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Estimation of sex using mandibular canine index in a young Nepalese population

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Abstract

Objectives: Tooth size standards based on odontometric investigations can be used in age and sex determination in forensic investigations and natural disasters such as tsunami, earthquakes etc. where bones are frequently fragmented. In such cases, mandibular canines are found to exhibit the highest degree of sexual dimorphism. This study aimed to assess the usefulness of mandibular canine for sex identification.

Methods: The present study was conducted based on measurements of mandibular canine teeth of 160 students (80 males and 80 females; aged 17–24 years) in Kathmandu University, Dhulikhel, Nepal.

Results: Mandibular canine index for right and left canines was found to be significantly different in males and females. The identification of sex correctly using right mandibular canine index was 53.75% in males and 41.25% in females; and using left mandibular canine index was 61.25% in males and 38.75% in females. The sex can be predicted correctly using a mandibular canine index: being higher in males (57.5%) than females (45.62%). The mean mesiodistal width of the right and left mandibular canines and intercanine distance were significantly greater in males than females. Sexual dimorphism in right mandibular canine was higher (8.29%) than that of the left mandibular canine (6.12%).

Conclusion: Sex can be predicted correctly using mandibular canine index. Right mandibular canine teeth are more sexually dimorphic than left. This may be influenced by gender, heredity, cultural, environmental and racial factors mostly influenced by Y chromosomes.

Keywords: canine; canine teeth; dimorphism; intercanine distance; mandibular canine index

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Introduction

Teeth are the hardest and chemically most stable tissue found in the body with the composition of enamel and dentine, and 11 other elements such as calcium, phosphorus, sodium, magnesium and aluminium in higher concentrations. Due to this, tooth are known to resist postmortem, mechanical and physical stresses, and from chemical destruction. Sexual dimorphism represents a group of morphological characteristics that differentiate males and females such as differences in size, stature and appearance that can be applied to dental identification, because no two mouths are alike.[1–4]

Bossert and Marks[5] stated that the study of the permanent mandibular and maxillary canine teeth offer certain advantages *i.e.* least used in the oral cavity and less affected by periodontal diseases and referred as cornerstone of dental arches with single-pointed cusps. The shape of the crowns with their single-pointed cusps, location in the mouth, strongly developed roots, anchorage in the alveolar process of the jaws makes mandibular canine teeth most stable in mouth and crown portions of the canines are shaped in the manner that promotes self-cleansing quality preserve these teeth throughout life.[3] Tooth size standards based on odontometric studies can be used in age and sex determination and its morphology is influenced by gender, heredity, cultural, environmental and racial factors. This remarkable capability of canine teeth for determining individual sex is based on the influence of the Y chromosomes which do not exhibit uniform influence on all teeth and the thickness of the dentin,

whereas the X chromosomes play a role in the thickness of the enamel and its relative uniformity.[6,7]

In sex determination studies from forensic medicine and mass graves where bones are frequently fragmented, mandibular canines exhibited the highest degree of sexual dimorphism with a mean age of eruption of 10.87 years and last teeth extracted with age.[8] Gender determination of skeletal remains is part of archaeological and many medicolegal examinations, but bones belonging to one single person cannot be found during exhumations of bodies from mass graves. This makes teeth and the skulls the only real material for identification, but the accurate result is only obtained from DNA technique.[9,10] Therefore, mandibular canine index (MCI) was employed in numerous studies on large populations, because it is simple, reliable, inexpensive and easy to perform; and the canine teeth were considered as key teeth for the personal identification.[8] As no such study has been performed in Nepal yet, the present study attempted to find the correlation between gender and MCI in a young Nepalase population.

Materials and Methods

The present study was conducted in 160 students (80 males and 80 females; min. 17 – max. 24 years of age) from Kathmandu University, Dhulikhel, Nepal and approved by Kathmandu University School of Medicine Institutional Review Committee (approval number: 16/14). Right and left mandibular canine mesiodistal width and mandibular intercanine distance were measured using a digital vernier calliper by the same person in a clean and well-illuminated room under aseptic precautions (**Figures 1** and **2**). Individuals with healthy gingiva and periodontium, caries-free teeth, normal overjet and overbite and absence of spacing in the anterior teeth were included in the study. Individuals with any pathological condition of canines, broken canines or any malformed canines were excluded. The data were analyzed using the Statistical Package for Social Sciences (SPSS for Windows, version 16.0, Chicago, IL, USA).

The observed and standard MCI were calculated using the following formula adapted from Kaushal et al.:[4,11]

$$\text{Observed MCI} = \frac{\text{Mesiodistal crown width of mandibular canine (mm)}}{\text{Intercanine distance (mm)}}$$

$$\text{Observed MCI} = \frac{\text{(mean male MCI - SD) + (mean female MCI + SD)}}{2}$$

If the observed MCI for the individual was higher than the standard MCI, the individual was considered to be male, and if lower or equal to standard MCI as female.

Sexual dimorphism represents a group of morphological characteristics that differentiate male and females such as differences in size, stature and appearance and calculated with the following formula adapted from Ibeachu et al.[12]

$$\text{Sexual dimorphism} = \left[\frac{X_m}{X_f} - 1\right] \times 100$$ (Xm=mean mesiodistal canine width in male; X_f=mean mesiodistal canine width in female)

Results

Mesiodistal width of right and left mandibular canine teeth, intercanine distance and right and left MCI are shown in **Table 1**. The value of the standard MCI for the right and left sides was 0.24. The observed right and

Table 1

The result of mesiodistal width of right and left mandibular canine teeth, intercanine distance, right and left MCI.*

Parameters	Sex	Range (mm)	Mean±SD (mm)	Variance	p-value
Mesiodistal width of RMC	Male	5.71–7.83	6.63±0.41	0.17	0
	Female	5.18–7.30	6.12±0.5	0.25	
Mesiodistal width of LMC	Male	5.09–7.24	6.52±0.4	0.16	0
	Female	4.19–7.40	6.14±0.61	0.38	
Intercanine distance	Male	24.04–33.66	27.76±2.07	4.30	0
	Female	21.57–31.66	25.15±1.98	3.92	
RMCI	Male	0.19–0.29	0.23±0.012	0.00041	0.17
	Female	0.17–0.30	0.24±0.02	0.00048	
LMCI	Male	0.15–0.26	0.23±0.02	0.00049	0.02
	Female	0.17–0.31	0.24±0.02	0.00071	

LMC: left mandibular canine; **LMCI:** Left mandibular canine index; **RMC:** right mandibular canine; **RMCI:** right mandibular canine index. *p>0.05.

left MCI in 160 students was calculated and categorized as above the standard MCI and equal and less than standard MCI. According to Kaushal et al.,[4] if the observed MCI for the individual is higher than the standard MCI, then the individual is predicted to be male and if lower or equal to standard MCI female. The frequency of standard and observed MCIs are shown in **Table 2**. MCI for right and left canines were found to be significantly different for males and females. The percentage of cases correctly identified using right MCI was 53.75% in males and 41.25% in females. This value is 61.25 % in males and 50% in females for the left MCI (**Table 3**). Thus, sex can be predicted correctly 57.5% higher in males compared to 45.62% in females using MCI.

The mean mesiodistal width of right and left mandibular canines teeth were found to be highly significant in male and female. The mean mesiodistal right mandibular canine (RMC) width for males 6.63 (range: 5.71–7.83) mm was higher than that of females 6.12 (range: 5.18–7.3) mm. The mean RMC mesiodistal width of males as 6.63 (range: 5.71–7.83) mm was higher than mean left mandibular canine mesiodistal width (LMC) in males as 6.52 (range: 5.09–7.24) mm. The mean LMC mesiodistal width in males as 6.12 mm was found to be nearly equal or greater than mean mesiodistal width of RMC in females as 6.14 (range: 5.18–7.3) mm. The mean intercanine distance (ICD) was 27.76 (range: 24.04–33.66) mm in males which is higher than the females 25.15 (range: 21.57–31.66) mm (**Table 1**).

Sexual dimorphism was calculated for the right mandibular canine as 8.29%, more dimorphic than the left mandibular canine (6.12%).

Table 2
Standard MCI and observed RMCI and LMCI values for males and females.

Parameters	Standard MCI	RMCI	LMCI
Male	>0.24	43	49
	≤0.24	37	31
Female	>0.24	47	40
	≤0.24	33	40

LMCI: Left mandibular canine index; **RMCI:** Right mandibular canine index.

Table 3
Percentage of sex correctly predicted using standard MCI value.

Sex	Parameter	Number	%	Correctly predicted sex (%)
Male	RMCI	43	53.75%	
	LMCI	49	61.25%	57.50%
Female	RMCI	33	41.25%	
	LMCI	30	50%	45.62%

LMCI: Left mandibular canine index; **RMCI:** Right mandibular canine index.

Discussion

The present study reports the estimation of sex using MCI in a young Nepalese population. The sex could be predicted correctly higher in males (57.5%) then females (45.62%) using MCI which was approximately similar to the results of the Al-Rifaiya et al.[13] (55.07%). However, studies of Yadav et al[14] (72%) and Rao et al.[15] (male=

Figure 1. Measurement of mesiodistal width of mandibular canine.

Figure 2. Measurement of mandibular intercanine distance.

84.3%; female=85.7%) in a Southern Indian population, Reddy et al.[9] (82%) in a Northern Indian population had comparatively higher sex prediction rates than that of the present study. These differences are attributable to the regional differences in the tooth size. Similarly, the percentage of females correctly predicted in studies by Rao et al.,[15] Ahmed,[16] Hosmani's et al.[17] was higher than the present study. For studies conducted for male sex prediction by Ahmed[16] in an Iraqi population, Acharya's et al.[18] and Hosmani's et al.[17] in an Indian population were lower than the present study (57.50%). The possible reason for low accuracy can be assumed as evolutionary change, genetic factors and ethnic background.

The study also showed that value of RMC was significantly different between males and females. This is similar to the findings of Ahmed,[16] Muhamedagic and Sarajlic,[10] Grover et al.,[6] and Ibeucu's et al.[12] However, the results of the present study for mean mesiodistal of RMC and LMC for males and females was lower than those by Ayoub et al.,[19] Vishwakarma and Guha[8] and Khan et al.[7] There are few differences in mesiodistal width of mandibular canine, which may be probably accounted for the racial variations in tooth size, as studies have been conducted in different populations and different countries. Therefore, evaluation and comparison of present data with the previous studies revealed several differences as well as similarities.

Mean ICD was higher in males in the present study, which is highly significant and in accordance with the findings of Ahmed,[16] Ayoub et al.,[19] Bakkannavar et al.,[5] Muller et al.,[20] and Kaushal et al.[4] and in controversy with the findings of Vishwakarma and Guha.[8] The mean ICD for males in the present study was 27.76±2.08 mm, which is approximately equal to the findings of Ayoub et al.[19] (27.62 mm) and Sherufudin et al.[21] (27.36 mm). The mean ICD distance was 25.16±1.98 mm in females, approximately equal to the findings of Muller's[20] (25.03 mm) and Kaushal's study[11] (25.07 mm).

This study also showed that the sexual dimorphism was more in right mandibular canine teeth (8.29%) than the left (6.12%). This finding supports the results of earlier studies by Vishwakarma and Guha[8] and Srivastava.[22] The value of sexual dimorphism for RMC (8.26%) was approximately equal to the findings of Reddy et al.[9] (8.78%), Kaushal et al.[4] (7.95%), Grover et al.[6] (RMC=9.43%), and Ayoub et al.[19] (RMC=9.7%). The controversial findings of the present study may be attributed to racial, environmental and nutritional factors of the study population.

Conclusion

Tooth size standards based on odontometric investigations can be used in age and sex determination and is known to be influenced by gender, heredity, cultural, environmental and racial factor mostly influenced by Y chromosomes. Y chromosomes control the thickness of the dentin but do not exhibit a uniform influence on all teeth, whereas X chromosomes play a role in the thickness of enamel and its relative uniformity. In this study, we have found the mean mesiodistal width of RMC, LMC, and intercanine distance higher in males, and concluded that sex can be predicted correctly 57.50% higher in males compared to 45.62% in females, and the MCI of right mandibular canine teeth was more sexually dimorphic than that of the left side.

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