

DOI <https://doi.org/10.33314/jnhrc.v17i4.2187>

Sex Predictability by Using Mandibular Canine Index

Alok Atreya,¹ Rijen Shrestha,² Lujaw RatnaTuladhar,³ Samata Nepal,¹ Raju Shrestha,¹ Sanjay Kumar Sah¹¹Lumbini Medical College Teaching Hospital, Palpa, Nepal, ²Maharajgunj Medical Campus, Kathmandu, Nepal, ³Nepal Medical College Teaching Hospital, Kathmandu, Nepal.

ABSTRACT

Background: Canines are known for their higher resistance to trauma and pathological alterations when compared to other teeth. Among all the teeth, canines show highest sexual dimorphism.

Methods: This descriptive cross-sectional study was commenced from January 2019 to April 2019 after the ethical approval from Institutional Review Committee. The maximum mesio-distal widths of right and left mandibular canines and mandibular inter-canine arch width were measured on the cast with the help of a divider and digital vernier callipers. Mandibular canine index was calculated by dividing the mesio-distal width of each mandibular canine with inter-canine arch width. Data was entered and analyzed using Statistical Package for the Social Sciences version 21.

Results: Sex predictability by using mandibular canine index in the present study showed poor sex predictability (57.5% - 62.5%).

Conclusions: Sex determination should be done by other methods and mandibular canine index should be used cautiously in Nepalese population.

Keywords: Canine dimorphism; forensic anthropology; forensic dentistry; forensic identification, sex determination.

INTRODUCTION

Sex estimation is an important and primary objective in the process of establishing identity. This is especially important in cases of mutilated bodies, fragmentary remains and skeletonized bodies. The importance of forensic odontology and dental examination is emphasized by the protection of teeth inside the oral cavity, rendering them resilient to effects of trauma, heat and other factors.^{1,2}

Study conducted by Rao et al., is considered the pioneer study on sexual dimorphism based upon mandibular canines.³ There have been numerous studies on the usefulness of mandibular canine index (MCI) for estimation of sex.⁴⁻²⁰ However, estimation of sex from teeth is still not widely used in practice. This study aims to examine the validity of estimation of sex from MCI in Nepalese context.

METHODS

The present descriptive cross-sectional study was conducted on the dental casts of patients attending Dental Clinic of Lumbini Medical College Teaching Hospital, Palpa. Ethical approval was obtained from Institutional Review Committee of Lumbini Medical College, Palpa (Ref No: IRC-LMC 06/J/018). Data collection was commenced in January 2019 and was continued till April 2019. The sample size was calculated taking reference to the study conducted by Bakkannavar et al.,¹ as follows:

Sample size (n) = $(Z\alpha/2)^2 \sigma^2 / E^2$ Where, $Z\alpha/2$ = standard normal value = 1.96; σ = Standard deviation = 0.44 and E = margin of error. Therefore, $N = (1.96)^2 \times (0.44)^2 / (0.1)^2 = 75$. The estimated sample size for the present study was considered 80 (40 males and 40 females).

The maximum mesio-distal (MD) widths of both

Correspondence: Dr Alok Atreya, Department of Forensic Medicine, Lumbini Medical College Teaching Hospital, Palpa, Nepal. Email: alokraj67@hotmail.com, Phone: +9779857052193.

mandibular canines and mandibular inter-canine arch width were measured on the cast with the help of a divider and digital vernier callipers. Each measurement was taken thrice by the same observer and the average of the three values was obtained to minimize the intra-observer error. Cast models showing dental or occlusal abnormalities (rotation, crowding, excessive spacing, missing anterior tooth etc.), wear and tear (e.g. attrition, erosion) were excluded from the study. The reference number on the cast model was matched with the register book to obtain the age and sex of the patient.

Consent was not obtained from the patients, as the study was done in casts. All patient identity details were kept confidential. The collected data was entered and analyzed using statistical analysis software SPSS 21 (SPSS. Inc., Chicago). Readings obtained were subjected for analysis to derive conclusions. Further the canine index and standard canine index were calculated for both the right and left mandibular canines using the formula cited by Muller et.al.⁴

Canine index (CI) = Mesio-distal crown width of canine/ inter-canine distance, Standard canine index = mean male (CI-Std.Deviation) + mean female (CI+Std.Deviation)/2

RESULTS

The mean MD crown width measurements for right and left mandibular canines in males were found to be greater than their female counterparts (Table 1).

Table 1. Mean widths of canine as per sex.

	Sex	N	Mean	Std. Deviation	P value
Width of right mandibular canine	Male	40	7.6375	.65032	0.028
Width of right mandibular canine	Female	40	7.3175	.62548	
Width of left mandibular canine	Male	40	7.5750	.56102	0.050
Width of left mandibular canine	Female	40	7.3050	.64687	

The mean was calculated from the measured inter-canine distance (Table 2). The mandibular canine index was then calculated for both right and left mandibular canines. The calculated mandibular canine index was not found to be statistically significant ($p > 0.01$) (Table 3).

Table 2. Mean inter-canine distance as per sex.

Sex	Mean	N	Std. Deviation
Male	33.2875	40	2.98047
Female	33.1775	40	4.04224
Total	33.2325	80	3.52915

Table 3. Mandibular Canine Index.

Sex	N	Mean	Std. Deviation	P value
Right canine				
Male	40	.230318	.0189548	0.112
Female	40	.222546	.0239859	
Total	80	.226432	.0218330	
Left canine				
Male	40	.2286	.01872	0.127
Female	40	.2218	.02042	
Total	80	.2252	.01976	

The standard canine index (SCI) was calculated by using the formula; $SCI = \frac{\text{mean male (CI-Std.Deviation)} + \text{mean female (CI+Std. Deviation)}}{2}$. For the right mandibular canine, the distinguishing point was found to be 0.2289. If the canine index was less than or equal to this value then the sex was considered to be female and more than this value was considered to be male. The segregating point for left mandibular canine was found to be 0.22605.

Cross-validation was performed to estimate the predictability of the mandibular canine index (Table 4).

Table 4. Sex predictability using mandibular canine index.

Standard canine index	Sex	Case	Percent
Right	Male	23 (n=40)	57.5%
	Female	24 (n=40)	60.0%
Left	Male	25 (n=40)	62.5%
	Female	23 (n=40)	57.5%

Table 5. Predictability of sex from teeth from some studies.

Author	Country	Variable	Predictability
Bakkannavar SM ¹	India	MCI	48.8%
Sai kiran S ²	India	MC	74.07%-77.78%
Rao NG ³	India	MCI	85.9%

Muller M ⁴	France	MCI	44.39%-74.76%
Reddy VM ⁷	India	MCI	72%
De Angelis D ¹¹	Italy	Canine volume	80.5%
Silva AM ⁶	Portugal	MCI	54.2%-64.2%
Ayoub F ¹⁸	Lebanon	MCI	95%
Acharya AB ⁸	Nepal	MCI	51.28%
Acharya AB ⁹	India	MCI	50.74%
Acharya AB ¹⁰	Nepal	Tooth dimensions of maxilla and mandible	62.3%-83.0%
El Seikhi F ¹⁹	Libiya	Odontometrics of Maxillary M1 and M2	63%
Latif M ¹²	India	MCI	78%
Hosmani JY ¹⁴	India	MCI	45%
Kapila R ¹⁵	India	Mandibular canine width	90%
Kaushal S ¹³	India	MCI	100%
Sassi C ¹⁶	Uruguay	MCI	41%
Nahidh M ¹⁷	Iraq	Maxillary canine index	59%
Yadav S ²⁰	India	MCI	81-83.3%
Present study	Nepal	MCI	57.5%-62.5%

DISCUSSION

Sex estimation has been found to be most accurate when the entire skeleton is available.^{1,6} However, this is usually not the case in violent deaths following bombings, earthquakes etc. This necessitates the establishment of verified methods of estimation of sex for identification of the deceased. Numerous studies have been published regarding the estimation of sex from bones. Teeth have also been used to develop identity and biological profile.²¹ This is especially true in cases of air crashes, bomb blasts etc. where the remains are highly fragmentary.²²

Forensic Odontology is an important field in the medico-legal death investigation system.^{1,2} Its importance has been well established in the Disaster Victim Identification system in mass fatality incidents.²¹ Dental findings are one of the four primary methods of identification along with fingerprints, DNA and other medical and surgical findings.²³

Teeth have also been used for estimating the age of individuals. Eruption and calcification of teeth, incremental lines and Gustafson's method are long been used for age estimation, especially in adolescents and young adults.²² Similarly, the unique features possible on the five surfaces of thirty-two teeth have been used to advocate for the individualism and potential for identification from bite marks.²²

Mandibular canines are often considered a 'key tooth' because they show high sexual dimorphism, are extremely resistant to trauma and are less frequently affected by periodontal disease.⁴⁻⁹

Studies on the use of bucco-lingual and mesio-distal measurements to estimate sex have found statistically significant dimorphism.^{2,5,10} Studies have also been used to estimate sex from canine volume.¹¹

Studies on MCI for prediction of sex have shown variable results, with prediction rates ranging from 100% accuracy to as low as 41% (Table 5).^{1-4,6-20}

The majority of studies have shown the predictability of MCI to range between 40 - 60%, indicating poor predictive value. The present study has validated the findings of majority of previous studies that mandibular canine index is not suitable for estimation of sex. This study has also found predictive value of MCI to be insignificant and other more valuable tools are available for estimation of sex. The difference with other authors who have found good predictable value of MCI could be due to the difference in a variety of factors in the sample population, including population genetics, dietary habits, etc.

Previous studies have shown good predictive value of mesio-distal length of canine.⁴⁻²⁰ This study however finds similar predictable values of MD length in comparison to MCI. The relation between sex and the measurements may be linear and while the combination should presumably be more effective in estimating sex, the relation may be more complex than what a simple index could classify. This necessitates the need to further study the relation between sex and other geo-morphometric variables that could better account for sex estimation.

Teeth are generally more resistant to trauma in general, with the canines and molar being particularly resilient. Identification from teeth can be a valuable tool for assistance in forensic cases and recent developments of forensic odontology and forensic anthropology have greatly helped in propagation of a scientific method of

identification in disasters.

Forensic evidence has been regularly accepted by the courts all over the world.²⁴ This could be due to the lack of knowledge or misguidance by the experts. While the misguidance is not all together malicious, it can have profound effects on the lives of those involved. Reports on the state of forensic sciences in general and forensic odontology in particular have necessitated research into validation of methods of medico-legal investigations.^{24,25}

Similarly, the use of research studies without population specific validation can have adverse effects on the identification of deceased. This can help prevent unwanted suffering on the part of the families of deceased. Validation studies are an extremely valuable tool in this regard.

CONCLUSIONS

The present study found that mandibular canine index (MCI) has poor sex predictability. Sex determination should be done by other methods and mandibular canine index should be used cautiously in Nepalese population.

This study further demonstrates the necessity of developing population specific studies and models derived thereof for use in the field. Comparative Forensics is now under siege and the only way to move forward is to reconquer the faith of the public by developing sound methods that have been tested and validated in the field.

REFERENCES

- Bakkannavar SM, Manjunath S, Nayak VC, Pradeep Kumar G. Canine index – A tool for sex determination. *Egyptian J Forensic Sci.* 2015;5:157-61. [[DOI](#)]
- Saikiran S, Khaitan T, Ramaswamy P, Sudhakar S, Smitha B, Uday G. Role of mandibular canines in establishment of gender. *Egyptian J Forensic Sci.* 2014;4:71-4. [[DOI](#)]
- Rao NG, Rao NN, Pai ML, Kotian MS. Mandibular canine index – a clue for establishing sex identity. *Forensic Sci Int.* 1989;42:249-54. [[PubMed](#)]
- Muller M, Lupi-Pegurier L, Quatrehomme G, Bolla M. Odontometrical method useful in determining gender and dental alignment. *Forensic Sci Int.* 2001;121:194-7. [[PubMed](#) | [DOI](#)]
- Shrestha B. Sexual dimorphism in permanent maxillary and mandibular canine of medical students in Gandaki Medical College, Nepal. *Birat J Health Sci.* 2019;4(1):654-9. [[Full Text](#) | [DOI](#)]
- Silva AM, Pereira ML, Gouveia S, Tavares JN, Azevedo Á, Caldas IM. A new approach to sex estimation using the mandibular canine index. *Med Sci Law.* 2016;56(1):7-12. [[PubMed](#) | [DOI](#)]
- Reddy VM, Saxena S, Bansal P. Mandibular canine index as a sex determinant: A study on the population of western Uttar Pradesh. *J Oral Maxillofac Pathol.* 2008;12:56-9.
- Acharya AB, Mainali S. Limitations of the mandibular canine index in sex assessment. *J Forensic Leg Med.* 2009;16(2):67-9. [[PubMed](#) | [DOI](#)]
- 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-e4. [[PubMed](#) | [DOI](#)]
- Acharya AB, Mainali S. Sex discrimination potential of buccolingual and mesiodistal tooth dimensions. *J Forensic Sci.* 2008;53(4):790-2. [[PubMed](#) | [DOI](#)]
- De Angelis D, Gibelli D, Gaudio D, Cipriani Noce F, Guercini N, Varvara G, *et al.*. Sexual dimorphism of canine volume: a pilot study. *Leg Med (Tokyo).* 2015;17(3):163-3. [[PubMed](#) | [DOI](#)]
- Latif M, Rashid W, Kaur B, Aggarwal A, Rashid A. Sex Determination from Mandibular Canine Index for the Age Group of 17-40 Years in North Indian Population. *Int J Sci Stud.* 2016;4(2):141-7.
- Kaushal S, Patnaik VVG, Agnihotri G. Mandibular canines in sex determination. *J Anat Soc India* 2003;52:119-24. [[Full Text](#)]
- Hosmani JV, Nayak RS, Kotrashetti VS, Pradeep S, Babji D. Reliability of mandibular canines as indicators for sexual dichotomy. *J Int Oral Health.* 2013;5(1):1-7. [[PubMed](#)]
- Kapila R, Nagesh KS, R Iyengar A, Mehkri S. Sexual dimorphism in human mandibular Canines: A radiomorphometric study in South Indian population. *J Dent Res Dent Clin Dent Prospects.* 2011;5(2):51-4. [[PubMed](#) | [DOI](#) | [Full Text](#)]
- Sassi C, Picapedra A, Lima LNC, Franceschini Júnior L, Daruge E, Daruge Júnior E. Sex determination in Uruguayans by odontometric analysis. *Braz J Oral Sci.* 2012;11:381-6. [[Full Text](#)]
- Nahidh M, Ahmed HMA, Mahmoud AB, Murad SM, Mehdi BS. The role of maxillary canines in forensic odontology. *J Bagh Coll Dentistry.* 2013;25(4):109-113. [[Full Text](#)]
- Ayoub F, Shamseddine L, Rifai M, Cassia A, Diab R, Zaarour I, *et al.*. Mandibular Canine Dimorphism in

- Establishing Sex Identity in the Lebanese Population. *Intl J Dentistry*. 2014; Article ID 235204, 4 pages. [[Full Text](#) | [DOI](#)]
19. El Sheikhi F, Bugaighis I. Sex discrimination by odontometrics in Libyan subjects. *Egyptian J of Forensic Sci*. 2016;6:157–64. [[DOI](#)]
 20. Yadav S, Nagabhushana D, Rao BB, Mamatha GP. Mandibular canine index in establishing sex identity. *Indian J Dent Res*. 2002;13(3–4):143–6. [[PubMed](#)]
 21. Manica S, Gorza L. Forensic odontology in the 21st century - Identifying the opinions of those behind the teaching. *J Forensic Leg Med*. 2019;64:7-13. [[PubMed](#) | [DOI](#)]
 22. Krishan K, Kanchan T, Garg AK. Dental Evidence in Forensic Identification - An Overview, Methodology and Present Status. *Open Dent J*. 2015;9:250-6. [[PubMed](#) | [DOI](#) | [FullText](#)]
 23. Wright K, Mundorff A, Chaseling J, Forrest A, Maguire C, Crane DI. A new disaster victim identification management strategy targeting “near identification-threshold” cases: Experiences from the Boxing Day tsunami. *Forensic Sci Int*. 2015;250:91-7. [[PubMed](#) | [DOI](#)]
 24. National Research Council. *Strengthening Forensic Science in the United States: A Path Forward*. Washington, DC: The National Academies Press; 2009. [[DOI](#)]
 25. President’s Council of Advisors on Science and Technology, Report to the president Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods, Washington DC; 2016. [[FullText](#)]