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Utility Of Mandibular Canine Index In Human Identification : A Forensic Study In Navi Mumbai

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ABSTRACT

Objective:
To establish the effectiveness of the mandibular canine index (MCI) in predicting sex in the Navi Mumbai population.
Materials and Methods:
A total of 200 subjects (100 males and 100 females), aged 17–25 years and residing in Navi Mumbai, were included in the study. Alginate impressions were taken, and study models were prepared using dental stone. The maximum mesiodistal width of mandibular canines and the intercanine distance (linear distance between the cusp tips of mandibular canines) were measured using a Vernier caliper. The observed mandibular canine index (MCI_o) was calculated as the ratio of the maximum mesiodistal width of the mandibular canine to the intercanine arch width.
Results:
The left mandibular canine exhibited greater sexual dimorphism (9.05%) compared to the right (8.78%). Sex could be accurately predicted in approximately 70% of the subjects.
Conclusion:
Using the standard MCI, sex determination was possible in about 72% of the studied Navi Mumbai population. Therefore, MCI serves as a simple, rapid, and reproducible method for gender determination, especially useful in forensic and anthropological contexts.

Keywords: Mandibular canine, mesiodistal width, Navi Mumbai, sexual dimorphism, forensic odontology

Introduction :

Sex determination from human skeletal remains plays a crucial role in both archaeological investigations and medico-legal contexts. While DNA analysis remains the gold standard for accurate sex identification, it is not always feasible due to degradation of biological material, cost constraints, or limited resources. In such instances, anthropometric methods—based on comparative measurements of skeletal structures—serve as valuable tools to estimate sex with reasonable accuracy.
Among skeletal structures, the dentition—especially mandibular canines—has been shown to exhibit notable sexual dimorphism. Odontometric parameters can be particularly useful when jaws and teeth are available, as teeth are often well-preserved due to their resistance to postmortem degradation, environmental influences, and physical trauma. Mandibular canines, in particular, are known to show the highest degree of sexual dimorphism among all teeth. These teeth are typically less affected by periodontal disease, wear, or occlusal forces compared to other teeth, and they often remain intact well into old age. Consequently, mandibular canines are frequently referred to as the "key teeth" for personal identification.
One widely accepted method for evaluating sexual dimorphism using mandibular canines is the "Mandibular Canine Index (MCI)". This index is calculated using the ratio of the mesiodistal crown width of the mandibular canine to the intercanine distance. Studies have demonstrated that this simple, cost-effective, and reproducible method can predict sex with high accuracy, ranging from approximately 81% to 87% in different populations.

Numerous studies across India have validated the utility of MCI in sex determination. However, geographic and ethnic variations can influence odontometric dimensions. Therefore, population-specific data is essential to improve accuracy and applicability.
The present study aims to evaluate the reliability and accuracy of the mandibular canine index for sex determination in the population of Navi Mumbai, and to compare the findings with those reported in other regional studies.

Materials and Methods

The study was conducted on a total of 200 participants, comprising 100 males and 100 females, all permanent residents of Navi Mumbai, aged between 17 and 25 years. Ethical approval was obtained from the institutional ethics committee prior to the commencement of the study, and informed consent was collected from all participants.
Inclusion Criteria
Participants were selected based on the following criteria to ensure measurement accuracy and standardization:
* Clinically healthy gingiva and periodontium
* Presence of caries-free permanent mandibular canines
* Normal occlusal relationships, with overjet and overbite ranging between 2–3 mm
* Absence of spacing in the anterior mandibular region
* Bilateral Angle's Class I molar and canine relationships
Procedure
Maxillary and mandibular impressions were obtained using irreversible hydrocolloid (alginate) impression material. The impressions were poured using Type III dental stone (gypsum product) to obtain accurate and durable study models.
Only the mandibular casts were selected for morphometric analysis. On each mandibular model, the following parameters were measured using a digital Vernier caliper (precision: 0.01 mm):
1. Mesiodistal crown width of the right and left permanent mandibular canines, measured at the widest mesiodistal dimension between the contact points.
2. Intercanine distance, defined as the linear distance between the cusp tips of the right and left mandibular canines.
Each measurement was performed twice by a single calibrated examiner at an interval of one week to minimize intra-observer error. The mean of the two readings was considered for final analysis.
The Observed Mandibular Canine Index (MCI_o)for each subject was calculated using the formula:

MCI_o = Mesiodistal width of mandibular canine / Intercanine distance
Statistical analysis was carried out to assess sexual dimorphism and to evaluate the predictive reliability of MCI in determining sex within the Navi Mumbai population using unpaired t-test. Intra-observer error was evaluated using a paired Student's t-test on 50 randomly selected casts.
The standard mandibular canine index (MCI_S), used as a cut-off value to differentiate males from females, was determined from the sample measurements using the formula:
MCI_S = Mean male MCI - SD + Mean female MCI + SD / 2
The observed MCI values were compared with the standard MCI derived in this study and correlated with findings from previous studies by Rao et al. and Muller et al.[5,7].

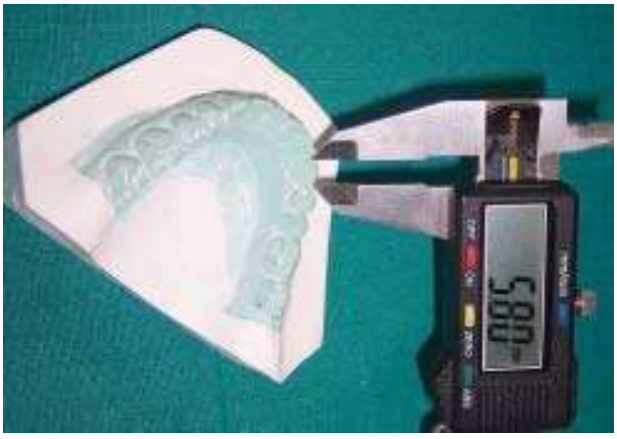

Figure 1: Measurement of Mandibular Canine Width using Vernier Calipers

Figure 2: Measurement of Mandibular Inter-Canine Width using Vernier Calipers

RESULTS

The results are presented in Tables 1. Table 1 demonstrates that the measured parameters—inter-canine distance, mandibular canine width, and the mandibular canine index (MCI)—show statistically significant differences between males and females. No statistically significant difference was observed between the right and left mandibular canines within either sex; therefore, the maximum crown width was used for further comparisons. Between males and females, however, the differences were highly statistically significant.

The intra-observer error, assessed at the $p < 0.05$ level, revealed no statistically significant differences. The standard MCI for both sexes was calculated as 0.256. Based on these calculations, the overall accuracy of sex prediction in this study was 72.5%.

When comparing the observed MCI (MCI_o) from this study with the standard MCI values reported by Rao et al. (0.274) and Muller et al. (0.269), the predictive accuracy was lower—averaging 35% and 52%, respectively.

Parameter	Sex	Mean ± SD	Co-efficient of Variation(%)	t-stat	p-value	Significance
Inter-Canine Distance(mm)	Male	26.860 ± 1.48	5.53	5.580	$p < 0.01$	Highly significant
	Female	26.287 ± 1.45	5.49			
Right canine width (mm)	Male	7.017 ± 0.43	6.18	4.618	$p < 0.01$	Highly significant
	Female	6.428 ± 0.35	5.38			
Left canine width (mm)	Male	7.030 ± 0.44	6.34	4.428	$p< 0.01$	Highly significant
	Female	6.446 ± 0.34	5.27			
Right mandibular canine index	Male	0.259 ± 0.003	3.86	3.009	$p< 0.01$	Highly significant
	Female	0.246 ± 0.002	4.07			
Left mandibular canine index	Male	0.261 ± 0.003	3.83	4.782	$p< 0.01$	Highly significant
	Female	0.247 ± 0.002	4.05			

Table 1 : Difference between various parameters in Males and Females

|DISCUSSION

Canines differ from other teeth in both survival rate and sexual dimorphism, traits likely linked to their unique functional role during human evolution. In modern humans, mandibular canines display the greatest sex-related differences in size, prominence, and eruption timing. While sexual dimorphism and enhanced survival of canines may not be directly related, both may stem from their evolutionary role as functional weapons essential for survival.

Canine separation is influenced by the widths of both incisors and canines, with significant correlations observed between canine separation and canine width in both sexes. The present study confirms the existence of statistically significant sexual dimorphism in mandibular canines, in agreement with findings by Hashim and Murshid, who reported significant sex differences only in canines, and by Lew and Keng in an ethnic Chinese population with normal occlusion.

The greater size of male teeth compared to female teeth is generally attributed to genetic factors. The pronounced dimorphism in canines may be linked to evolutionary functions. Eimerl and DeVore proposed that in primate evolution, aggressive functions shifted from canines (in apes) to the hands (in humans), and that until this transition was complete, survival depended heavily on canines—particularly in males.

From a forensic perspective, mandibular canines are valuable in gender determination due to their high survival rate. The Y chromosome predominantly influences tooth size by controlling dentine thickness, whereas the X chromosome has a more uniform effect across all teeth by influencing enamel thickness.

Previous studies using the MCI—calculated as the ratio between maximum crown width and canine arc width—have shown strong predictive potential. For example, Nair et al. reported accuracies of 84.3% for males and 87.5% for females in a South Indian population. Similarly, Muller et al. found statistically significant results in a French student population. In the present study, MCI values differed significantly between sexes, supporting its reliability as a supplementary forensic tool.

In the current analysis, the percentage dimorphism—calculated as the male/female ratio minus 1.00—was higher for the left mandibular canine (9.058%). This aligns with Garn and Lewis (6.47%) and Lysell and Myrberg (5.7%), and is comparable to Nair et al.'s findings of 7.7% for the left and 6.2% for the right mandibular canine.

It is important to note that tooth measurements should be interpreted cautiously when age, race, and sex are unknown. In this study, sex prediction accuracy was approximately 70%, but accuracy can vary with geographic and ethnic background, highlighting the need for population-specific MCI standards.

CONCLUSION

The mandibular canine index is a rapid and reliable method for sex determination when a population-specific standard is available. In this study, MCI demonstrated an overall accuracy of 72.5% for sex prediction. Although skeletal indicators such as the pelvis and skull can achieve accuracies exceeding 95%, MCI remains a valuable supplementary tool in forensic identification—particularly when more definitive anatomical evidence is unavailable.

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