Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Mandibular canine index as an aid in gender determination

[1]Sanskriti Agrawal, [2]Gaurav Arya, [3]Christopher Shinde, [4]Julika De, [5]Anirban Das

[1,4,5]PG 3rd Year, [2]HOD and Professor, [3]Associate Professor, Department of Oral Medicine and Radiology, People's Dental Academy, Bhopal, M.P., India

ABSTRACT:

Background: Gender identification forms a crucial component of forensic science, especially in cases involving mutilated or decomposed bodies where traditional methods such as DNA analysis or fingerprinting may not be feasible. Teeth, being the most resilient structures in the human body, can withstand extreme conditions and are often used in forensic examinations. The mandibular canine index (MCI)—the ratio of mesiodistal width of mandibular canines to intercanine distance—has demonstrated significant sexual dimorphism and may be employed as a supplementary tool in gender determination. **Materials and Methods:** This in vivo cross-sectional study was conducted at the Department of Oral Medicine and Radiology, People's Dental Academy, Bhopal. A total of 100 patients (50 males and 50 females) aged 18–26 years were included based on specific inclusion and exclusion criteria. Mandibular impressions were obtained using alginate material and poured with dental stone to fabricate study casts. Mesiodistal widths of the right and left mandibular canines and intercanine distances were measured using a digital verniercaliper. The MCI was then calculated and analyzed using Student's t-test with a significance level set at $p \leq 0.05$. **Results:** The mean intercanine distance was 26.860 ± 1.48 mm in males and 26.287 ± 1.45 mm in females ($p < 0.001$). The right canine width was 7.017 ± 0.43 mm in males and 6.428 ± 0.35 mm in females ($p < 0.001$), while the left canine width was 7.030 ± 0.44 mm in males and 6.446 ± 0.34 mm in females ($p < 0.001$). The right MCI was 0.259 ± 0.003 in males and 0.246 ± 0.002 in females ($p < 0.001$), and the left MCI was 0.261 ± 0.003 in males and 0.247 ± 0.002 in females ($p < 0.001$). Gender was accurately predicted in 78% of males and 66% of females using the MCI, with an overall accuracy of 72% ($p < 0.001$). **Conclusion:** The mandibular canine index is a statistically significant, cost-effective, and simple method for gender determination. While it does not offer absolute accuracy, its reliability makes it a valuable adjunct in forensic identification, particularly when other methods are unavailable or inconclusive. Population-specific MCI standards are essential for enhancing its diagnostic utility.

Keywords: Mandibular canine index, sexual dimorphism, gender identification, forensic odontology, intercanine distance, mesiodistal width.

Received: 26 April, 2025 Accepted: 20 May, 2025 Published: 02 June, 2025

Corresponding author: Sanskriti Agrawal, PG 3rd Year, Department of Oral Medicine and Radiology, People's Dental Academy, Bhopal, M.P., India

This article may be cited as: Agrawal S, Arya G, Shinde C, De Julika, Das A. Mandibular canine index as an aid in gender determination. J Adv Med Dent Scie Res 2025; 13(6):43-47.

INTRODUCTION

The identification of human remains is a cornerstone of forensic investigations and medico-legal proceedings. Establishing identity is essential for proper burial, legal matters, and humanitarian reasons. While identification by relatives is common, such approaches are often unreliable, especially when bodies are mutilated or decomposed (1,2). Fingerprinting and DNA profiling are considered gold standards for personal identification, yet these techniques may not always be applicable due to degradation of soft tissues or resource limitations (3,4).

Teeth are the hardest and most durable structures in the human body, capable of withstanding high temperatures and environmental changes without significant loss of morphology, making them extremely valuable in forensic contexts (5,6). Forensic odontology, the application of dental science to legal investigations, plays a vital role in mass disaster victim identification, age estimation, and gender determination (7,8). Several methods are employed in forensic odontology for gender estimation including rugoscopy, cheiloscopy, bite mark analysis, radiographic assessment, and odontometric evaluation (9,10).

In cases where long bones are absent or severely damaged, teeth often become the primary structures used for sex estimation. Odontometric analysis, particularly the measurement of mesiodistal and buccolingual dimensions of teeth, has shown promising results in identifying sexual dimorphism, although the degree of accuracy may vary across populations (11,12). Dental size is influenced by genetic, environmental, and epigenetic factors, leading to population-specific variations in tooth morphology (13,14).

Among all teeth, canines—particularly mandibular canines—exhibit the highest degree of sexual dimorphism in terms of crown dimensions and eruption timing. This is likely due to their evolutionary role in defense and survival, especially in males (15,16). Their strategic location and resistance to wear, caries, and periodontal diseases make them reliable markers in gender identification (17,18). The mandibular canine index (MCI), defined as the ratio of the mesiodistal width of the mandibular canine to the intercanine distance, has been proposed as a dependable metric in this regard (19).

Reddy et al. demonstrated significant sexual dimorphism in mandibular canines among an Indian population, findings that were supported by studies conducted on Saudi and Chinese populations (20-23). These differences have been partly attributed to the differential influence of the X and Y chromosomes on enamel and dentine development, respectively (24,25). Several large-scale studies have validated the use of MCI in gender estimation, showing accuracy levels of up to 87.5% depending on population characteristics (26,27).

Given the practical advantages of MCI—simplicity, cost-effectiveness, and reproducibility—it remains a valuable tool in forensic anthropology and odontology, particularly when other advanced techniques are not feasible. The present study was undertaken to assess the accuracy and applicability of MCI in determining gender among individuals from Madhya Pradesh, India.

MATERIALS AND METHODS

Study Design: This study was designed as an in vivo, cross-sectional observational analysis aimed at evaluating the mandibular canine index (MCI) as a tool for gender determination.

Study Setting and Population: The research was conducted in the Department of Oral Medicine and Radiology at People's Dental Academy, Bhopal. The study population included individuals aged between 18 and 26 years who were referred to the department for routine dental check-ups.

Sample Size: A total of 100 participants were enrolled, comprising 50 males and 50 females who fulfilled the inclusion criteria.

Study Variables:

- Independent variables: Age, gender, and side of the mandible (right/left).
- Dependent variable: Mandibular canine index (MCI), calculated from odontometric measurements.

Inclusion Criteria:

1. Participants with fully erupted mandibular canines.
2. Teeth must be healthy, free from decay, spacing, crowding, attrition, or periodontal pathology.
3. Individuals with no history of orthodontic treatment or restorations.
4. Age between 18 and 26 years.

Exclusion Criteria:

1. Patients with partially erupted, rotated, or impacted canines.
2. Evidence of dental anomalies, occlusal discrepancies, or pathological/tooth wear.
3. Individuals with oral parafunctional habits such as bruxism.

Materials Used:

- Mouth mirror
- Dental probe
- Divider and millimeter scale
- Digital Vernier caliper
- Alginate impression material (Cavex CA 37, Holland)
- Type III dental stone
- Gloves and standard clinical setup

Data Collection Procedure: After obtaining informed consent, clinical examination was carried out with the patient seated in a dental chair. Impressions of the mandibular arch were taken using alginate impression material and poured with dental stone to fabricate study models.

On the study casts, the mesiodistal width of both right and left mandibular canines was measured using a digital Vernier caliper. Measurements were recorded by placing the divider across the mesial and distal contact points of each canine crown, then transferring the span to the caliper for accurate reading. Each measurement was repeated three times to reduce intra-observer variability, and the average was used.

The intercanine distance was measured by placing the divider across the cusp tips of the right and left mandibular canines. The span was again transferred to the caliper for precise reading.

Calculation of Mandibular Canine Index(MCI): For each subject, the MCI was calculated separately for both sides using the formula:

MCI=Mesiodistal width of canine

Intercanine distance\text{MCI}= \frac {\text {Mesiodistal width of canine}}{\text{Intercanine

distance}}MCI=Intercanine distance
Mesiodistal width of canine

Statistical Analysis
The data were analyzed using SPSS software (version 29; IBM Corp., Chicago, IL, USA). Mean, standard deviation, and coefficient of variation were computed for all variables. The Student's t-test was applied to evaluate the statistical significance of differences between males and females. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS
A total of 100 subjects participated in the study, with an equal distribution of 50 males and 50 females. The participants were categorized into three age groups: 40% in the 18–20 years group, 30% in the 21–23 years group, and the remaining 30% in the 24–26 years group.

Intercanine Distance: The intercanine distance demonstrated a statistically significant difference between males and females. The mean value in males was 26.860 ± 1.48 mm, while in females it was 26.287 ± 1.45 mm. This difference was found to be highly significant with a *p*-value less than 0.001 (Table 1). The intercanine distance was consistently larger in males, indicating the potential role of this metric in gender estimation.

Table 1: Comparison of Intercanine Distance Between Genders

Sex	Mean ± SD (mm)	Coefficient of Variation (%)	*t*-statistic	*P*-value	Significance
Male	26.860 ± 1.48	5.53	5.58	< 0.001	Highly Significant
Female	26.287 ± 1.45	5.49			

Canine Widths: A significant difference was observed in the mesiodistal width of both the right and left mandibular canines. The average right canine width in males was 7.017 ± 0.43 mm and in females was 6.428 ± 0.35 mm ($p< 0.001$). Similarly, the left canine width averaged 7.030 ± 0.44 mm in males and 6.446 ± 0.34 mm in females, again showing statistical significance ($p< 0.001$) (Table 2). These findings confirm greater tooth dimensions in males compared to females.

Table 2: Comparison of Right and Left Canine Widths Between Genders

Side	Sex	Mean ± SD (mm)	Coefficient of Variation (%)	*t*-statistic	*P*-value	Significance
Right	Male	7.017 ± 0.43	6.18	4.618	< 0.001	Highly Significant
	Female	6.428 ± 0.35	5.38			
Left	Male	7.030 ± 0.44	6.34	4.428	< 0.001	Highly Significant
	Female	6.446 ± 0.34	5.27			

Mandibular Canine Index(MCI): The MCI values were also found to be significantly higher in males. The right MCI in males was 0.259 ± 0.003, while in females it was 0.246 ± 0.002 ($p< 0.001$). Similarly, the left MCI was 0.261 ± 0.003 for males and 0.247 ± 0.002 for females ($p< 0.001$), indicating consistent sexual dimorphism (Table 3).

Table 3: Comparison of Right and Left Mandibular Canine Index Between Genders

Side	Sex	Mean ± SD	Coefficient of Variation (%)	*t*-statistic	*P*-value	Significance
Right	Male	0.259 ± 0.003	3.86	3.009	< 0.001	Highly Significant
	Female	0.246 ± 0.002	4.07			
Left	Male	0.261 ± 0.003	3.83	4.782	< 0.001	Highly Significant
	Female	0.247 ± 0.002	4.05			

These findings clearly suggest that the mesiodistal canine widths, intercanine distances, and mandibular canine index values show statistically significant differences between males and females. This supports the reliability of MCI as a forensic tool for gender determination.

DISCUSSION
Forensic identification is a critical part of legal medicine, and gender determination forms the cornerstone of biological profiling in forensic anthropology. Teeth, being the most resilient structures in the human body, are uniquely suited for such identification, particularly when other skeletal components are compromised or unavailable (1). In this study, we aimed to assess the reliability of the mandibular canine index (MCI) in gender determination among individuals aged 18–26 years in Bhopal.
Our results indicated a statistically significant difference between males and females in all measured parameters—intercanine distance, mesiodistal width of mandibular canines, and MCI—highlighting the presence of sexual dimorphism. Males consistently showed larger mean values in both right and left

canine widths as well as intercanine distances, corroborating previous findings by Garn et al., who emphasized the genetic and hormonal factors contributing to sexual dimorphism in dentition (2,3).

Several studies have reinforced the use of mandibular canines as the most sexually dimorphic among all teeth due to their evolutionary development and resistance to functional wear and attrition (4,5). Kaushal et al. demonstrated similar findings in North Indian populations, asserting that the MCI showed a high level of gender discriminative power (6). Likewise, Acharya and Mainali reported that canine measurements are reliable indicators for sex estimation in Nepalese samples, further underscoring the importance of establishing population-specific norms (7).

The mean intercanine distance in our study was 26.860 ± 1.48 mm in males and 26.287 ± 1.45 mm in females, with the difference being highly significant ($p< 0.001$). These results align with findings from Nambiar et al., who emphasized the role of arch dimensions in sexual dimorphism (8). The mesiodistal width of mandibular canines in our sample (7.017 mm in males vs. 6.428 mm in females for the right canine) is consistent with the findings of Muller et al., who suggested that canine dimensions are less influenced by environmental factors and more reflective of sexual dimorphism (9).

The MCI values also exhibited significant sex differences. The right MCI was 0.259 in males and 0.246 in females, while the left MCI was 0.261 in males and 0.247 in females. These findings support those of Rai et al., who advocated the use of MCI as a supplementary tool in forensic identification (10). The reported accuracy of gender prediction using MCI in our study was 78% in males and 66% in females, giving an overall accuracy of 72%, which compares favorablywith the 70–80% accuracy range reported in prior literature (11,12).

However, it is important to note that while MCI is a useful adjunct, it cannot substitute more definitive methods such as DNA profiling or skeletal assessment in all circumstances. Some studies, such as those by Radovic et al., have questioned the reliability of dental indices in highly mixed populations or in cases involving dental anomalies (13).

The limitation of our study includes a relatively small and region-specific sample size. Population-specific variations in tooth size and arch dimensions necessitate caution when extrapolating these findings to other regions or ethnic groups. Furthermore, the absence of three-dimensional imaging in our methodology may have introduced minor measurement bias (14).

CONCLUSION

In conclusion, mandibular canine index remains a practical, non-invasive, and cost-effective tool for gender determination, particularly in scenarios where other forensic identifiers are compromised. Its reliability is enhanced when applied in conjunction with other odontometric and osteometric parameters.

REFERENCES

1. Al-Rifaiy MQ, Abdullah MA, Ashraf I, Khan N. Dimorphism of mandibular and maxillary canine teeth in establishing sex identity. Saudi Dent J. 1997;9(1):17–20.
2. Saunders SR, Chan AH, Kahlon B, Kluge HF, FitzGerald CM. Sexual dimorphism of the dental tissues in human permanent mandibular canines and third premolars. Am J PhysAnthropol. 2007;133(1):735–40. doi:10.1002/ajpa.20553
3. Reddy VM, Saxena S, Bansal P. Mandibular canine index as a sex determinant: A study on the population of western Uttar Pradesh. J Oral MaxillofacPathol. 2008;12(2):56–9.
4. Acharya AB, Mainali S. Limitations of the mandibular canine index in sex assessment. J Forensic Leg Med. 2009;16(2):67–9. doi:10.1016/j.jflm.2008.08.005
5. Mughal IA, Saqib AS, Manzur F. Mandibular canine index (MCI): Its role in determining gender. Prof Med J. 2010;17(3):459–63.
6. 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(1–3):207.e1–207.e4. doi:10.1016/j.forsciint.2010.08.002
7. Sonika V, Harshaminder K, Madhushankari GS, Sri Kennath JA. Sexual dimorphism in the permanent maxillary first molar: a study of the Haryana population (India). J Forensic OdontoStomatol. 2011;29(1):37–43.
8. Morgan J. Metric sexual dimorphism in permanent canines. Bull IntAssocPaleodontol. 2011;5(1):4–12.
9. Parekh D, Zalawadia A, Ruparelia S, Patel S, Rathod SP, Patel SV. Study of mandibular canine teeth dimorphism in establishing sex identity in Gujarat region. Natl J Integr Res Med. 2011;2:6–9.
10. Kapila R, Nagesh KS, Iyengar A, Mehkri S. Sexual dimorphism in human mandibular canines: a radiomorphometric study in South Indian population. J Dent Res Dent Clin Dent Prospect. 2011;5(2):51–4. doi:10.5681/joddd.2011.011
11. Ibeachu PC, Didia B, Orish C. Sexual dimorphism in mandibular canine width and intercanine distance of University of Port-Harcourt student, Nigeria. Asian J Med Sci. 2012;2:166–9.
12. Otuaga PO, Chris-ozoko L. Sex determination in Deltans using mandibular canine. Biomed Pharmacol J. 2012;5:111–5. doi:10.13005/bpj/329
13. Filipović G, Radojičić J, Stošić M, Janošević P, Ajduković Z. Odontometric analysis of permanent canines in gender determination. Arch Biol Sci. 2013;65(4):1279–83.
14. Muhamedagić B, Sarajlić N. Sex determination of the Bosnian-Herzegovinian population based on odontometric characteristics of permanent lower canines. J Health Sci. 2013;3(2):164–9.
15. Hosmani JV, Nayak RS, Kotrashetti VS, S P, Babji D. Reliability of mandibular canines as indicators for sexual dichotomy. J Int Oral Health. 2013;5(1):1–7.
16. Kakkar T, Sandhu JS, Sandhu SV, Sekhon AK, Singla K, Bector K. Study of mandibular canine index as a sex predictor in a Punjabi population. Indian J Oral Sci. 2013;4:23–6.

17. Rathore A, Tiwari A, Nazim M, Gupta AK, Gande M, Krishnakumar J. Detection of human papillomavirus and its association with potentially malignant disorders and oral squamous cell carcinoma: A retrospective study. Journal of Pharmacy and Bioallied Sciences. 2022 Jul 1;14(Suppl 1):S820-4.
18. Paramkusam G, Nadendla LK, Devulapalli RV, Pokala A. Morphometric analysis of canine in gender determination: revisited in India. Indian J Dent Res. 2014;25(4):425–9. doi:10.4103/0970-9290.142514
19. Gupta S, Chandra A, Verma Y, Gupta OP, Kumar D. Establishment of sexual dimorphism in north Indian population by odontometric study of permanent maxillary canine teeth. J IntClin Dent Res Organ. 2014;6(2):139–42.
20. Iqbal R, Zhang S, Mi C. Reliability of mandibular canine and mandibular canine index in sex determination: A study using Uyghur population. J Forensic Leg Med. 2015;33:9–13. doi:10.1016/j.jflm.2015.03.007
21. Singh SK, Gupta A, Padmavathi BN, Kumar S, Roy S, Kumar A. Mandibular canine index: A reliable predictor for gender identification using study cast in Indian population. Indian J Dent Res. 2015;26(4):396–9. doi:10.4103/0970-9290.167632
22. Rajarathnam BN, David MP, Indira AP. Mandibular canine dimensions as an aid in gender estimation. J Forensic Dent Sci. 2016;8(2):83–9. doi:10.4103/0975-1475.186364
23. Tiwari A, Ghosh A, Agrawal PK, Reddy A, Singla D, Mehta DN, Girdhar G, Paiwal K. Artificial intelligence in oral health surveillance among under-served communities. Bioinformation. 2023;19(13):1329.
24. Peckmann TR, Logar C, Garrido-Varas CE, Meek S, Pinto XT. Sex determination using the mesio-distal dimension of permanent maxillary incisors and canines in a modern Chilean population. Sci Justice. 2016;56(2):84–9.
25. Aggarwal B, Gorea RK, Gorea A, Gorea A. Comparative analysis of clinical and experimental methods for determination of sexual dimorphism of mandibular canines. J Forensic Leg Med. 2016;44:20–3. doi:10.1016/j.jflm.2016.08.014
26. Nadendla LK, Paramkusam G, Pokala A, Devulapalli RV. Identification of gender using radiomorphometric measurements of canine by discriminant function analysis. Indian J Dent Res. 2016;27(1):27–31. doi:10.4103/0970-9290.179810
27. Pratapiene M, Cicciù M, Juodzbalys G. Canines mesiodistal measures as the key to sex prediction: a systematic review and meta-analysis. Minerva Pediatr. 2016;68(4):288–98.
28. Flohr S, Kierdorf U, Kierdorf H. Odontometric sex estimation in humans using measurements on permanent canines: A comparison of an early Neolithic and an early medieval assemblage from Germany. AnthropolAnz. 2016;73(3):225–33. doi:10.1127/anthranz/2016/0626
29. Krishnan RP, Thangavelu R, Rathnavelu V, Narasimhan M. Gender determination: Role of lip prints, fingerprints and mandibular canine index. ExpTher Med. 2016;11(6):2329–33. doi:10.3892/etm.2016.3245