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A substantiate comparative study of the mandibular canine index method of gender assessment using two decedent Maharashtra population

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Introduction: Mandibular Canine Index (MCI), indispensable tools of forensic odontology in gender determination of skeletal remains is a contributing part of anthropological, genetic, odontological, and forensic investigations as well as archaeological and medico-legal examinations. **Aim & Objective**: To compare the differences in odontometrics of mandibular canine between males and females of two different regions in Maharashtra. **Method**: Present study includes 60 individuals (15 male and 15 female subjects belonging to the Kolhapur region and 15 male and 15 female subjects belonging to the Mumbai region) having age group 21 to 28 years. The mesio-distal width of the right and left mandibular canine and intercanine distance were measured. Subsequently, standard MCI, intercanine distance, sexual dimorphism, and percentage accuracy in both regions were calculated. **Result**: Statistically highly significant variation was seen in mesio-distal width of mandibular canine in the left side of the population of both the regions as compared to the right side. Also, variation in intercanine distance was seen in females of both the population. There was no variation seen in MCI of both the population. The standard MCI was 0.24 for Mumbai and 0.25 for the Kolhapur population. **Conclusion**: As region, racial patterns, genetic and epigenetic factors indirectly affect MCI values, this technique can be used as one of the diagnostic adjuvant and reliable methods for gender determination in forensic dentistry.

KEYWORDS

Forensic odontology; Odontometrics; Mandibular canine index

[*]MBP: Conceptualization, Methodology, MAS: Data curation, Writing- Original draft preparation. AS: Visualization, Investigation.

1 | INTRODUCTION

Human identification and sex differentiation, an indispensable step in reconstructive recognition in forensic investigation and a mainstay of civilization, implement craniofacial morphology, tooth dimensions, and DNA analysis as diagnostic and differentiating tools.[1] Human teeth being chemically the most stable tissues of the body with extreme durability even at high temperatures and least turnover of normal structure and resistance to postmortem insults are therefore invaluable for identification on the fragmentary adult skeleton. Since no two teeth have similar morphology and are readily accessible for examination, teeth are an excellent tool for anthropological, genetic, odontological, and forensic investigations.[2]

Sexual variations in humans have been a great concern for both odontologists and anthropologists as correct evaluation of such dimorphisms depends on the available bones and their condition. The sex identification using dental features primarily consists of nonmetric (carabelli's trait of upper molars, deflecting wrinkle of lower first molars, distal accessory ridge of the upper and lower canines or shoveling of the upper central incisor) and metric dental traits (the tooth dimensions, i.e. odontometrics). Literature shows the massive and important role of odontometrics in sexual dimorphism. Various bone structures of the human body show sexual dimorphisms of which mandibular canines are considered to be the key teeth that consistently exhibit greater sex discrimination. As mandibular canines are less prone to plaque, calculus, periodontal problems, brush abrasion, and trauma from occlusion, they play an important role in odontometric investigations display the greatest and most consistent univariate sexual dimorphism reinforcing a plethora of previous study reports.[4]

Although the tooth dimension data provide a preliminary odontometric description of a rarely reported population, it is a composite of diverse ethnic groups. This is explained as the result of complex interactions between a variety of genetic and environmental influences that act to produce different magnitudes of sex dimorphism in diverse populations. Thus, this study was conducted to compare the differences in odontometrics of mandibular canine between males and females of two different regions in Maharashtra (Kolhapur and Mumbai).

2 | METHOD

The present study comprised of 60 individuals (30 males and 30 females) of which 15 were males & 15 were females of Kolhapur region and 15 male & 15 female subjects belong to Mumbai region. All 60 individuals included in the study ranged from 21 to 28 years. The study was conducted in the Department of Oral Medicine and Radiology in Mumbai and private clinic in Kolhapur. Participation in the study was voluntary and followed informed consent. The study was approved by the Institutional Ethics Committee (GDC& H/EC Meet/1088/2018 dated 06.03.2018). It was designed according to the principles manifested in the Declaration of Helsinki and consistent with the guidelines of Good Clinical Practice provided by the International Conference of Harmonization (ICH-GCP).[5]

The inclusion criteria were as follows: 1. A healthy gingival and periodontal tissues 2. Anterior teeth with no caries and/or malocclusion like spacing or crowding 3. Complete eruption of all permanent teeth. 4. Normal overjet and overbite (2-3 mm) 5. Normal molar and canine relationship (Angle's classification). The exclusion criteria were as follows: 1. Any soft and/or hard tissue pathology related to teeth and periodontium 2. Missing, mal-aligned and/or orthodontically treated anterior and/or posterior teeth 3. Any trauma to the canine teeth 4. Age more than 28 years. The subjects with permanent dentition were selected as dimensions of permanent tooth crowns remain stable except when there are functional, pathological, or nutritional disorders that affect the morphology or structure of the teeth. Subjects in the age group of 21-28 years were only included in the study sample as attrition is minimal in this group and also because of complete development of tooth more stability is achieved in this age group.[6]

Sample size calculation was done online using the Open-Epi operating system. To avoid a biased study, every subject was unknown to the investigator and one assistant was recording all the personal history of subjects. Subjects were based on the following inclusion and exclusion criteria. After taking a detailed case history and

informed consent, the following intraoral measurements were taken using a vernier caliper with resolution 0.02 mm as shown in Figure 1, and a double-ended divider to study the odontometric data of mandibular canine.

1.**Mesio-distal width**: The width of the mandibular canine was taken as the greatest mesiodistal width between the contact points of the teeth as shown in Figure 1 (A) on both the side of the jaw (with the divider/caliper). Mesio-distal width of the right and left mandibular canine was calculated. 2. **Inter-Canine distance (ICD)**: It was measured as shown in Figure 1 (B), between the cuspal tips of both the canines in the lower jaw. 3. **MCI** To study the gender prediction of individuals using these two above mentioned measurements mandibular canine index (MCI), both right and left sides were calculated based on the formula used by Rao et al. [6]

MCI = Mesio-distal crown width of canine/Inter-canine distance

4. Based on these values, standard MCI was calculated as follows: Inter-regions statistical analysis was done by one way two way ANOVA test further with post hoc test on excels 2010. The significant difference was checked for following parameters of both the regions: mesio-distal width of males females of right left side, intercanine width of males and females, MCI of males females of right left side.

5.**Sexual dimorphism**: Calculation of sexual dimorphism was done in mesio-distal width of mandibular canine of both right and left side. Sexual dimorphism is nothing but the percentage dimorphism i.e. the percent to which the tooth size of males exceeded that of females and is calculated by using the formula given by Garn et al.[7]

Sexual dimorphism = (Xm/Xf − 1) x

Xm - Mean values of mesio-distal width of mandibular canines in males, Xf - Mean values of mesio-distal width of mandibular canines in females.

3 | STATISTICS

Statistical analysis was done using XLstat software with excel spread sheets on Microsoft excel 2010.

4 | RESULTS

The present study comprised of 60 individuals (15 males and 15 females each) from both the regions of Kolhapur and Mumbai with the inclusion criteria mentioned in the materials and methods. The subjects were between the age group 21-28 years, since the attrition is usually minimal in this age group. The standardized methods were used for the measurement of the mesiodistal width of mandibular canines and intercanine width of mandibular arch. Table 1 depicts the difference in the mesio-distal width of mandibular canines, inter-canine distance, and mandibular canine index between males and females of both regions of Maharashtra. Results were statistically analyzed by using mandibular canine index (MCI), calculated by formula and observed that statistically highly significant variation was seen in mesio-distal width of mandibular canine in the left side of population of both the regions as compared to the right side. Also variation in intercanine distance was seen in females of both the population. There was no variation seen in MCI of both the population. The standard MCI was 0.24 for Mumbai and 0.25 for Kolhapur population. The percentage accuracy of gender identification was around 53 % in males and 73% in females of Kolhapur population while it was 67% in both males and females of Mumbai population. The sexual dimorphism for the right mandibular canine was found to be 9.2% in both populations whereas, for the left it was 10% in Mumbai population and 10.2% in Kolhapur populations. With these calculations, we could predict sex correctly in approximately 71% of the cases in both regions.

5 | DISCUSSION

The study of ancient remains shed a wealth of information pertaining to our vanished civilizations, anthropological information, medico legal examinations, and forensic investigations. Archaeological and anthropologic exhibit primarily include teeth and jaws. Sex determination has immense forensic importance. Kaushal et al in their study on 60 subjects in a North Indian population found a statistically significant dimorphism in mandibular canines with left canine exhibiting greater sexual dimorphism (8.8 %) than the right mandibular canine (7.9 %).[8] Another study by Nair et al on South Indian sub-

TABLE 1 Descriptive statistics of the mesio-distal width, inter-canine distance, and mandibular canine index among male and female.

Gender	Kholapur (n = 15) †	Mumbai (n = 15)†	*P*-value
Mesido-distal canine width			
Right			
Male	6.76±0.48	6.6±0.59	>0.001
Female	5.88±0.14	6.16±0.36	<0.001**
Left			
Male	6.92±0.25	6.51±0.61	< 0.001**
Female	5.84±0.3	6.16±0.36	< 0.001**
Intercanine Distance			
Male	25.74±1.91	25.96±1.83	> 0.001
Female	23.64±2.03	26.3±2.09	< 0.001**
Mandibular canine index			
Right			
Male	0.25±0.02	0.25±0.02	> 0.001
Female	0.24±0.02	0.23±0.01	>0.001
Left			
Male	0.26±0.02	0.24±0.02	< 0.001**
Female	0.24±0.02	0.23±0.01	> 0.001

†, mean and SD; **, Statistically significant

jects concluded that the left mandibular canine with 7.7%, followed by right mandibular canine with 6.2 %, shows the maximum sexual dimorphism.[9] The results of the present study, which was conducted in two different regions of Maharashtra, are consistent with the results of above-mentioned studies, where greater sexual dimorphism was exhibited in the left mandibular canine than in the right mandibular canine. In spite of tooth size variability factors, the studies conducted by Sherfudhin et al.[10] on Saudi Arabian population and by Bishara et al.[11] on the population of Egypt, Mexico, and the United States showed the consistent finding that the mesiodistal width of the mandibular canines is more in males than females, and the difference is statistically significant. Literature shows many studies done using permanent mandibular canine in estimating the sexual dimorphism and have obtained reliable accuracy. Among all these studies, the study carried out by Rao et al.[6] in Karnataka populations is important because they proposed the MCI. They concluded that 84.3% of the males and 85.7% of the females could be discriminated correctly with respect to sex and achieved 72% accuracy in sex estimation in other South Indian populations. Similar study was conducted by Reddy et al.[12] in Uttar Pradesh populations and achieved 72% accuracy in sex estimation. In the present study the percentage accuracy of gender identification was around 53 % in males and 73% in females of Kolhapur population while it was 67% in both males and females of Mumbai population. The standard MCI for both the study population using the formula given by Rao et al.[6] was 0.24 for Mumbai and 0.25 for Kolhapur population. The findings were in accordance with Rao et al.[6], Nair et al.[13], Muller et al. [14] & Yadav et al.[15]. Further comparative discussion of our study was not possible due to lack of such kind of studies. Limitation of the study includes small sample size for two study populations. In addition, habit history and patient's dexterity was not recorded. There is a need of long-term observational intra-state inter-state comparative studies for further confirmation our results. In addition, there is a need of standardization of this technique,

of gender determination so that it can become widely acceptable, non-invasive, reliable tool in forensic odontology.

6 | CONCLUSION

The emerging field of forensic odontology in India primarily depends on economical and easy means of sex identifications. A database may be established of dental morphometric measurements using intraoral periapical radiographs with a view to determine variations among large populations that may be beneficial for anthropological, genetic, legal, and forensic applications. There is a difference between odontometrics of mandibular canine of two different regions because of factors like geographical distribution, genetic and epigenetic factor, racial pattern etc. The left side odontometrics of both the population showed higher degree of variation especially for mesiodistal width of canine. Hence, for such type of comparative study, mesio-distal width of mandibular canine is more reliable factor for gender determination than the MCI and inter-canine distance.

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Nil

Conflict of interest

The authors have no conflicts of interest to declare

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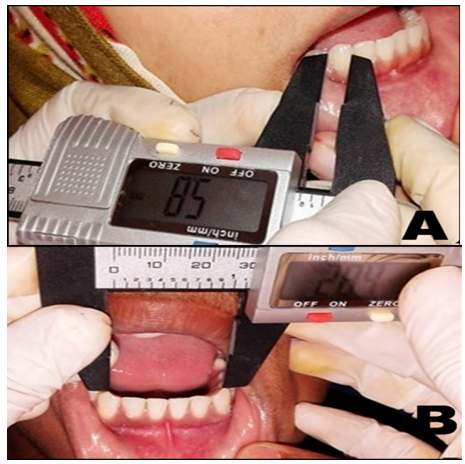

FIGURE 1 Measurement of mesiodistal width of permanent canine with digital vernier caliper