Original Research Article

Sex Estimation using Mandibular First Molar and Maxillary First Molar: A Comparative Study

Mohammad Abdurrahman Khan[1], Manisha Verma[2], Anoop Kumar Verma[3], Syed Belal Hassan[4], Syed Fiza Mustaqueem[5], Iram Khan[6]

[1]Associate Professor, Department of Forensic Medicine and Toxicology, Hind Institute of Medical Sciences, Barabanki, [2]Senior Resident, Department of Periodontology, Faculty of Dental Sciences, King George's Medical University, Lucknow, [3]Professor and Head, Department of Forensic Medicine and Toxicology, King George's Medical University, Lucknow, [4]Associate Professor, Department of Community Medicine, Integral Institute of Medical Sciences & Research; Integral University, Lucknow, [5]Associate Professor. Department of Pathology, Integral Institute of Medical Sciences & Research; Integral University, Lucknow, [6]Professor and Head, Department of Forensic Medicine and Toxicology, Hind Institute of Medical Sciences, Barabanki.

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Abstract

Introduction: Estimation of sex from skeletal remains is an important initial medicolegal aspect of forensic and anthropological examination. Among various methods of sex estimation only DNA analysis gives absolute proof of sex estimation, but such methods are meticulous, immoderate and relatively prolonged and involves difficult DNA extraction technique. Teeth are strongest and toughest structure in the human body which are resistance to fire, decomposition and many other changes and teeth development completed before bone maturation making teeth relevant sex indicator hence teeth can be used for sex estimation. The 1st molar tooth is suitable tooth since it erupts early and very little chance of impaction than other teeth.

Aim: The aim of our study was to evaluate the sex estimation by mesiodistal width of mandibular and maxillary 1st molar teeth in north Indian population.

Materials and Methods: The sample comprised of dental impression from 106 individuals (53 males and 53 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 1st molar of both right and left side were measured by digital caliper.

Results: Data were summarized as Mean and SD. Groups (in Gender Male vs female) were compared by unpaired or independent Student's t test. Mean maxillary width of 1st molar of both right and left side were higher in male than female but were statistically not significant whereas mean of maxillary 1st molar width of right side though

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

E-mail: drmak2005@gmail.com

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slightly higher in male than female but was statistically not significant whereas of left side mean was lower in male than female and statistically not significant in young north Indian population. Very little sexual dimorphism shown by maxillary and mandibular 1st molar.

Conclusion: The study confirmed that maxillary and mandibular 1st molar did not establish a tool for sex estimation in north Indian populations since there was no statistically significant difference in mesiodistal width of mandibular and maxillary 1st molar among males and females on both the right and the left sides jaw.

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

Abbreviations: MD: Mesiodistal, SD: Standard deviation, mm: Millimetre.

Introduction

Estimation of sex from skeletal remains is an important initial medicolegal aspect of forensic and anthropological examination[1,2]. There are various methods of sex estimation like cheiloscopy[3,4,5], odontometry[6], osteometry[7], DNA analysis[8] and among them only DNA analysis gives absolute proof of sex estimation, but such methods are meticulous, immoderate, relatively prolonged and involves difficult DNA extraction technique and requires skilled and trained personnel[9,10]. Teeth are strongest and toughest structure in the human body which are resistance to fire, decomposition and many other changes[11] and teeth development completed before bone maturation making teeth relevant sex indicator[12,13,14] hence teeth can be used for sex estimation not only in living but also in mutilated bodies, decomposed bodies, or from fragmentary skeletal remains[15,16]. Sexual dimorphism means difference in size and appearance among male and female teeth that can be applied forsex determination[17]. Sex estimation by dental characteristics is mainly based on the comparison of metric and non-metric dental traits between men and women[1,18]. Metric analysis of tooth parameter is one of the acknowledged methods of sex determination by teeth. The 1st molar tooth is suitable tooth since it erupts early and very little chance of impaction than other teeth[19]. The aim of our study was to evaluate the sex estimationby mesiodistal width of mandibular and maxillary 1st molar teeth 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_{α} is critical value of z-score at αlevel of significance (at α= 5%, Z_{α}=1.96), p is proportion and E is permissible error. 7.48 % of sexual dimorphism observed by 1st molar width (7.03% by 1st maxillary molar width and 7.93% by 1st mandibular molar width parameter)[20]. So, p=7.48%, i.e., .0748, 1-p=.9252, E=5% i.e., .05. So, n= $(1.96)^2\times0.0748\times0.9252/(.05)^2=106.34\approx106$.

Studywas conducted on 106 volunteer subjects (53 male and 53 female) of both the sex having age group between 20 to 35 years at Integral Institute of Medical Sciences & Research, Integral University Lucknow. Informed consent was taken from all participants. Before starting study, ethical clearance was taken from Institutional Ethics Committee (IEC), IIMS&R Integral University, Lucknow with reference number IEC/IIMSR/2023/11.

Inclusion Criteria:

1. Age between 20 to 35 years.
2. Fully erupted with complete set of teeth.

3. No history of orthodontic treatment.
4. No history of any type of prosthesis.
5. Non-carious, non attrited, non-hypoplastic, non-traumaticand 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 tooth measurements

Impressions of the teeth were taken using irreversible hydrocolloid (alginate) material and poured by dental stone (Figure 1). Mesiodistal (MD) dimensions of mandibular 1st molar and maxillary 1st molar 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 and 3). If 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 given by Garn et al[21].

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

Figure 1. Dental cast

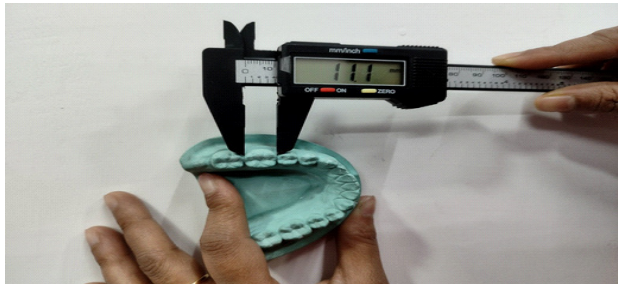

Figure 2. Measuring mesiodistal width of mandibular 1st molar by caliper

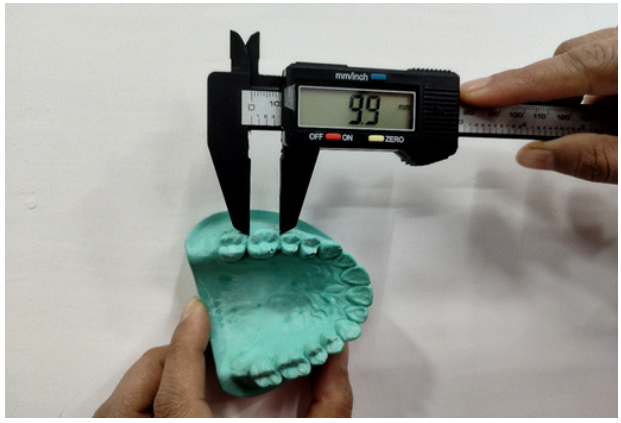

Figure 3. Measuring mesiodistal width of maxillary 1st molar by caliper

Results

Data obtained were quantified and analysed statistically using SPSS (Statistical Package for the Social Sciences). All description shown in table 1 to 4. Data were summarized as Mean and SD. Groups (in Gender Male versus female) were compared by unpaired or independent Student's t test.In our study mean of right mesiodistal mandibular 1st molar width was higher in male (for right mesiodistal mandibular 1st molar width 8.045472±.803611) than female (for right mesiodistal mandibular 1st molar width 7.892075±.761553) but statistically not significant (p value >.05). whereas the mean of left mesiodistal mandibular 1st molar width (Table 1) was slightly lower in male (for left mesiodistal mandibular 1st molar width 8.040566±.70829) than female (for left mesiodistal mandibular 1st molar width 8.081321±.857824) and was statistically not significant (p value >.05).Whereas as mean of right and left mesiodistal maxillary 1st molar width (Table 2) was higher in male (for right mesiodistal maxillary 1st molar width 8.509434±.657093 and for left mesiodistal

maxillary 1st molar width 8.53283±.632797) than female (for right mesiodistal maxillary 1st molar width 8.476981±.741891 and for left mesiodistal maxillary 1st molar width 8.411887±.843263) but was statistically not significant ((p value >.05 for both right side and left side maxillary 1st molar). Very little sexual dimorphism shown by right and left mandibular 1st molar (Table 3) as well as right and left maxillary 1st molar (Table 4).

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

Sex	Right mesiodistal mandibular 1st molar width (in mm)			Left mesiodistal mandibular 1st molar width (in mm)		
	Mean	Standard deviation	p value	Mean	Standard deviation	p value
Male	8.045472	.803611	.315479	8.040566	.70829	.790241
Female	7.892075	.761553		8.081321	.857824	

Table 2. Measurement of mean and standard deviation of maxillary 1st molar width among male and female

Sex	Right mesiodistal maxillary 1st molar width (in mm)			Left mesiodistal maxillary 1st molar width (in mm)		
	Mean	Standard deviation	p value	Mean	Standard deviation	p value
Male	8.509434	.657093	.812051	8.53283	.632797	.405701
Female	8.476981	.741891		8.411887	.843263	

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

Right mandibular 1st molar	1.94 %
Left mandibular 1st molar	-0.5 %

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

Right maxillary 1st molar	0.38 %
Left maxillary 1st molar	1.43 %

Discussion

Sex determination is initial steps in reconstruction of the identity of a person. Due to their durability and strength, teeth have excellent value for sex estimation especially when there is difficulty in preservation of skeleton either due to anthropic or taphonomic reasons[22,23,24,25,26,27]. Although the morphology of teeth is similar among male and female, it is not necessary that size of teeth remain same, as the size of teeth is influenced by multiple factors like diet, metabolic activities etc. Assessment of tooth parameter are non-invasive, quick, easy, less time consuming compared to analysis of DNA[28]. In this study the mean value of mesiodistal maxillary 1st molar width of both right and left side was compared. Mean mesiodistal value was slightly higher in male compared to female but the difference was not statistically significant (with p value >.05). The finding was similar with study done byAditya Jain[29], Dahal S. etal[30], Deo et al[31], Babu et al[32]. Whereas statistically significant difference (p value) found in mean value of mesiodistal width of maxillary 1st molar between male and female in studies done by Stroud et al[33], Perzigian[34], Sonika et al[35], Ghose and Baghdady[36], Hattab et al[37], Ghodosi et al[38], and Rai et al[39] in which they found male had larger teeth parameter than female in all dimension. Though the difference in teeth parameterswas due to more thickened dentine in male than female, as the Y chromosomes in male increases the mitotic strength of teeth germ and promotes dentinogenesis, whereas X chromosomes promotes amelogenesis[40]. The present study showed no significant difference(with p value >.05) in mean value of mesiodistal width of mandibular 1st molar of both right and left side between male and female (though right mesiodistal width was slightly higher in male than female and left mesiodistal width was slightly higher in female than male but insignificant), indicating almost symmetrical dimension which is similar to study done by Dr. Chandramani et al[41] who found mesiodistal width

of mandibular first molar was not significant for sex estimation. In contrast to our study KazzaziSM and Kranioti EF[20] and many others[17,42,43,44,45,46,47] who found statistically significant difference in mandibular mesiodistal measurement between male and female (p value <0.001). These differences may be due to geographical variation. In the present study very little sexual dimorphism shown by mesiodistal dimension of mandibular and maxillary 1st molar. Sexual dimorphism shown by right and left maxillary first molar was 0.38 % and 1.43% respectively (average 0.905%). These finding of present study was similar with study done by Dahal S.et al[30] who reported sexual dimorphism of 0.893% and 0.606% by right and left maxillary 1st molar respectively and study done by Ghose and Baghdady[36], who observed sexual dimorphism of 0.8% in the study of Iraqi population. Many studies in Indian scenario showed different results as Narang et al[48] and Ahmed et al[32]observed 6.9% and 4.4% of sexual dimorphism on right and left sides of maxillary 1st molar respectively. Similar finding was reported by Sonika et al.[35] who found sexual dimorphism of 4.74% and 4.84% in the right and left maxillary 1st molar respectively. Sexual dimorphism shown by right and left mandibular 1st molar was 1.94 % and -0.5 %(no sexual dimorphism) respectively. Little study present on sexual dimorphism shown by mandibular 1st molar. Study of Kazzazi SM and Kranioti EF[20] shows 7.93 % of sexual dimorphism in mandibular 1st molar which is much higher than finding in our study.These variations among various populations may be related to sample size of the study and selections, as well as genetical and racialvariances, which are most probably linked to different ethnicity.

Conclusions

The present study did not show statistically significant difference in mesiodistal width of mandibular and maxillary 1st molar among males and females on both the right and the left sides jaw. Hence, this study could not establish mandibular and maxillary 1stmolar as a tool for sex estimation.

Conflict of Interest: Nil

Source of Funding: Nil

Ethical Clearence: Has been taken from the Institutional Ethics Committee (IEC), IIMS&R Integral University, Lucknow with reference number IEC/IIMSR/2023/11.

References

1. Banerjee A, Kamath VV, Satelur K, Rajkumar K, Sundaram L, J Forensic Dent Sci, 8(2016). DOI: 10.4103/0975-1475.176946.
2. Omar A, Azab S, Cairo Dental Journal, 25 (2009) 167.
3. Sandhu SV, Bansal H, Monga P, Bhandari R. Study of lip print pattern in a Punjabi population. J Forensic Dent Sci. 2012 Jan;4(1):24-8. doi: 10.4103/0975-1475.99157. PMID: 23087578; PMCID: PMC3470414.
4. Devi A, Astekar M, Kumar V, Kaur P, Singh N, Sidhu GK. The study of inheritance analysis and evaluation of lip prints in individuals. J Forensic Dent Sci. 2015 Jan-Apr;7(1):49-53. doi: 10.4103/0975-1475.150309. PMID: 25709320; PMCID: PMC4330619.
5. Narwal A, Bala S, Hooda A, Gupta R. Cheiloscopy-an adjunct in identification of familial lineage. Journal of Oral Health and Community Dentistry. 2014;8(2):82-85. DOI: 10.5005/johcd-8-2-82
6. Khangura RK, Sircar K, Grewal DS. Four odontometric parameters as a forensic tool in stature estimation. J Forensic Dent Sci. 2015 May-Aug;7(2):132-6. doi: 10.4103/0975-1475.146367. PMID: 26005302; PMCID: PMC4430571.
7. Hasegawa I, Uenishi K, Fukunaga T, Kimura R, Osawa M. Stature estimation formulae from radiographically determined limb bone length in a modern Japanese population. Leg Med (Tokyo). 2009 Nov;11(6):260-6. doi: 10.1016/j.legalmed.2009.07.004. Epub 2009 Sep 6. PMID: 19736033.
8. Sharma M, Gorea RK. Importance of mandibular and maxillary canines in sex determination. J Punjab Acad Forensic Med Toxicol. 2010;10(1):27-30.
9. Iwamura ES, Soares-Vieira JA, Muñoz DR. Human identification and analysis of DNA in bones. Rev Hosp Clin Fac Med Sao Paulo. 2004 Dec;59(6):383-8. doi: 10.1590/s0041-87812004000600012. Epub 2005 Jan 11. PMID: 15654493.
10. Dumpala RK, Guttikonda VR, Madala J. Kanth S. Sex determination using diagonal measurement of teeth in a tribal and an urban population: a comparative study Int J Cont Med Res. 2014;1(2):27-33.
11. Eboh DE, Etetafia MO. Maxillary canine teeth as supplement tool in sex determination. Ann Biomed Sci. 2010;9:25-30. DOI: 10.4314/abs.v9i1.66571
12. Singla S, Gupta R, Puri A, Bansal S, Singla S, Nangia R. Determination of sexual dimorphism via maxillary first molar teeth in Himachali population. J Forensic Dent Sci. 2015 May-Aug;7(2) 90-94. doi:10.4103/0975-1475.156190. PMID: 26005295; PMCID: PMC4430581.

13. Dalli DT, Reddy S, Dathar S, Nallakunta R, Madugula P, Darna G. Odontometrics: A Key to Gender Determination. World J Dent 2016;7(3):150-154. DOI: 10.5005/jp-journals-10015-1385

14. Acharya AB, Mainali S. Are dental indexes useful in sex assessment? J Forensic Odontostomatol. 2008 Dec 1;26(2):53-9. PMID: 22717790.

15. Whittaker DK. An introduction to forensic dentistry. Quintessence Int. 1994 Oct;25(10):723-30. PMID: 9161251.

16. Kaushal, S, Patnaik VVG, Agnihotri G. Mandibular canines in sex determination. J Anat Soc India 2003;52: 119-124.

17. Vodanovic M, Demo Z, Njemirovskij V.Odontometrics: a useful method for sex determination in anarchaeological skeletal population. Journal of Archaeological Science,2007, 34:905-913.https://doi.org/10.1016/j.jas.2006.09.004

18. Ambika M. Permanent maxillary first molars: Role in gender determination (Morphometric analysis). J Forensic Dent Sci. 2019;4:101-2.

19. Yaseen SM, Naik S, Uloopi KS. Ectopic eruption - A review and case report. Contemp Clin Dent. 2011 Jan;2(1):3-7. doi: 10.4103/0976-237X.79289. PMID: 22114445; PMCID: PMC3220171.

20. Kazzazi SM, Kranioti EF Odontometric analysis of sexual dimorphism in permanent maxillary and mandibular molars. J Forensic Sci Criminol,2017, 5(1): 102. doi: 10.15744/2348-9804.5.102.

21. Garn SM, Lewis AB, Swindler DR, Kerewsky RS. Genetic control of sexual dimorphism in tooth size. J Dent Res. 1967 Sep-Oct;46(5):963-72. doi: 10.1177/00220345670460055801. PMID: 5234039.

22. Scheuer L. Application of osteology to forensic medicine. Clin Anat. 2002 Jun;15(4):297-312. doi: 10.1002/ca.10028. PMID: 12112359.

23. Bruzek J, Murail P. Methodology and reliability of sex determination from the skeleton. Forensic Anthropology and Medicine: Complementary Sciences From Recovery to Cause of Death. 2006; 225-242.

24. Thompson T, Black S, editors. Forensic human identification: an introduction. CRC press; 2006 Nov 14. https://doi.org/10.1201/9781420005714

25. Ubelaker DH. Forensic anthropology: methodology and diversity of applications. Biological anthropology of the human skeleton. 2008 Mar 21:41-69.

26. Iscan MY, Steyn M. The human skeleton in forensic medicine. Charles C Thomas Publisher; 2013 Sep 1.

27. Scott GR, Turner CG. Anthropology of modern human teeth. Cambridge: Cambridge University Press; 1997 Apr 17.

28. Shireen A, Ara SA. Odontometric analysis of permanent maxillary first molar in gender determination. J Forensic Dent Sci. 2016 Sep-Dec;8(3):145-149. doi: 10.4103/0975-1475.195120. PMID: 28123268; PMCID: PMC5210101.

29. Aditya Jain. . Odontometric Analysis of Permanent Maxillary First Molar for Sex Determination. Indian Journal of Public Health Research & Development,2020, 11(11), 77–85. https://doi.org/10.37506/ijphrd.v11i11.11350

30. Dahal S, Baral R, Gupta SP, Chaudhary GK. Sex determination using mesiodistal width of permanent maxillary molar. J Kathmandu Med Coll. 2021;10(4):213-7.https://jkmc.com.np/ojs3/index.php/journal/article/view/1133

31. Deo E. A dimorphic study of maxillary first molar crown dimensions of Urhobos in Abraka, South-Southern Nigeria. J Morphol Sci. 2012;29:96-100.

32. Ahmed BRM, Tarigoppula RK, Kulkarni PG, Anil BS. Gender determination using diagonal measurements of maxillary molar and canine teeth in Davengere population. J Clin Diagn Res. 2014;8(11):ZC141-ZC144. doi: 10.7860/JCDR/2014/9944.5218

33. Stroud JL, Buschang PH, Goaz PW. Sexual dimorphism in mesiodistal dentin and enamel thickness. Dentomaxillofac Radiol. 1994 Aug;23(3):169-71. doi: 10.1259/dmfr.23.3.7835519. PMID: 7835519.

34. Perzigian AJ. The dentition of the Indian Knoll skeletal population: odontometrics and cusp number. Am J Phys Anthropol. 1976 Jan;44(1):113-21. doi: 10.1002/ajpa.1330440116. PMID: 1247106.

35. 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 Jul 1;29(1):37-43. PMID: 21841267; PMCID: PMC5734842.

36. Ghose LJ, Baghdady VS. Analysis of the Iraqi dentition: mesiodistal crown diameters of permanent teeth. J Dent Res. 1979 Mar;58(3):1047-54. doi: 10.1177/00220345790580030301. PMID: 284038.

37. Hattab FN, al-Khateeb S, Sultan I. Mesiodistal crown diameters of permanent teeth in Jordanians. Arch Oral Biol. 1996 Jul;41(7):641-5. doi: 10.1016/s0003-9969(96)00066-0. PMID: 9015564.

38. Ghodosi A, Mosharraf R, Nia FF. Sexual variation in bucco-lingual dimensions in Iranian dentition. Int J Dent Anthropol 2008; 12:1-7.

39. Rai B, Dhattarwal SK, Anand SC. Sex determination from tooth. Med Leg Update. 2008;8(1):3-5.

40. Shireen A, Ara SA. Odontometric analysis of permanent maxillary first molar in gender determination. J Forensic Dent Sci. 2016 Sep-Dec;8(3):145-149. doi: 10.4103/0975-1475.195120. PMID: 28123268; PMCID: PMC5210101.

41. Preeti N, Balaji Rao B, Anniger RG. A study of tooth size, symmetry and sexual dimorphism. JFMT 1999;16:10-3.

42. More C, Rajeshkumar RN, Peter R, Patel PT. Sexual dimorphism and odontometric analysis of permanent maxillary and mandibular first molar: an anthropometric study. Int J Current Research.2017; 9(04), 49364-49367.DOI:10.13140/RG.2.2.10864.97281

43. Viciano J, López-Lázaro S, Alemán I. Sex estimation based on deciduous and permanent dentition in a contemporary Spanish population. Am J Phys Anthropol. 2013 Sep;152(1):31-43. doi: 10.1002/ajpa.22324. Epub 2013 Jul 30. PMID: 23907722

44. Zorba E, Moraitis K, Manolis SK. Sexual dimorphism in permanent teeth of modern Greeks. Forensic Sci Int. 2011 Jul 15;210(1-3):74-81. doi: 10.1016/j.forsciint.2011.02.001. Epub 2011 Mar 2. PMID: 21371836.

45. Viciano J, Alemán I, D'Anastasio R, Capasso L, Botella MC. Odontometric sex discrimination in the Herculaneum sample (79 AD, Naples, Italy), with application to juveniles. Am J Phys Anthropol. 2011 May;145(1):97-106. doi: 10.1002/ajpa.21471. Epub 2011 Feb 10. PMID: 21312179.

46. Zorba E, Moraitis K, Eliopoulos C, Spiliopoulou C. Sex determination in modern Greeks using diagonal measurements of molar teeth. Forensic Sci Int. 2012 Apr 10;217(1-3):19-26. doi: 10.1016/j.forsciint.2011.09.020. Epub 2011 Oct 17. PMID: 22005548.

47. Zorba E, Spiliopoulou C, Moraitis K. Evaluation of the accuracy of different molar teeth measurements in assessing sex. Forensic Sci Med Pathol. 2013 Mar;9(1):13-23. doi: 10.1007/s12024-012-9372-8. Epub 2012 Aug 28. PMID: 22926774.

48. Peckmann TR, Meek S, Dilkie N, Mussett M. Sex estimation using diagonal diameter measurements of molar teeth in African American populations. J Forensic Leg Med. 2015 Nov;36:70-80. doi: 10.1016/j.jflm.2015.09.001. Epub 2015 Sep 12. PMID: 26408392.

49. Narang RS, Manchanda AS, Malhotra R, Bhatia HS. Sex determination by mandibular canine index and molar odontometrics: A comparative study. Indian J Oral Sci. 2014;5:16-20.DOI:10.4103/0976-6944.129944.