

Comparative Study of Mandibular Canine Index and Maxillary Canine Index in Sex Estimation among North Indian Population

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How to cite this article: Mohammad Abdurrahman Khan, Manisha Verma, Sangeeta Kumari et. al. Comparative Study of Mandibular Canine Index and Maxillary Canine Index in Sex Estimation among North Indian Population. Indian Journal of Forensic Medicine and Toxicology/Volume 18 No. 1, January-March 2024.

Abstract

Introduction: Since teeth are easily approachable and each having different morphology, they form an excellent medicolegal and anthropological tool for sex estimation. Sexual dimorphism is difference in size and appearance among male and female teeth that can be applied for determination of sex. The basis of estimation of sex is comparing tooth parameters in male and female individual. Canine teeth shows highest sexual dimorphism among all teeth. Mesiodistal width of maxillary and mandibular canine can be used for sex determination based on sexual dimorphism.

Aim: The aim of our study was to evaluate the comparative sex estimation by mandibular canine index and maxillary canine index in north Indian population.

Materials and Methods: The sample comprised of dental impression from 120 individuals (60 males and 60 females), all young adults between 20 and 35 years of age. Impressions of the teeth were made using irreversible hydrocolloid (alginate) material and casts poured in dental stone. Mesiodistal dimensions and intercanine distance of mandibular and maxillary canine of both right and left side was measured by caliper. Mandibular and maxillary canine index was calculated by formula given by Nageshwar Rao et al.

Results: Data were summarized as Mean and SD. Groups (in Gender Male vs female) were compared by unpaired or independent Student's t test. When the level of accuracy for sex determination was measured using canine index it was found that 65% males and 65.83% females were predicted correctly. When maxillary canine index was used the sex was correctly predicted in it was found that 40.83% females and 32.50% males were predicted correctly.

Conclusion: Mandibular and maxillary canine index can be used for sex estimation in North Indian population but accuracy of mandibular canine index is better than maxillary canine index.

Keywords: Sex estimation, Sexual dimorphism, Mesiodistal width, Intercanine distance, Mandibular canine index, Maxillary canine index, Accuracy, Predictability.

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Submission Date: Aug 18, 2023

Revision Date: Sep 11, 2023

Publication date: Jan 19, 2024

Introduction

Being superior and matchless material, teeth are used as investigating material in genetics, odontology, anthropology and in forensic medicine¹. Teeth are hardest and most stable part of body, decay resistance and are buoyant in case of fire, air disaster, hurricane². Hence teeth may be used for identification of an individual in decomposed bodies especially on skeletal remains³. Sex estimation from skeletal remains or mutilated or decompose bodies is an inevitable part of medicolegal examination⁴. Sex determination has various methods like cheiloscopy^{5,6,7}, odontometry⁸, osteometry⁹ and DNA analysis¹⁰. Among these methods only DNA analysis gives absolute proof of sex estimation, but analysis of DNA is extensive, expensive and exhaustive involves difficult DNA extraction technique and requires trained and qualified staff^{11,12}. Since teeth are easily approachable and each having different morphology, they form an excellent medicolegal and anthropological tool for sex estimation³. Sexual dimorphism is difference in size, stature and appearance among male and female that can be applied for determination of sex¹³. The basis of estimation of sex is comparing tooth parameters in male and female individual. Canine teeth shows highest sexual dimorphism among all teeth¹⁴. Mesiodistal width of maxillary and mandibular canine can be used for sex determination based on sexual dimorphism¹⁵. The aim of our study was to evaluate the comparative sex estimation by mandibular canine index and maxillary canine index in north Indian population.

Material and Methods

Material required

1. Alginate
2. Dental stone
3. Maxillary Impression Trays
4. Mandibular Impression Trays
5. Rubber Bowl
6. Spatula

The alginate dental impression forms an imprint (i.e., a 'negative' mould) of those teeth and gums, which can then be used to make a cast or 'positive' model of the patient's dentition (Figure 1).

Sample size

Sample selection:

sample size was calculated by formula

$$N = Z_{\alpha}^2 p(1-p) / E^2$$

Where Z_{α} is critical value of z-score at α level of significance (at $\alpha = 5\%$, $Z_{\alpha} = 1.96$), p is proportion and E is permissible error. 65% of cases were correctly estimated for their sex (overall 57.5% by maxillary canine index and 72.5% by mandibular canine index. So average 65% of sex were correctly predicted using both mandibular and maxillary canine index)¹⁶ So, $p = 65\%$, i.e., 0.65, $1-p = 0.35$, $E = 8.5\%$ i.e., 0.085. So, $n = (1.96)^2 \times 0.65 \times 0.35 / (0.085)^2 = 119.38 \approx 120$.

The present study is cross sectional study conducted during the period of one year from January 2022 to December 2022. Study was conducted on 120 volunteer subject (60 male and 60 female) of both the sex having age group between 20 to 35 years at Hind Institute of Medical Sciences, Barabanki. Informed consent was taken from all participants.

Inclusion Criteria:

1. Age between 20 to 35 years.
2. Fully erupted with complete set of teeth.
3. No history of orthodontic treatment or any type of prosthesis.
4. Non traumatic, non attrited, non-carious, non-hypoplastic and periodontally healthy teeth.

Exclusion Criteria:

1. Age below 20 years and above 35 years.
2. Diastema, crowded teeth, spacing teeth or misaligned.
3. Carious teeth fractured teeth, attrited teeth, hypoplastic teeth, restored teeth, teeth with prosthesis, mobile teeth.

Methodology and tooth measurements

Impressions of the teeth were taken using irreversible hydrocolloid (alginate) material and poured by dental stone (Figure 1). The alginate dental impression forms an imprint (i.e., a 'negative' mould) of those teeth and gums, which can then be used to make a cast or 'positive' model of the patient's dentition. Mesiodistal (MD) dimensions

of mandibular canine and maxillary canine of both right and left side, were measured on the casts using a digital caliper calibrated to 0.01 mm. The MD dimension was defined as the greatest distance between contact points on the approximate surfaces of the tooth crown and was measured with the caliper beaks placed occlusally and aligned with the long axis of the tooth (Figure 2&3). If teeth were rotated or misaligned, measurements were taken between points on the approximate surfaces of the crown where it was considered that contact with adjacent teeth would normally occur. The mandibular intercanine distance is measured by calliper as linear distance between tips of both side mandibular canine (Figure4). The maxillary intercanine distance is measured by calliper as linear distance between tips of both side maxillary canine (Figure 5).Mandibular canine index and maxillary canine index are calculated by following formula¹⁷.

Mandibular Canine index (MnCI) = $\frac{\text{Mesiodistal crown width of mandibular canine}}{\text{Mandibular canine arch width}}$

Maxillary Canine index (MxCI) = $\frac{\text{Mesiodistal crown width of maxillary canine}}{\text{Maxillary canine arch width}}$

The mean values for both male MnCI & MxCI and female MnCI & MxCI were obtained. After that, the standard MnCI and MxCI value were calculated by using given below formula¹⁸: -

Standard mandibular canine index (MnCI)

= (mean male MnCI - standard deviation [SD]) + (mean female MnCI + SD)/2.

Standard maxillary canine index (MxCI)

= (mean male MxCI - standard deviation [SD]) + (mean female MxCI + SD)/2.

In this study gender determination was based on observed canine index and standard canine index. We used standard canine index value as cut off value to differentiate the gender. All observed canine index value above the standard canine index values were consider as male and all observed canine index value below or up to standard canine index value were consider as female. Sexual dimorphism calculated by following formula¹⁹.

Sexual Dimorphism in percentage (%) = $[(Xm/Xf)-1] \times 100$, where Xm is the mean value for males and Xf is the mean value for females.



Figure 1. Dental cast



Figure 2: Measuring of mesiodistal dimension of mandibular canine by the digital caliper



Figure 3: Measurement of mandibular intercanine distance by digital caliper



Figure 4: Measurement of mesiodistal dimension of maxillary canine by caliper



Figure 5: Measurement of maxillary intercanine distance by digital caliper

Results

Data obtained were quantified and analysed statistically using SPSS (Statistical Package for the Social Sciences). All description shown in table 1 to 8. Data were summarized as Mean and SD. Groups (in Gender Male vs female) were compared by unpaired or independent Student’s t test.

The value of right mandibular canine index was higher in male (mean .251308±.024137) than female (mean .232384±.02378) and was statistically significant (p value <.0001). Left mandibular

Table 1. Observed mandibular canine index among male and female

Sex	Right mandibular canine index (MnCI)			Left mandibular canine index (MnCI)		
	Mean	Standard deviation	p Value	Mean	Standard deviation	P Value
Male	.251308	.024137	<0.0001	.251376	.025765	< 0.001
Female	.232384	.02378		.233512	.026935	

canine index (Table 1) was also higher in male (mean .251376±.025765) than female(.233512±.026935) and was statistically significant (p value <.001)

(Table 1). Whereas right and left maxillary canine index was higher in female (Mean value of right MxCI .212502±.021346 and

Table 2. Observed maxillary canine index among male and female

Sex	Right maxillary canine index (MxCI)			Left maxillary canine index (MxCI)		
	Mean	Standard deviation	p Value	Mean	Standard deviation	P Value
Male	.203411	.017982	.0130	.205253	.018689	0.0177
Female	.212502	.021346		.214612	0.02363	

for left MxCI .214612±.02363) than male (for right MxCI .203411±.017982 for left MxCI .205253±.018689) and were statistically significant (p value <.05 in both right and left MxCI) (Table 2). Using right standard MnCI (Table 3) sex was correctly predicted in 65% male and 65% female while using left standard MnCI the sex was correctly predicted in 65% male and 66.66% in female (Table 5). Similarly using right standard MxCI (Table 4) sex was correctly predicted in

Table 3. Calculation of standard mandibular canine index among male and female

Standard mandibular canine index (MnCI)	
Right	Left
.2416475	.243029

Table 4. Calculation of standard maxillary canine index among male and female

Standard maxillary canine index (MxCI)	
Right	Left
.2096385	.212403

Table 5. Prediction of sex using Mandibular Canine Index

Sex	Using right MnCI	Using left MnCI
Male	39/60=65%	39/60=65%
Female	39/60=65%	37/60=66.66%

Table 6. Prediction of sex using Maxillary Canine Index

Sex	Using right MxCI	Using left MxCI
Male	21/60=33.33%	19/60=31.66%
Female	24/60=40%	25/60=41.66%

33.33% male and 40% female while using left standard MxCI (Table 4) the sex was correctly predicted in 31.66% male and 41.66% in female (Table 6). The overall sex prediction using mandibular canine index was 65% for male and 65.83% for female (Table 7, Figure 6&8) whereas the overall sex prediction using maxillary canine index was 32.50% for male and 40.83% for female (Table 8, figure 7&8).

Table 7. Overall accuracy of sex prediction using mandibular canine index

Sex	Mandibular canine index (MnCI)	% Of sex prediction	Overall, correctly predicted sex (%)
Male	Right MnCI	65%	65%
	Left MnCI	65%	
Female	Right MnCI	65%	65.83%
	Left MnCI	66.66%	

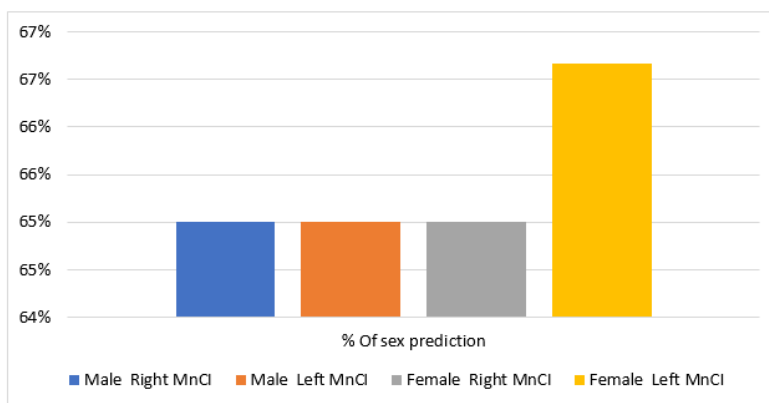


Figure 6. Showing % of sex prediction using right and left mandibular canine index

Table 8. Overall accuracy of sex prediction using maxillary canine index

Sex	Maxillary canine index (MxCI)	% Of sex prediction	Overall, correctly predicted sex (%)
Male	Right MxCI	33.33%	32.50%
	Left MxCI	31.66%	
Female	Right MxCI	40%	40.83%
	Left MxCI	41.66%	

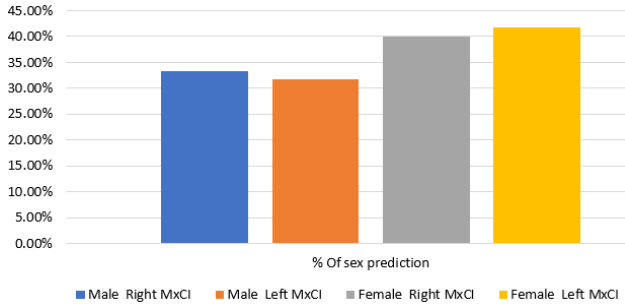


Figure 7. Showing % of sex prediction using right and left maxillary canine index

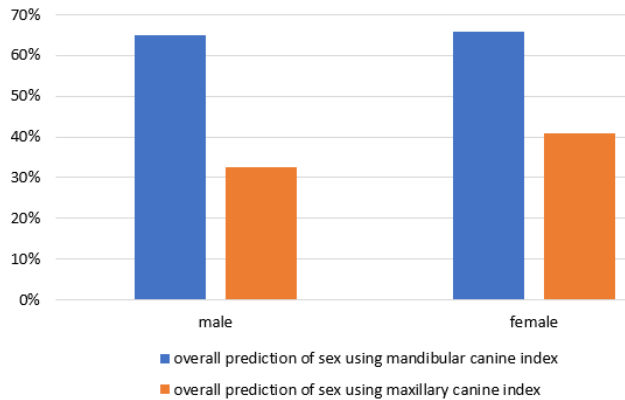


Figure 8. Showing overall sex prediction using mandibular and maxillary canine index

Discussion

Estimation of sex, age and race of an individual even in mutilated or decompose bodies from teeth is an importance forensic aspect²⁰. Sexual dimorphism is difference in physical appearance among male and female that is applicable in dental sex estimation¹³. Sexual dimorphism not only provide information about individual but also about evolution of population²⁰. In the present study using right mandibular canine index sex was correctly predicted in 65% male and 65% female with overall accuracy was 65% while using left mandibular canine index the sex was correctly predicted in 65% male and 66.66% in female with overall accuracy was 65.83%.

Our study was comparable to the study done by Yuvenya Kaeswaren and Anita Zara Weinheimer in Malaysian population who found correct prediction of sex using right mandibular canine index was 67% in male and 71% in female with overall accuracy was 69% while using left mandibular canine index the sex was correctly predicted in 66% male and 64% in female with overall accuracy was 65%²¹. Higher sex prediction was found by Bakkannavar SM et al²² who found correct prediction of sex using right mandibular canine index was 73.2% in males and 75.6% in females with overall accuracy of 74.2% while using left mandibular canine index the sex was correctly predicted in 73.2% in male and 76.8% in female with overall accuracy was 74.8% and Kaushal et al³ in North Indian population who found correct prediction of sex using right mandibular canine index was 70% in males and 80% in females with overall accuracy of 75% while using left mandibular canine index the sex was correctly predicted in 66.67% in male and 83.33% in female with overall accuracy was 75%³. Lower accuracy of sex prediction was observed by Mohsenpour, K et al who found correct prediction of sex using right mandibular canine index was 44% in males and 62% in females with overall accuracy of 53% while using left mandibular canine index accuracy was 54% for males and 64% for females with overall accuracy of 59%²³. In our study the overall accuracy for prediction of sex using mandibular canine index (average of sex prediction using right and left mandibular canine index) was 65.42% (65% + 65.83%/2=65.42) which is similar with study done by Yuvenya Kaeswaren and Anita Zara Weinheimer in Malaysian population with overall accuracy using mandibular canine index was 67%²¹. Higher overall sex prediction using mandibular canine index was observed by Mohsenpour, K et al²³, 75% by Kaushal et al³ in North Indian populations, 85.9% by Rao NG et al¹⁷ in south Indian population, 82.2% by Yadav et al²⁴ in central Karnataka. Overall lower sex predictability

than our study using mandibular canine index was observed by Mohsenpour, K et al²³ who found 56% sex predictability and Muller et al who found 59.57% in French population²⁵.

In the present study using right maxillary canine index sex was correctly predicted in 33.33% male and 40% female (lower in male than female) with overall accuracy was 36.66% while using left maxillary canine index the sex was correctly predicted in 31.66% male and 41.66% (lower in male than female) in female with overall accuracy of prediction of sex using maxillary canine index (average of sex prediction using right and left maxillary canine index) was 36.66% ($(31.66\%+41.66\%)/2=36.66$) whereas, Bakkannavar SM et al observed higher accuracy of sex prediction using right maxillary canine index in male (63%) than female (33.6%) with overall accuracy 48.4% while using left maxillary canine index the sex was correctly predicted in 64% male and 33.6% in female with overall accuracy was 36.66%²² which is similar with our study in sense of overall accuracy of sex prediction using maxillary canine index, whereas it was observed 58% by Yuvenya Kaeswaren and Anita Zara Weinheimer in Malaysian population²¹. In our study statistically significant sexual dimorphism was observed by maxillary canine index in male and female whereas Bakkannavaret al²² who observed no statistical significance of sexual dimorphism in Maxillary canine index values between male and female.

Conclusions

Present study reveals that mandibular canine index of both right and left side was higher in male than female and was statistically significant whereas maxillary canine index of both right and left side was lower in male than female. When the level of accuracy for sex determination was measured using canine index it was found that 65% males and 65.83% females were predicted correctly. When maxillary canine index was used the sex was correctly predicted in it was found that 40.83% females and 32.50% males were predicted correctly. So, from present study it can be concluded that mandibular canine index is better than maxillary canine index for correctly predicting the sex.

Conflict of Interest: Nil

Source of Funding: Nil

Ethical Clearence: Has been taken from the institutional ethical committee.

Abbreviations: MD: Mesiodistal dimension, MnCI: Mandibular canine index, MxCI: Maxillary canine index, SD: Standard deviation.

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