Saini V, et al., J Forensic Leg Investig Sci 2023, 9: 075
DOI: 10.24966/FLIS-733X/100075

HSOA Journal of Forensic, Legal & Investigative Sciences

Research Article

Mandibular Canine Index: A Tool for Sex Estimation in Forensic Cases

Vineeta Saini*, Angel Kathpal and Rahul Shekhawat

Department of Forensic Science, Faculty of Science, SGT University, India

Abstract

Due of its robustness and tolerance to peri and postmortem damage, teeth are widely used in sex estimation. Canines show maximum sexual dimorphism and are resistant to pathology and trauma. Some researchers are investigating its application in sex prediction. Created the Mandibular Canine Index (MCI), which successfully indicated sex in 86% of South Indian population. Other Indian studies also confirmed these findings on southern and northern Indians, but not on another South-Asian or European group. The current research re-examined the approach in 101 Indians subjects of Haryanvi origin (45 Males and 56 females) ages 18- 50 years with various religion (Mostly Hindu) and caste affiliations. We achieved poor sex estimate accuracy utilising the MCI i.e. 55.45% using left MCI and 56.43% with right MCI. This is despite the mesiodistal dimensions of canines and inter-canine distance which were used to derive the MCI - showing statistically significant sex differences (P=0.05).

Our results confirm that tooth ratios, such as the MCI, do not represent sexual dimorphism in absolute measures and the MCI for sex estimation is dubious. Therefore we suggest that it should not be used of sex estimation, instead the direct measurements of canine can be used for sex estimation.

Keywords: Canines; Forensic science; Mandibular canine index; Sexual dimorphism

Introduction

The comparative approach or post-mortem dental profiling was used for dental recognition. The greatest benefit of dental documentation is that it may be kept forever after death. The special tooth pattern, metric variables of teeth allows for the personal identification in living as well as in dead. But the current scenario in India is not very promising for dental identification as the biggest issue is proper maintenance of dental records of patients, collection of dental evidences in dead and obtain and compare the antemortem records is a cumbersome task. Also variation due tooth wear and tear with time also makes the comparison task quite difficult.

For sex determination, various approaches have been used. Two approaches can be used to compare the teeth in living and dead i.e. morphological or the metric approach to determine a person's sex [2]. The estimation and analysis of tooth size is known as odontometrics. It is used to research human phenotypic diversity in biological anthropology and bioarchaeology. The reasoning for its usage is close to that in the examination of dentition, or the form and alignment of teeth. Via the application of odontometrics, a variety of characteristics of human teeth may be detected. Callipers are used to determine the length and breadth of teeth from front to back and side to side. Researchers use dental casts or skeletal material or living people to take measurements with the help of callipers.

Using metric-based methods, post-cranial components have been shown to be more accurate for sex determination than the skull [3]; nevertheless, it is not uncommon for forensic anthropologists to examine instances where only the skull or even only a mandible is available. When knowledge about the deceased is inaccessible, sex estimation may provide critical lead towards its identification. Determining a person's sex becomes the first issue in the procedure of identifying a person by a forensic expert in the case of accidents, chemical and nuclear explosions, natural calamities, criminal trials, and anthropological researches.

Teeth in humans are sexually dimorphic, but less so than in other primate species such as baboons, where canines may show 70 percent or more dimorphism. Canine dimorphism affects approximately 40% to 20% of great apes. Human dental dimorphism ranges from 2 and 6 percent, with mandibular canines being the most dimorphic at 6 percent, but this varies based on population. Males, on average, have bigger canines than females, rendering them potentially useful in sex evaluation studies [4,5]. The higher sexual dimorphism of canines has been speculated to be attributed to the assumption that canines evolved as a token of male superiority, which might be a holdover from our hominin origins, as most great apes share this trait except to a greater extent [3]. The most stable teeth in oral cavity is canine, usually they help to promote cleaning and tearing. Canines have unique characteristicsto no get damaged easily due to infections as compared to molars and premolars. Thus "key teeth" are referred as canines due to their individuality. Teeth estimations seems to be the most effective method in criminal investigation as it has positive aspects like quickness and less time consuming. Theses teeth are less prone to dental disease and more able to withstand serious injuries such as an air storm, earthquake, or burn due to very compact layer of enamel. Teeth don't undergo bacterial decomposition and also don't get burn easily even the whole body gets burned and plays a very important role in criminal investigations. Sexual dimorphism is a pervasive phenomenon among anthropoid primates. Dental variations lead to a new way about differentiating sexual dimorphism. Sexual dimorphism in craniofacial morphology, tooth dimensions and DNA analysis all help in personal identification. Odontometrics helps in sex identification

***Corresponding author:** Vineeta Saini, Department of Forensic Science, Faculty of Science, SGT University, India, E mail: vineeta_fpsc@sgtuniversity.org

Citation: Saini V, Kathpal A, Shekhawat R (2023) Mandibular Canine Index: A Tool for Sex Estimation in Forensic Cases. J Forensic Leg Investig Sci 9: 075.

Received: March 19, 2023; **Accepted:** April 06, 2023; **Published:** April 12, 2023

even in younger individuals, before the development of secondary sexual characteristics. Dentition in females is smaller than males and former posses small crowns.

[1] Derived Mandibular Canine Index (MCI) on south Indian population and advocated that the mandibular canine index provide high classification accuracy (85.9%) and can be successfully used to estimate sex in forensic cases. In their study sex estimation accuracy was found to be 84.3% in the male and 87.5% in the female. After that study several studies conducted in North and South India and around the world. Some studies appreciated and advised to use it as sex predictor and other criticised it [6].

[7] Studied 150 Haryanvi subjects for sex estimating using mandibular canine index and found 76-78% sexing accuracy. [8] Studied the dental cast of 100 people from Rajasthani subjects of 20–30 years for calculating Mandible canine index. They found significant differences between inter-canine distance, right and left canine width and right and left MCI between males and females. The maximum classification accuracy reached 85.5%. [9] Examined 200 males and 200 female subject of Gandhi Nagar district of Gujarat. They measured width of both sides of canines along with inter canine distance and found these variables to be smaller in females. Further, sexual dimorphism index in left canine, right canine and inter canine distance was 8.40%, 8.42% and 2.75% respectively.

[10] Studied the sexual dimorphism in 200 subjects of 17 to 25 years of Western Uttar Pradesh using mandible canine index. The conclusion from the study was found that left canine is 9.05% and right canine 8.782% was sexually different and predicted sexing accuracy was 70%. It has been observed that the measurements of canine teeth including left and right canine and inter canine index are important for sexing. A study was done by Vijayan and colleagues in 2019 on 100 undergraduates students (M:F, 50:50) showed that left and right canine and inter canine distance are highly dimorphic.

In 2017, Gandhi and associates observed the sexual dimorphism in mandible canine index after taking measurements from 62 subjects with equal ratio of both sexes using calipers. In the above study the author observed that there was less sexual dimorphism in right canine 6.85% and in left 7.82%. The overall estimation of sexual difference was found to be 79.03%. It was observed that sexual difference can be easily done by mandible canine index method. [11] Studied Malwari people, among which 137 were males and 163 were female. The measurements of mandibular canine index of left and right canine and inter canine distance were calculated and sexual dimorphism was calculated as 5.58% in left canine and 4.30% in right canine and sex prediction was done with 65.52% accuracy.

In view of above studies on the subjects we tried to see the actual utility of MCI. So, the aim of the present study is to examine the importance of MCI in sex estimation in Haryanvi population.

Materials and Methods

The study was conducted in the Department of forensic science, Faculty of science, SGT University, Gurgaon, Haryana. A total of 101 subjects were taken into consideration. Out of 101 subjects, 56 were females and 45 were males. The measurements were directly taken on the healthy subjects. After explaining the procedure of taking measurements written consent of subjects was taken on the consent forms. The measurements were recorded in the proforma. The data was recorded in Excel sheet and analyzed statistically using an online application Graphpad.com. We have applied student t-test for examining the significance of differences between the collected data of males and females. The subjects were chosen according to the following inclusion criteria.

Inclusion criteria

1. Persons of Haryanvi origin with an age range of 18-50 years.
2. Completely erupted, well-aligned, healthy, and non-worn out mandibular canines
3. Without any developmental anomalies, crowding or spacing, attrition, caries or fractures of mandibular canines

Following variables of mandibular arch were measured using calibrated digital callipers.

1. Greatest mesiodistal width (Canine width): Measured on both sides. The average mandibular canine width was recorded for both sides of each subject.
2. Intercanine mandibular arch width: The linear distance between the cusp tips (between the apices of both canines) of the right and left lower canines. All variables were taken three times and the average was recorded.

The MCI was calculated for every individual by the given formula of Rao et al. (1989) as follows:

$$MCI = \frac{\text{Mean mesiodistal width of mandibular canine}}{\text{Intercanine mandibular arch width}}$$

After calculation of MCI of both sexes the standard MCI was obtained using the following formula:

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

Where SD=Standard deviation

Here the standard MCI value was used as a cutoff point for differentiation males from females.

If the value of MCI ≤ standard MCI=female

If the value of MCI> standard MCI=Male

After getting the MCI score using the formula, actual sex of the subjects was compared and percentage of accuracy was calculated [1].

Results

Table 1 shows the mean values of width of right and left mandibular canines, intercanine distance, standard deviations, t-value and p values. On the basis of formula given by [1], Mandibular canine index for right and left side was calculated using values of right and left side canines. The t-test revealed that width of right and left mandibular canines and intercanine distance are highly significant, while the Mandibular canine indices for left and right side shows nonsignificant differences between male and females.

Based on these values, method of sex prediction from a standard value of MCI was derived as follows:

Standard Right MCI (SRMCI) = (Male Mean RMCI-SD) + (Female Mean RMCI+ SD)/2
= (.258-.0336) + (.244+.0437)/2
= .2244+.2877/2
=.256

Standard Left MCI (SLMCI) = (Male Mean LMCI-SD) + (Female Mean LMCI+ SD)/2
= (.251-.0279) + (.239+.0422)
= .5043/2
= 0.252

On the basis of above standard mandibular canine Index (both left and right), each participant's MCI were calculated prior to reporting sex, and the results are as follows.

Up to the Standard MCI value (0.256 for the right and.252 for the left), all MCI readings were reported as female. Values exceeding this threshold were classified as male. As the genuine sex of each participant was known, the percentage accuracy of reporting sex identity by this method was subsequently verified on an Excel file using filters.

Variable	Males (n=45)	±SD	Females (n=56)	±SD	T-value	P-value
Left canine Width	7.0596	0.699	5.859	±0.935	7.147	0.0001*
Right canine Width	7.25	0.825	5.94	±0.930	7.361	0.0001*
Inter-canine distance	28.231	1.653	24.58	±2.275	9.013	0.0001*
Right MCI	.258	0.034	.244	±0.044	1.783	.0777
Left MCI	.251	0.028	.239	±0.042	1.487	0.14

Table 1: Descriptive analysis with t – test and p- value.

*Highly significant at p<.0001

The data obtained is presented in (Table 2).

Variable	Males (n=45)	Female (n=56)	Total N=101	Over sex classification accuracy (%)
SLMCI	21 (46.67%)	35 (62.5%)	56	55.45
SRMCI	23 (51.11%)	34 (60.71%)	57	56.43

Table 2: Sex classification accuracy using mandibular canine indices for right and left sides.

Table 2 revealed the sexing accuracy for males and females using standard mandibular canine's indices of left and right sides. The sexing accuracy was merely 55.45% and 56.43% using Left and right side mandibular canine index.

Discussion

Prior studies revealed that canines were not employed for mastication during the evolution of primates, but rather that they were connected to both potential and actual aggressiveness [12].

Therefore, sexual dimorphism in mandibular canines in contemporary humans depends on functional behaviour instead of coincidence. The mandibular canine diameter has a clear association with the canine arch width, allowing the MCI to be calculated, based on this and earlier research by the Rao and associates [13,14] on different parameters of permanent mandibular canines in determining sex identification. In further study by [1] revealed high classification accuracy (85.9%) on South Indian population of 15-21 years age group, with completely erupted and healthy mandibular canines. Sex estimation was found to be 84.3% in the male and 87.5% in the female. Till then several studies on different Indian population groups has been done, specially included student belong to a specific population group [15-18]. One of the first research to look at cultures outside of India was Muller et al. (2001). They validated the MCI on a population from Nice, France, and concluded that proper tooth alignment inside the alveolus is critical, and that a normal MCI must be determined for each population.

[19] Advised against the use of Mandibular canine index method. In her study, she included 45 skulls from the C.A. Pound Human Identification Lab and the Wichita State Biological Anthropology Lab with complete lower dentition. The standard MCI was 0.24 for the right and 0.20 for the left side. The sex classification accuracy was 37–44% for males and 44–45% for female sample, worse than chance. However, the direct measurements such as the canine width (p=.002 for right and .001 for left) and canine arch width (p=.019) were significantly different between the sexes and have utility in sex assessment, although they have high error rates.

Meany researchers advocated the importance of mandibular canine dimensions in sex estimation in forensic scenarios [20-22].

We are also in agreement of these study. The mandibular canine measurements and arch width itself proved to be sexually dimorphic and significant differences were observed in males and females, while indices on left and right side were non-significant (Table 1). The sexing accuracy was merely 55.45% and 56.43% using left and right side mandibular canine index. [23] Found an accuracy of 64.2% and 63.3% respectively for left and right mandibular canine index. They suggested for the use of only widths of canines instead of indices. Jain and Kuriakose studied cast of Malwa population and found canines more dimorphic than indices.

Conclusion

The method is totally futile as it revealed accuracy only better than chance. In forensic scenario we need accuracy at least more than 80%. Though inter canine distance and left and right canine width depicted significant differences between the sexes and have potential to be used as sex predictor.

Author's contribution

Dr. Vineeta Saini designed, standardised and supervised the findings of this work. Angel Kathpal and Rahul Shekhawat collected data. All authors discussed the results and contributed to the final manuscript.

References

1. Rao NG, Rao NN, Pai ML, Kotian MS (1989) Mandibular canine index-A clue for establishing sex identity. Forensic Sci Int 42: 249-254.
2. Ayoub F, Shamseddine S, Rifai M, Cassia A, Diab R, et al. (2014) Mandibular Canine Dimorphism in Establishing Sex Identity in the Lebanese Population. International Journal of Dentistry 2014: 235204.
3. Spradley MK, Jantz RL (2011) Sex estimation in forensic anthropology: Skull versus postcranial elements. Journal of Fore-sic Sciences 56: 289-296.
4. Acharya AB, Mainali S (2009) Limitations of the mandibular canine index in sex assessment. Journal of Forensic and Legal Medicine 16: 67-69.
5. Hillson S (1996) Dental anthropology. Cam-bridge University Press.
6. Acharya AB, Angadi PV, Prabhu S, Nagnur S (2011) Validity of the mandibular canine index (MCI) in sex prediction: Reassessment in an Indian sample. Forensic Science International 204: 207-e211.
7. Latif M, Rashid W, Kaur B, Aggarwal A, Rashid A (2016) Sex Determination from Mandibular Canine Index for the Age Group of 17-40 Years in North Indian Population. International Journal of Scientific Study 4: 141-147.
8. Singh P, Singh SK, Saxena S, Chandra S, Sharma S, et al. (2019) Evaluation of canine index and intercanine width to establish sexual dimorphism among three different populations. Oral & Maxillofacial Pathology Journal 10: 396-399.
9. Duraiswamy P, Tibdewal H, Patel K, Kumar S, Dhanni C, et al. (2009) Sex de-termination using mandibular canine index in optimal-fluoride and high-fluoride areas. Journal of Forensic Dental Sciences 1: 99-103.
10. Reddy VM, Saxena S, Bansal P (2008) Mandibular canine index as a sex determinant: A study on the population of Eastern Uttar Pradesh. Journal of Oral and Maxillofacial Pathology 12: 56-94.
11. Jain S, Kuriakose M (2020) Mandibular Canine Index as A Tool in Gender Identification-Study in Malwa Population. Indian Journal of Forensic Medicine & Toxicology 14: 645-652.
12. Eimerl S, De Vore L (1965) The Ptimates, New York, Times Inc.
13. Rao NG, Pai LM, Rao NN, Rao TSK (1986) Mandibular canines in establishing sex identity. J Ind Acad Forensic Med 8: 6-12.
14. Rao NG, Rao NN (1988) Mandibular canine study to establish sex identity in mutilated cadavers. Karnataka State Dent J 6: 77-83.
15. Kaushal S, Patnaik VVG, Sood V, Agnihotri G (2004) Sex determination in North Indians using mandibular canine index. Journal of Indian Academy of Forensic Medicine 26: 45-49.
16. Narang RS, Manchanda AS, Malhotra R, Bhatia HS (2014) Sex determination by mandibular canine index and molar odontometrics: A comparative study. Indian Journal of Oral Sciences 5: 16-20.
17. Rathi N, Bhat S, Desai R (2019) Mandibular canine Index: A reliable sex determinant. Journal of Indian Dental Association 13: 13-16.
18. Vijayan A, Jayarajan J, Jaleel BNF (2019) Significance of mandibular canine index in sex determination. International Journal of Forensic Odontology 4: 54-58.
19. Coberly S (2020) A Validation Study of the Mandibular Canine Index Method of Sexual Assessment Using Two Decedent American Populations. New Florida Journal of Anthropology 1: 14-27.
20. Kapila R, Nagesh KS, Iyengar AR, Mehkri S (2011) Sexual dimorphism in human mandibular canines: A radiomorphometric study in South Indian population. Journal of Dental Research Dental Clinics Dental Prospects 5: 51-54.
21. Bakkannavar SM, Monteiro FNP, Arun M, Kumar GP (2012) Mesiodistal width of canines: A tool for sex determination. Medicine Science and the Law 52: 22-26.
22. Ayoub F, Yehia M, Rizk A, Al-Tannir M, Abi-Farah A, et al. (2018) Forensic norms of female and male Lebanese adults. Journal of Forensic Odonto-Stomatology 26: 18-23.
23. Azevedo Á, Pereira ML, Gouveia S (2019) Sex estimation using the mandibular canine index components. Forensic Sci Med Pathol 15: 191-197.

HERALD

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal Of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal Of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal Of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752