

# Comparative Study of Sex Estimation by Mesiodistal width of Mandibular Canine and Mesiodistal width of Maxillary Canine in North Indian Population

Mohammad Abdurrahman Khan<sup>1</sup>, Manisha Verma<sup>2</sup>, Syed Belal Hassan<sup>3</sup>,  
Anoop Kumar Verma<sup>4</sup>, Syed Fiza Mustaqueem<sup>5</sup>, Shilpi Gupta<sup>6</sup>

<sup>1</sup>Associate Professor, Department of Forensic Medicine and Toxicology; Hind Institute of Medical Sciences, Barabanki. <sup>2</sup>Senior Resident, Department of Periodontology, Faculty of Dental Sciences, King George's Medical University Lucknow. <sup>3</sup>Associate Professor, Department of Community Medicine, Integral Institute of Medical Sciences & Research; Integral University, Lucknow. <sup>4</sup>Professor and Head, Department of Forensic Medicine and Toxicology, King George's Medical University, Lucknow. <sup>5</sup>Associate Professor, Department of Pathology, Integral Institute of Medical Sciences & Research; Integral University, Lucknow. <sup>6</sup>Assistant Professor, Department of Dentistry Dr. Sonelal Patel Autonomous State Medical College Pratapgarh.

**How to cite this article:** Mohammad Abdurrahman Khan, Manisha Verma, Syed Belal Hassan et. al. Comparative Study of Sex Estimation by Mesiodistal width of Mandibular Canine and Mesiodistal width of Maxillary Canine in North Indian Population. Medico Legal Update/Volume 24 No. 2, April-June 2024.

## Abstract

**Introduction:** Various methods of identification such as anthropometry, stature estimation, dactylography, sex estimation, age estimation, DNA analysis, differentiation by blood groups and odontology are used in forensic medicine to create biological profile of an unknown individual. Estimation of sex is the first step towards identification of person. Determination of sex from skeletal remains is an essential task in medicolegal examination. Teeth are highly indestructible and reveal minimal turnover of natural substance hence teeth can be used for sex estimation. Mesiodistal parameter of mandibular and maxillary canine gave evidence of sex estimation due to sexual dimorphism.

**Aim:** The aim of our study was to evaluate the sex estimation by mesiodistal width of mandibular canine and mesiodistal width of maxillary canine in north Indian population.

**Materials and Methods:** The sample comprised of dental impression from 120 individuals (60 males and 60 females), all young adults between 20 and 35 years of age. Impressions of the teeth were made using irreversible hydrocolloid (alginate) material and casts poured in dental stone. Mesiodistal (MD) dimensions of mandibular and maxillary canine of both right and left side is measure by caliper.

**Corresponding Author:** Sunil B. Bhatt, Mohammad Abdurrahman Khan, Associate Professor, Department of Forensic Medicine and Toxicology; Hind Institute of Medical Sciences, Barabanki.

**Mobile No:** 9335763465

**E-mail:** drmak2005@gmail.com

**Submission date:** Jan 2, 2024

**Revision date:** Jan 15, 2024

**Published date:** May 13, 2024

This is an Open Access journal, and articles are distributed under a Creative Commons license- CC BY-NC 4.0 DEED. This license permits the use, distribution, and reproduction of the work in any medium, provided that proper citation is given to the original work and its source. It allows for attribution, non-commercial use, and the creation of derivative work.

**Results:** Mean mandibular canine width of both right and left side were higher in male than female and were statistically significant whereas, mean maxillary canine width of both right and left side were slightly higher in male than female but were not statistically significant in young north Indian population. Left mandibular canine width (6%) was more sexually dimorphic than right mandibular canine width (5.1%). Whereas negligible sexual dimorphism shown by maxillary canine.

**Conclusion:** The study confirmed that among maxillary and mandibular canine, mandibular canine can be used for sex estimation and shows significant sexual dimorphism.

**Keywords:** Maxillary canine, Mandibular canine, Sexual dimorphism, Sex estimation, Mesiodistal width.

## Introduction

Forensic derives utmost importance when there is requirement of the identification of an individual either from partial or complete remains<sup>1</sup>. Personal identification requires in courts of law for not only criminal identification but also for identification of other living individuals, dead person and body remains<sup>2</sup>. Various methods of identification such as anthropometry, stature estimation, dactylography, sex estimation, age estimation, DNA analysis, differentiation by blood groups and odontology are used in forensic medicine to create biological profile of an unknown individual<sup>3,4,5</sup>. Estimation of sex is the first step towards identification of person<sup>6</sup>. Determination of sex from skeletal remains is an essential task in medicolegal examination specially in damaged, mutilated or decomposed bodies<sup>7</sup>. Among various methods of sex estimation like osteometry, odontometry, DNA analysis and cheiloscropy, only analysis of DNA gives definitive proof of sex determination, but such methods are expensive, exhaustive, relatively prolonged involving difficult DNA extraction technique and requires trained staff<sup>8</sup>. Teeth are highly indestructible and reveal minimal turnover of natural substance hence teeth can be used for sex estimation in decomposed, mutilated bodies or from fragmentary skeletal remains<sup>9,10</sup>. Sexual dimorphism means difference in size and appearance in teeth among male and female that can be used for sex determination<sup>11</sup>. Mesiodistal parameter of mandibular and maxillary canine gave evidence of sex estimation due to sexual dimorphism<sup>12</sup>. The aim of our study was to evaluate the sex estimation by mesiodistal width of mandibular canine and mesiodistal width of maxillary canine in north Indian population.

## Material and Methods

### Material required

1. Alginate
2. Dental stone
3. Maxillary Impression Trays
4. Mandibular Impression Trays
5. Rubber Bowl
6. Spatula

The alginate dental impression forms an imprint (i.e., a 'negative' mould) of those teeth and gums, which can then be used to make a cast or 'positive' model of the patient's dentition.

### Sample size

#### Sample selection:

sample size was calculated by formula

$$N = Z_{\alpha}^2 p(1-p) / E^2$$

Where  $Z_{\alpha}$  is critical value of z-score at  $\alpha$  level of significance (at  $\alpha = 5\%$ ,  $Z_{\alpha} = 1.96$ ),  $p$  is proportion and  $E$  is permissible error. 5.738 % of sexual dimorphism observed by canine width (6.80% by right mandibular canine width and 7.72% by left mandibular canine width parameter. Average of sexual dimorphism by mandibular canine = 7.26 %. 4.58 % of sexual dimorphism observed by right maxillary canine width and 3.85 % by left maxillary canine mesiodistal width). Average of sexual dimorphism by maxillary canine = 4.215. So overall average is 5.738<sup>12</sup>. So,  $p = 5.738\%$ , i.e., .05738,  $1-p = .9427$ ,  $E = 4.1\%$  i.e., .041. So,  $n = (1.96)^2 \times 0.05738 \times 0.9427 / (.041)^2 = 123.6 \approx 120$ .

Study was conducted on 120 volunteer subject (60 male and 60 female) of both the sex having age

group between 20 to 35 years at Integral Institute of Medical Sciences & Research, Integral University, Lucknow. Institutional ethical clearance was taken for this study with reference number IEC/IIMSR/2023/13. Informed consent was taken from all participants.

#### Inclusion Criteria:

1. Age between 20 to 35 years.
2. Fully erupted with complete set of teeth.
3. No history of orthodontic treatment or any type of prosthesis
4. Non-carious, non-hypoplastic, non-traumatic, non attrited and periodontally healthy teeth.

#### Exclusion Criteria:

1. Age below 20 years and above 35 years.
2. Misaligned, spacing teeth, diastema or crowded teeth
3. Carious teeth, restored teeth, fractured teeth, hypoplastic teeth, teeth with prosthesis, attrited teeth, mobile teeth.

#### Methodology and toothmeasurements

Impressions of the teeth were taken using irreversible hydrocolloid (alginate) material and poured by dental stone (Figure 1). Mesiodistal (MD) dimensions of mandibular canine and maxillary canine of both right and left side, were measured on the casts using a digital caliper calibrated to 0.01 mm. The MD dimension was defined as the greatest distance between contact points on the approximate surfaces of the tooth crown and was measured with the caliper beaks placed occlusally and aligned with the long axis of the tooth (Figure 2&3). If any teeth were rotated or misaligned, measurements were taken between points on the approximate surfaces of the crown where it was considered that contact with adjacent teeth would normally occur. Sexual dimorphism calculated by following formula<sup>13</sup>.

Sexual Dimorphism in percentage (%) =  $[(Xm/Xf)-1] \times 100$ , where  $Xm$  is the mean value for males and  $Xf$  is the mean value for females.



Figure 1- Image of dental cast



Figure 2: Measuring mesiodistal dimension of mandibular canine teeth by the digital caliper



Figure 3: Measurement of mesiodistal dimension of maxillary canine teeth by the digital caliper

#### Results

Data obtained were quantified and analysed statistically using SPSS (Statistical Package for the Social Sciences). All description were shown in table 1 to 4. Data were summarized as Mean and standard deviation (SD). Groups (in Gender Male vs female)

were compared by unpaired or independent Student's t test. In our study mean of right and left mesiodistal mandibular canine width (Table 1, chart 1) was higher in male (for right mesiodistal mandibular canine width  $6.042167 \pm .518561$  and for left mesiodistal mandibular canine width  $6.084 \pm .604484$ ) than female (for right mesiodistal mandibular canine width  $5.74367 \pm .45661$  and for left mesiodistal canine width  $5.73783 \pm .60016$ ) and was statistically highly significant ((p

value = .0011 for right side and p value .002083 for left side). Whereas as mean of right mesiodistal maxillary canine width (Table 2, chart 2) was slightly higher in male ( $6.66533 \pm .69064$ ) than female ( $6.56667 \pm .58321$ ) and was statistically not significant whereas mean of left mesiodistal maxillary width was almost equal in male and female and was statistically not significant (for male it was  $6.678 \pm .75049$  whereas for female it was  $6.62933 \pm .72876$  with p value .71922).

Table 1. Measurement of mean and standard deviation of mandibular canine width among male and female

Sex	Right mesiodistal mandibular canine width (in mm)			Left mesiodistal mandibular canine width (in mm)		
	Mean	Standard deviation	p value	Mean	Standard deviation	p value
Male	6.04217	.51856	0.0011	6.084	.604484	.002083
Female	5.74367	.45661		5.73783	.60016	

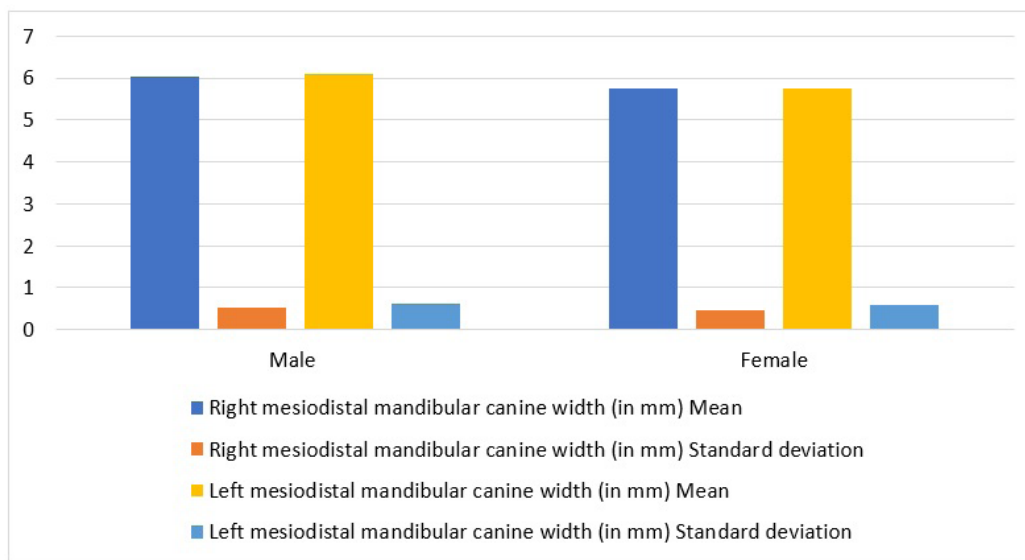


Chart 1. Measurement of mean and standard deviation of mandibular canine width among male and female

Table 2. Measurement of mean and standard deviation of maxillary canine width among male and female

Sex	Right mesiodistal maxillary canine width (in mm)			Left mesiodistal maxillary canine width (in mm)		
	Mean	Standard deviation	p value	Mean	Standard deviation	p value
Male	6.66533	.69064	.3996	6.678	.75049	.71922
Female	6.56667	.58321		6.62933	.72876	

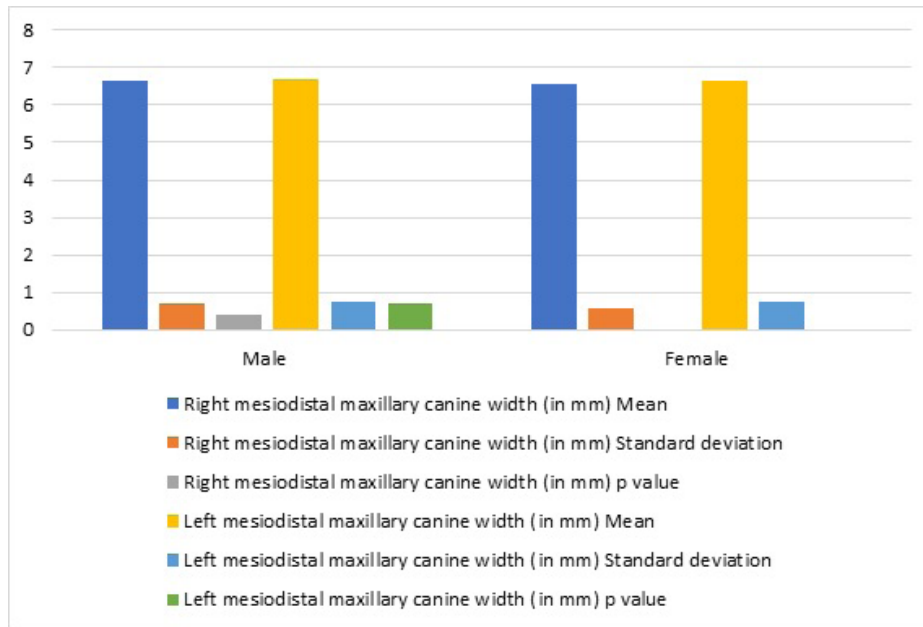


Chart 2. Measurement of mean and standard deviation of maxillary canine width among male and female

Table 3. Calculation of % Sexual dimorphism from right and left mandibular canine

Right mandibular canine	5.1 %
Left mandibular canine	6.0 %

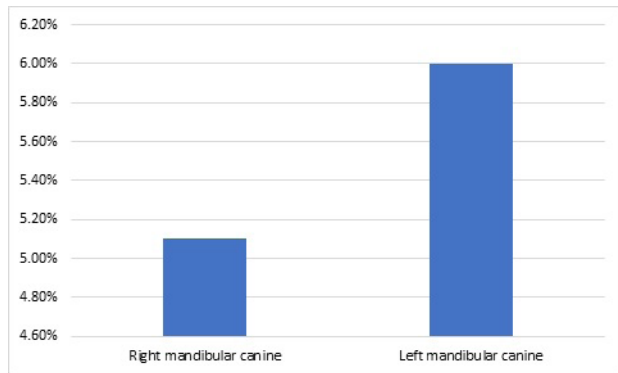


Chart 3. % Sexual dimorphism shown by right and left mandibular canine

Table 4. Calculation of % Sexual dimorphism from right and left maxillary canine

Right maxillary canine	1.5 %
Left maxillary canine	0.73 %

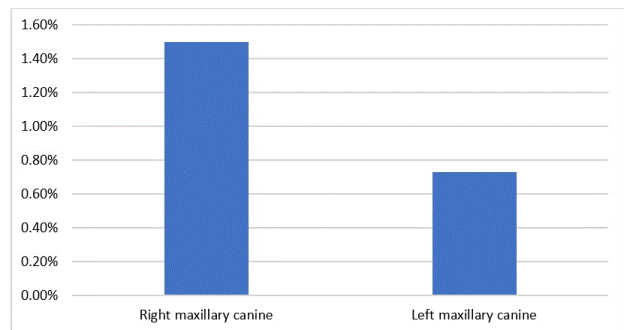


Chart 4. % Sexual dimorphism shown by right and left maxillary canine

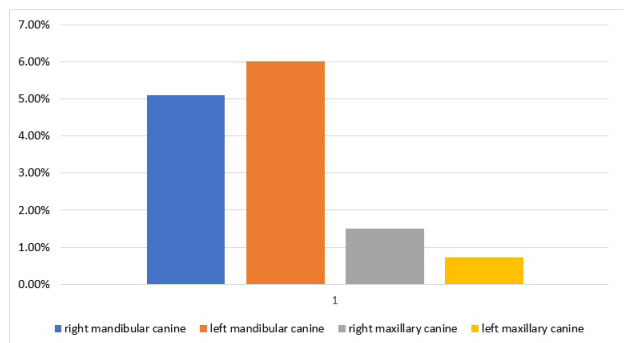


Chart 5. Comparative % sexual dimorphism shown by right and left mandibular and maxillary canine

Significant sexual dimorphism shows by right and left mesiodistal mandibular canine width (Table 3, chart 3). Left mesiodistal mandibular canine (6%) higher sexual dimorphism than right mesiodistal

mandibular canine width (5.1%). Negligible sexual dimorphism shown by maxillary canine (Table 4, chart 4). Comparative sexual dimorphism by mandibular and maxillary canine was shown in chart 5.

### Discussion

Sex determination from mutilated or damaged or from skeleton remains is most important steps in forensic medicolegal examination of identification. Identification of missing person become simplified and easy because missing person of that sex will be considered<sup>14</sup>. Canine play as key teeth for identification of a person since it is decay resistance, least affected by dental caries or oral disease, comparatively better to withstand severe trauma and last tooth to be extracted with respect to age<sup>15</sup>. Sexual dimorphism is difference in the physical appearance between male and female that is vital in dental identification<sup>16</sup>. Identification of an individual by means of teeth and gender determination is consider as top priority because tooth is very decisive in identification when other evidence is lacking<sup>12</sup>. Present study revealed comparative analysis of the mesiodistal dimension of maxillary and mandibular canine in sex estimation among male and female subjects in north Indian population. Our study revealed that mean value for right and left mesiodistal mandibular and mesiodistal maxillary canine width were less for female than male which was similar to the study of Gustafsson and Lindenfors<sup>17</sup>, studies of Frayer and Wolpoff<sup>18</sup> and study done by Syed MA et al<sup>19</sup> and in many other studies<sup>20,21</sup>. In their study, Otuga et al<sup>12</sup> found that mean of left mesiodistal maxillary canine width is higher in female than male. Though mean value of right and left maxillary mesiodistal canine width was slightly higher in male ( $6.66533 \pm .69064$  for right and  $6.678 \pm .75049$  for left) than female ( $6.56667 \pm .58321$  for right and  $6.62933 \pm .72876$  for left) but difference in male and female was not significant (p value was .3996 and .71922 for right and left side respectively) in our study which was similar to the study of Mohammed et al<sup>11</sup> on Saudi Arabian population who found that the mean value of mesiodistal width of maxillary canines was  $7.54 \pm 0.68$  mm (right) and  $7.54 \pm 0.67$  mm (left) in males, while in females mean value was  $6.8 \pm 0.925$  mm (right) and  $6.83 \pm 0.934$  mm (left), but the differences in males and females were not statistically significant. So, it is clear

out from our study and study of Mohammed et al<sup>11</sup> that mesiodistal width of maxillary canine was not suitable for sex estimation.

In our study left mesiodistal mandibular canine (6%) showed higher sexual dimorphism than right mesiodistal mandibular canine width (5.1%) which is similar to study done by Kaushal et al<sup>9</sup> on 60 north Indian subject who found left mandibular canine (9.796% in cast and 8.891% intraoral) to be more dimorphic than right mandibular canine (7.954% in cast and 7.594% intraoral), study of Nair et al<sup>22</sup> who found higher sexual dimorphism by left mandibular canine than right mandibular canine (6.2%) and observation of Kapila et al<sup>23</sup> in their study where greater sexual dimorphism (9.7%) was exhibited in the left mandibular canine than in the right mandibular canine (7.4%). Reason for such finding may be due the fact sexual dimorphism for tooth is population dependent and vary accordingly in different ethnic group<sup>13</sup>. Similar results also observed by Knak Priya et al<sup>24</sup>. Maneel et al<sup>25</sup> observed higher sexual dimorphism in right mandibular canine (10.11%) than left mandibular canine (4.44%) which was contradictory to our study. Negligible sexual dimorphism shown by maxillary canine in our study (for right maxillary mesiodistal canine teeth sexual dimorphism was 1.5% while for left maxillary mesiodistal canine it was 0.73%) which is contrary to study of Otuga et al<sup>12</sup> who found sexual dimorphism for right maxillary canine was 4.58 and for left maxillary canine was 3.85% and study of Yuvenva et al<sup>26</sup> who observed sexual dimorphism for right maxillary canine was 8.85% and for left maxillary canine it was 6.85.

### Conclusion

The right and left mandibular mesiodistal canine width dimension have comparatively higher mean in male than female and are statistically significant whereas right and left mesiodistal maxillary canine width is slightly higher in male than female but are not statistically significant. Hence among maxillary and mandibular canine, mandibular canine can be used for sex estimation and shows significant sexual dimorphism whereas, maxillary canine is not suitable for sex estimation.

**Conflict of interest:** Nil

**Source of Funding:** Nil

**Ethical Clearence:** Taken from Institutional Ethical Committee with reference number IEC/ IIMSR/2023/13.

**Consent:** Informed consent taken from all the volunteer subjects.

**Abbreviations:** MD: Mesiodistal, SD: Standard deviation, mm: millimetres.

## References

- Rajendran R. Shafer's textbook of oral pathology. Elsevier India; 2009.
- Rentoul Edgar, Smith Hamilton, editors. Glaister's medical jurisprudence and toxicology, identification. London: Churchill Livingstone; 1973. p. 59-100.
- Brickley M, McKinley JI. Guidelines to the Standards for Recording Human Remains. Highfield, Southampton, BABAO. 2004. [http://www.babao.org.uk/Humanremains\\_FINAL.pdf](http://www.babao.org.uk/Humanremains_FINAL.pdf). Accessed 22 April 2015.
- Cattaneo C. Forensic anthropology: developments of a classical discipline in the new millennium. *Forensic Sci Int*. 2007 Jan 17;165(2-3):185-93. doi: 10.1016/j.forsciint.2006.05.018. Epub 2006 Jul 14. PMID: 16843626.
- Reddy LV. Lip prints: An overview in forensic dentistry. *J Adv Dent Res*. [2]2011;2(1):1720.
- Dinakaran J, Dineshkumar T, Nandhini G, Priyadarshini N, Rajkumar K. Gender determination using dentition. *SRM J Res Dent Sci*. 2015;6(1):29-34.
- Boaz K, Gupta C. Dimorphism in human maxillary and maxillary canines in establishment of gender. *J Forensic Dent Sci*. 2009;1:42-44.
- Beschiu LM, Ardelean LC, Tigmeanu CV, Rusu LC. Cranial and Odontological Methods for Sex Estimation-A Scoping Review. *Medicina (Kaunas)*. 2022 Sep 14;58(9):1273. doi: 10.3390/medicina58091273. PMID: 36143950; PMCID: PMC9505889.
- Kaushal, S, Patnaik VVG, Agnihotri G. Mandibular canines in sex determination. *J Anat Soc India* 2003;52: 119-124.
- Kieser JA. Human adult odontometrics. In: *The study of variation in adult tooth size*. Cambridge University Press. 1990.
- Mohammed QAR, Abdullah MA, Ashraf, Khan N. Dimorphism of mandibular and maxillary canine teeth in establishing identity SDJ, 1997; 9:17-20.
- Otuaga PO, Chris-Ozoko LE, lyndaSakpoba O, Oyem JC. A comparative study of the canine tooth as a tool in gender determination in Nigerian population. *Galician medical journal*. 2019 Jun 25;26(2).
- Garn SM, Lewis AB, Swindler DR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. *J Dent Res*. 1967;46(5):963- 972.
- Dahberg AA. Dental traits as identification tools. *Dent Prog*. 1963; 3:155-160.
- Gustafson G. (1950). Age determination on teeth. *J. Am. Dent. Assoc.*, 1950; 41: 45-54.
- Kieser JA. Human adult odontometrics: the study of variation in adult tooth size. Cambridge: University Press; c1990. DOI: <https://doi.org/10.1017/CBO9780511983610> [PMCID: PMC258591].
- Gustafsson A, Lindenfors P. Human size evolution: No allometric relationship between male and female stature. *J Hum Evol* 2004; 47:253-66.
- Frayner DW, Wolpoff MH. Sexual dimorphism. *Ann Rev Anthropol* 1985; 14:429-73.
- Syed MA, Selarka B, Tarsariya V. Sexual dimorphism in permanent maxillary and mandibular canines and intermolar arch width: Endemic study. *J Indian Acad Oral Med Radiol* 2015; 27:405 11.
- Mohsenpour K., Gangadhar MR and Samehsalari SJ. *Morphol. Sci.*, 2017, vol. 34, no. 4, p. 247-250.
- Bakkannavar SM, Manjunath S, Nayak VC, Kumar GP. Canine index - A tool for sex determination Egyptian *Journal of Forensic Sciences* (2015) 5, 157-161.
- Nair P, Rao BB, Annigeri RG. A study of tooth size, symmetry and sexual dimorphism. *J Forensic Med Toxicol* 1999; 16:10-13.
- Kapila R, Nagesh KS, Iyengar AR, 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):51-54.
- Priya K, Agrawal P, Bagga PK, Kalra H, Sirohi D and Gupta R. Sexual Dimorphism in Mandibular Canine Crown Dimensions in Early Adolescents: A Hospital based Study, *Indian Journal of Forensic Medicine & Toxicology*, January-March 2020, 14(1), 56-60.
- Maneel G, Girja BR, Tharaka R, Malik PP, Ghodke Kanchana G. Anodontologist's key to sex determination: Study analysis of mandibular canine teeth in South Indian population. *Journal of Orofacial research* 2013; 3(3):157-160.
- YuvenyaKaeswaren, Anita Zara Weinheimer. The Use of Mandibular and Maxillary Canine Teeth in Establishing Sexual Dimorphism in The Malaysian Population of Selangor. *J Forensic Sci & Criminal Inves*. 2019; 11(3): 555815.