special individuals who provide a wealth of information including intriguing and illuminating insights into the mechanism of human craniofacial growth and development.

The canine index of each individual was derived as a ratio between the above two parameters, that is,

Mandibular Canine Index =

$$\frac{\text{Mesio–distal crown width of mandibular canine}}{\text{Mandibular canine arch width}}$$

Later mean Mandibular Canine Index (MCI) was calculated using Rao[16] et al formula:

Standard MCI =

$$\frac{\text{(Mean Male MCI – S.D.) + (Mean Female MCI + S.D.)}}{2}$$

Percentage of accuracy was calculated with predicted MCI and also using MCI of Rao et al.[16]

The data assimilated was subjected to statistical analysis to obtain p value, mean values and standard deviation. Independent sample t-test was used for comparison of means.

Results

The descriptive statistics and the degree of sexual dimorphism for mesio-distal measurements of mandibular canines and the inter-canine arch width are depicted in Table 1. The mean value of mesio-distal dimensions of right and left mandibular canine was slightly greater in males compared to females. The mandibular canine index showed practically no difference between the sexes.

Inter-canine distance was marginally higher in males compared to females. Despite of higher values in males none of the parameters were statistically significant as shown in Table 1.

Standard MCI was calculated according to suggestions by Rao et al[16] classification. The percentage of estimating the sex accurately was 40% and 50% in males and females respectively when the present sample's Standard MCI was used.

When Rao's Standard MCI was subjected for prediction of accuracy in estimating the sex we obtained an even lower accuracy rate in

predicting males (33.33%) although females

Table 1: Difference between the various Parameters in Males and Females					
Parameters		Mean	SD	T value	Sig. (2 tailed)
Mesiodistal of Mandibular Right Canine(mm)	**Male(50)** **Female(50)**	7.32 7.06	.705 .879	1.632	0.106
Mesiodistal value of Mandibular Left Canine(mm)	**Male(50)** **Female(50)**	7.04 6.90	.630 .958	0.863	0.390
Mean value	**Male(50)** **Female(50)**	7.18 6.95	.5848 .7954	1.647	0.103
Intercanine Distance (mmm)	**Male(50)** **Female(50)**	27.17 26.25	2.577 2.339	1.869	0.065
Mandibular Canine Index	**Male(50)** **Female(50)**	.26574 .26406	.032518 .034560	0.250	0.803

Table 2: Sex Classification Accuracy using Standard Canine Index in Mandibular Canine				
	Mandibular Canine Index (Our study)		Mandibular Canine Index (Rao et al)[16]	
Sex	Number correctly predicted (total no.)	Percentage	Number correctly predicted (total no.)	Percentage
Males	20 (50)	40 %	10 (30)	33.33 %
Females	25 (50)	50 %	18 (30)	60 %
Total	45 (100)	45 %	28 (60)	46.67 %

showed higher accuracy at 60% as shown in Table 2.

Discussion

Human sexual dimorphism is said to be an outcome of a survival strategy, a balancing of the need for high degree of biological variation within the species with the need for a narrow range of variation in the female, who is physically structured for the support of an infant

prenatally and postnatally.[17] Thus, the differences are a reflection of the ongoing processes of evolution. The genetic basis for variation has been explained by a polygenic model of inheritance. This is the basis of the sexual dimorphism in the morphological and metric attributes of males and females.[18]

There are many studies done using permanent mandibular canine in estimating sexual dimorphism and have obtained reliable accuracy. Amongst all these studies, the study carried out by Rao et al[16] on a diverse sample that originated from the state of Karnataka in Southern India stands out because they proposed the 'Mandibular Canine Index (MCI). They concluded that 84.3% males and 85.7% females could be discriminated correctly with respect to sex.[16] The method has been tested on other Indian samples in Southern India by Yadav et al and they have achieved 72% accuracy in sex estimation.[19] Similar study was conducted by Reddy et al from the state of Uttar Pradesh in Northern India and they have achieved 82% accuracy in sex estimation.[20]

Lower levels of accuracy (51%) in sex estimation was obtained by Muller et al when MCI was applied to the students enrolled in the University of Nice-Sophia Antipolis.[21] 210 girls and 214 boys were randomly sampled in that study. Lower levels (63%) was achieved by Acharya et al too, who interrogated the practicality of the MCI in sex assessment and reputed that MCI do not reflect dental sex dimorphism precisely.[22]

When MCI was applied in the present study, we also could not yield high level of accuracy and we could achieve only an average accuracy of 50%.

A recent study by Acharya et al (2011), have actually questioned the accuracy of MCI in sex determination among Indian Population. In their study they derived there own MCI index and obtained an accuracy level of 50.74%. They also subjected individual mandibular canine index of their study to various MCI developed by other authors. They obtained accuracy ranging

between 51.23-53.20%.[15] Even in the present study when we applied Standard MCI of Rao et al[16] we achieved accuracy rates as low as 45%.

Further to ascertain the usefulness of absolute measurements vis-à-vis ratios in sex estimation, Acharya et al (2011) utilized logistic regression analysis for M-D canine dimension, intercanine width, as well as MCI. With this statistical analysis also they achieved predictive value as low 50.2% for MCI. But they obtained an average accuracy of 65.7% when only M-D dimension of right canine is considered. They further debated the inclusion of the intercanine dimension for sex assessment considering the fact that males have larger jaw dimensions and a greater predilection for bilobate and square shaped chin in males in contrast to pointed ones in females. They stated that the inter-canine width-which is related to the mandibular arch dimension-may therefore be expected to show recognizable sexual dimorphism, just like canine dimensions. They also questioned the basis of developing the MCI by Rao et al where it is implied that the canine dimension has a direct relationship with the inter-canine width in both sexes, negating possible reflection of sexual dimorphism. They reasoned out that these factors could probably be responsible for the minimal sex difference in the MCI in their study and they concluded that MCI has little utility in sex estimation and its application should be restricted.[15]

In another study conducted Acharya et al (2008) it has been shown that tooth ratios do not reflect sexual dimorphism that may exist in absolute tooth measurements such as MD and buccolingual dimensions.[22]

However, in our study absolute measurements yielded minor variations but we could not

obtain statistically significant difference either. Mean values of mesio-distal dimensions of mandibular canine measurements for males was 7.18 mm and for females it was 6.95mm. Similarly predictive value for sexual dimorphism was low. Even the intercanine distance in our study showed only mild difference in the mean values between males and females as depicted inTable-1.

The probable reason for low accuracy could be evolutionary change, genetic factors and ethnic background.

Our study conclusively refutes applicability of MCI in determination of sex among Indian population and hence use of mandibular canines should be discarded in forensic investigations.

References

1. Scheuer L. Application of osteology to forensic medicine. Clin Anat 2002;15(4):297-312.
2. Subrhamanyan BV (Ed). Modi's Medical Jurisprudence and Toxicology. New Delhi, India. Butterworths; 2001.Pg 250
3. Sweet D. Why a dentist for identification? Dent Clin North Am. 2001;45(2):237-51.
4. Sogannaes RF. Forensic Stomatology. New England J Med 1997;296(2):79-85.
5. Lund H, Mörnstad H. Gender determination by odontometrics in a Swedish population. J Forensic Odontostomatol. 1999; 17(2):30-4.
6. Luo YC. Sex determination from the pubis by discriminant function analysis. Forensic Sci Int 1995;74:89-98.
7. Williams BA, Rogers TL. Evaluating the accuracy and precision of cranial morphological traits for sex determination. J Forensic Sci 2006;51(4):729-35.
8. Schwartz TR, Schwartz EA, Mieszerski L, McNally L, Kobilinsky L. Characterization of deoxyribonucleic acid (DNA) obtained from teeth subjected to various environmental conditions. J Forensic Sci. 1991;36(4):979-90.
9. Yuen KK, So LL, Tang EL. Mesiodistal crown diameters of the primary and permanent teeth in southern Chinese. A longitudinal study.Eur J Orthod.1997;19(6):721-31.
10. Anderson DL, Thompson GW. Interrelationships and sex differences of dental and skeletal measurements. J Dent Res.1973;52(3):431-8.
11. Lysell L, Myrberg N. Mesiodistal tooth size in the deciduous and permanent dentition. Eur J Orthod. 1982;4(2):113-22.
12. Lavelle CL. Maxillary and mandibular tooth size in different racial groups and in different occlusal categories. Am J Orthod.1972;61(1):29-37.
13. Barrett MJ. Dental Observations on Aborigines. Mesiodistal Crown Diameter of Permanent Teeth. Aus Dent J 1963;8:150-5.
14. Sherufudhin H, Abdullah MA, Khan N. A cross-sectional study of canine dimorphism in establishing sex identity: comparison of two statistical methods.J Oral Rehabil.1996;23(9):627-31.
15. Acharya AB, Angadi PV, Prabhu S, Nagnur S. Validity of the mandibular canine index (MCI) in sex prediction: Reassessment in an Indian sample. Forensic Sci Int. 2011;204(1):e1-4
16. Rao NG, Rao NN, Pai MP, Kotian MS. Mandibular canine Index- a clue for

establishing sex identity. Forensic Sci Int. 1989;42(3):249-54.

17. DeVito C, Saunders SR. A discriminant function analysis of deciduous teeth to determine sex. J Forensic Sci. 1990;35(4):845-58.

18. Bishara SE, Garcia AF, Jakobsen JR, Fahl JA. Mesiodistal crown dimensions in Mexico and the United States. Angle Orthod 1986;56(4):315-23.

19. Yadav S, Nagabushan D, Rao BB, Mamatha GP. Mandibular canine index in establishing sex identity. Indian J Dent Res. 2002;13(3-4):143-6.

20. Reddy VM, Saxena S, Bans P. Mandibular canine index as a sex determinant: a study on the population of western Uttar Pradesh. J Oral Maxillofac Pathol. 2008;12(2):56-59.

21. Muller M, Lupipegurier L, Quatrehomme G, Bolla M. Odontometrical method in determining gender and dental alignment. Forensic Sci Int. 2001;121(3):194-7.

22. Acharya AB, Mainali S. Are dental indexes useful in sex identification? J Forensic Odontostomatol. 2008;26(2):53-9.