Canine Width as a Means for Stature & Sex Prediction

Jyoti Barwa[1], Rattan Singh[2], Shipra Agarwal[3]

[1] Assistant Professor, Department of Forensic Medicine & Toxicology, Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar, Dehradun, Uttarakhand, [2]Assistant Professor, Department of Forensic Medicine & Toxicology, Himalayan Institute of Medical & Health Sciences, SRHU, Jolly Grant, Dehradun, Uttarakhand, [3]MDS, 1st yr student, Deparment of Periondontics,Vokkaligari Sangha Dental College & Hospital, KR road, Visvesvarapuram, Bangaluru, Karnataka

Abstract

Background: Estimation of stature, along with sex, age and race, is one of the four pillars of forensic anthropology and is considered a preliminary screening in identification of skeletal remains. Teeth, particularly the canines form an excellent material for such forensic investigations as they resist decay due to caries or other diseases of tooth as well as remain highly stable during natural calamities.

Materials & Method: Study was conducted in SSSMC, Dehradun among 100 healthy subjects (>17 years), comprising 66 males and 34 females. Mean mesio-distal width of mandibular canine tooth was measured on both side on dental casts and mean stature measured by anthropometer. The collected data was subjected to statistical analysis; correlation and sexual dimorphism was calculated for both sexes and a linear regression formula obtained for estimating stature.

Observations & Result: Mean canine width on both right and left side as well as height was more in males as compared to females. Sexual dimorphism was more involving right canine width. The findings were found to be statistically significant for right canine width (RCW) and for height, between male and females. Accuracy for sex prediction was high in females (F= 64.7%, M=59.1%). Using the values of RCW and LCW, regression equations were obtained for estimating height.

Conclusion: Width of mandibular canine is reliable for stature estimation but for sex prediction it is not much reliable on the left side. However these parameters can be used as an adjuvant in situations when only single tooth is available for identification.

Keywords: *canine width, stature, identification, sexual dimorphism*

Introduction

In mass disasters, identification of an unknown person from fragmentary remains is the utmost requirement in order to aid the legal authorities in further investigation. Significant parameters for establishing the identity include age, sex and stature because as only these criteria needs to be considered and rest all can be excluded in the missing persons[1]. A definite biologic relationship exists proportionately with every part of the human body including head, face, trunk, long bones, foot length as well as shoe print.[2-9]Forensic dentistry too plays an important role in human identification, especially when conventional methods cannot be applied, usually due to advanced decomposition, carbonization or fragmentation of the body.[10,11]

The method of using teeth has several advantages as it is easy to locate & measure. Also, they are relatively resistant to damage and most of the odonto-metric parameters remain constant over time[12].Amongst all the teeth in human dentition, canines are the most stable because of the labio-lingual thickness of the crown and root anchorage in the alveolar process of jaws. They are the least frequently extracted tooth or affected by periodontal diseases, less exposed to plaque, calculus and abrasion from brushing. In fact, they are

reported to withstand extreme conditions and have been recovered from human remains even after hurricanes and air disasters[13-16] Though, most of studies have been conducted to correlate combined mesio-distal width of maxillary or mandibular anterior teeth with stature and sex prediction doe using various indices; this study aims to study the relationship of only mandibular canine with stature and sex which could prove to be useful when disarticulated tooth from the socket is recovered in above mentioned situations.

Materials & Method

The study was conducted in Shridev Suman Subharti Medical College, Dehradun among 100 (66 males & 34 females) healthy students of the Institute having age > 17 years. Those having broken/ damaged or caries involving canine, spinal deformity (kyphosis, scoliosis etc.) or any history of orthodontic/ orthognathic treatment were excluded from the study. A written informed consent was duly obtained from all the willing participants; procedure and purpose of study was explained in detail. Stature was measured as the vertical distance from the vertex to the floor using a standard anthropometer. Measurements were taken by making the barefooted subject stand erect on a horizontal resting plane. Anthropometer was placed in straight vertical position behind the subject with the head oriented in the Frankfurt Horizontal Plane & shoulders & hips touching the vertical limb of the instrument. The movable rod of the anthropometer was brought in contact with the vertex in the mid-sagittal plane. A dental cast of lower jaw was prepared for all the subjects using alginate paste and dental stone. Maximum mesio-distal width of mandibular canines was measured directly on these casts using a digital vernier calliper. It was noted by a single observer on both sides to minimise subjective errors; all these measurements were taken twice and an average was duly noted. Subsequently, using statistical software SPSS version 20, sexual dimorphism, Pearson's correlation and simple linear regression equations formulated for determining stature.

Observation & Results

Among the subjects in the study, mean canine width on both right and left side was more in males as compared to females. Similarly, height was found to be more in males. In all the parameters, t value expressed a very slight difference between male and females, in a positive direction. These findings were found to be statistically significant for right canine width and for height between male and females since p value (0.032) is less than 0.05. However, they were found to be insignificant for left canine width. Sexual dimorphism is highest when height is being considered, but among canine width it is more on the right side.(Table 1)

Table 1: Independent sample t- test

	Sex	N	Mean	SD	Std. Error Mean	t value	p value	Sexual dimorphism
RCW	M	66	6.48	.49	.05983	2.177	.032	3.43 %
	F	34	6.27	.43	.07433			
LCW	M	66	6.47	.52	.06444	1.645	.103	2.71%
	F	34	6.30	.43228	.07414			
H	M	66	167.61	8.09	.99590	4.345	.000	4.95 %
	F	34	159.70	9.60	1.64550			
	total	100	164.9176	9.37	0.937	-	-	

NOTE: RCW-Right canine width, LCW-Left canine width, H-Height, N-Number, SD-Standard deviation

Paired t test showed that in females LCW > RCW as the t value obtained is –0. 596 while in males RCW >LCW as t value is 0.170. However, there is statistically non-significant difference between right and left canine width in both the sexes as p value is more than 0.05. (Table 2)

Table 2: Paired t test for finding correlation between right and left canine width in both sexes

Sex of subjects	Number	t value	p value
F	34	-0.596	0.55
M	66	0.170	0.87

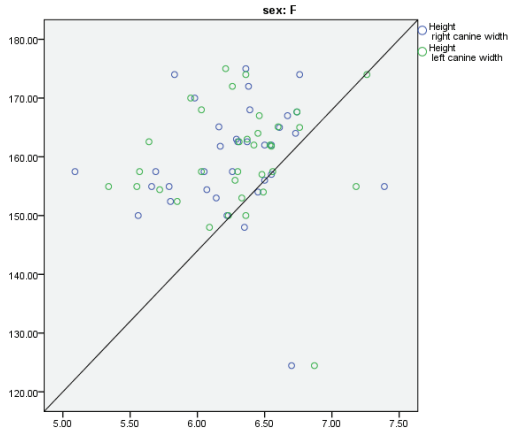
The percentage of accuracy in predicting sex was found to be 64.7% for females and 59.1% for males by using Discriminant function analysis.

In females, the Pearson's correlation value between height and canine width on both sides is found to be positive and very weak having statistically non-significant correlation as p value is more than 0.05.Similarly, in males, correlation value between height and RCW is positive and very weak; statistically non-significant correlation. However, on left side (LCW) there is statistically significant correlation. Also, in total subjects, correlation value is positive, very weak and found to be statistically significant. Using the values of RCW and LCW as independent variable, regression equations were obtained for predicting height in both the

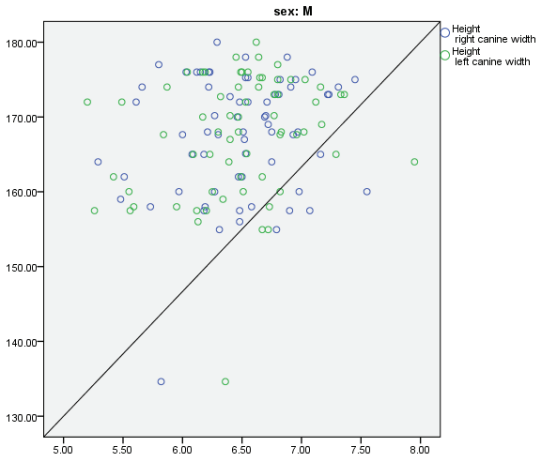
Table 3: Simple linear regression equations (height as dependent variable and canine width as independent variable)

	Variables	Mean	S.D	r	r2	P-Value	Regression
F (34 Subjects)	Height	159.69	9.59	0.08	.006	0.35	Y1= 148.60 ɤ 1.77 (RCW)
	RCW	6.27	0.43				
	Height	159.69	9.59	0.06	0.004	0.36	Y2= 150.83 ɤ 1.41 (LCW)
	LCW	6.30	0.43				
M (66 subjects)	Height	167.608	8.09	0.17	.030	0.08	Y3= 148.80 ɤ 2.90 (RCW)
	RCW	6.48	0.48				
	Height	167.608	8.09	0.24	0.06	0.026	Y4= 143.52 ɤ 3.72 (LCW)
	LCW	6.47	.52				
Total Subjects (100)	Height	164.918	9.37	0.21	0.045	0.017	Y5= 138.31 ɤ 4.15 (RCW)
	RCW	6.41	.48				
	Height	164.918	9.37	0.23	0.052	0.011	Y6= 137.47 ɤ 4.28 (LCW)
	LCW	6.41	.498				

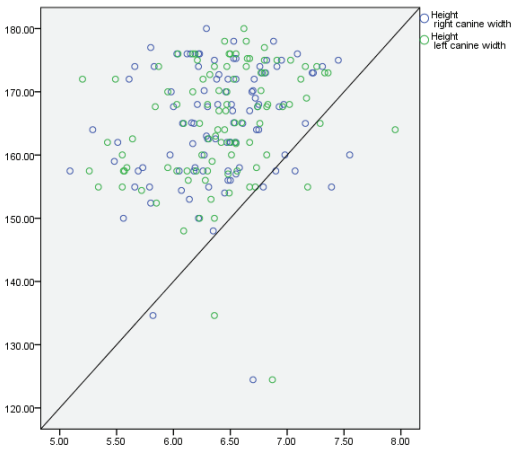
sexes as well as in total subjects. (Table 3, graph 1 to 3)



Graph 1: Scatter diagram showing weak and positive correlation between Right and Left canine width and height in Female subjects.



Graph 2: Scatter diagram showing weak and positive correlation between Right and Left canine width and height in male subjects



Graph 3: Scatter diagram showing weak and positive correlation between Right & left canine width with height in total subjects

Discussion

Since no two dentitions are alike, this dental identification can be applied for differentiating the size, stature and appearance between male and females.[17]Various studies have been conducted in the past to predict sex from tooth measurements and to determine sexual dimorphism.[13,18,19] It has been found that highest sexual dimorphism is observed with canines as compared with other teeth. [21,22]

Most of the authors failed to obtain a significant difference in canine widths between the right and left sides[18-20] which is consistent with our study. Also, statistically significant differences were obtained by some authors in mesiodistal widths of mandibular canines between males and females.[18,2] which is inconsistent with our study. This significant sexual dimorphism in the tooth can be attributed to the presence of relatively more dentine in males when compared with females.[18]

Similar to our study, some of the authors[18,23] found a higher sexual dimorphism in right canines as compared to the left canines except in the study by Kaushal et al[24] who found a higher sexual dimorphism on the left side.

Numerous studies[25-29] have been conducted considering various odontometric parameters either individually or collectively, having some degrees of positive correlations with stature with or without significance between them.

Yadav AB et al[30] conducted a study involving individual tooth dimensions of maxillary canines which revealed that that all odontometric parameters showed positive correlation with stature independent of gender; among them maxillary canine width showed highest correlation. Few studies[31,3] involving only crown dimensions of teeth failed to provide accuracy of estimation of stature due to significant but low to moderate correlations. This is in concordance with our study to some extent as we did observe statistically significant correlation when all the subjects were considered together and among the male on left side. These relatively non-significant findings could possibly be attributed to early completion of growth of tooth crowns as compared to other parameters such as long bones which on the other hand mature much later and have a higher stature-correlation.[31]

Conclusion

From the present study, it can be concluded that regression equations generated from meso-distal width of mandibular canine can be used as a supplementary

approach for predicting stature when limbs/extremities are not available or are fragmented. Since, there is statistically significant difference between male and female only for RCW and sexual dimorphism is more on the right side, sex prediction is not much reliable using measurement of left canine. Also, accuracy for sex prediction using canine width as a parameter is more in females (64.7%). However, these parameters are population specific and anthropometric difference varies between races. It is also invariably influenced by national, social and economic conditions.[32] Hence, the findings need to be used with caution and the study requires to be extended further to involve different population groups.

Conflict of Interest: None

Funding: Self

Ethical Clearance: obtained from the Institutional ethics committee

References

1. Dahlberg AA. Dental traits as identification tools. Dent Prog 1963; 3: 155-60.
2. Yadav AB, Yadav SK, Kedia NB, Singh AK. An odontometric approach for estimation of stature in Indians: Cross – Sectional analysis. J Clin Diagn Res 2016;10(3):24-6.
3. Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry and skull anthropometry. Indian J Dent Res 2008 Apr-Jun;19(2):150-154.
4. Jasuja OP, Singh G. Estimation of stature from hand and phalange length. Journal of Indian Academy of Forensic Medicine. 2004; 26:100-06.
5. Holland TD. Estimation of adult stature from fragmentary tibias. J Forensic Sci. 1992:37:1223-29
6. Jason DR, Taylor K. Estimation of stature from the length of the cervical, thoracic and lumbar segments of the spine in American Whites and Blacks. J Forensic Sci. 1995;40: 59-62
7. Bidmos MA, Asala S. Calacaneal measurement in estimation of stature of South African Blacks. Am J Phys Anthropol. 2005; 126:335-42.
8. Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. J Forensic Leg Med. 2007;14:327-32.
9. Jasuja OP, Singh J, Jain M. Estimation of stature from foot and shoe measurements by multiplication factors: a revised attempt. Forensic Sci Int. 1991; 50:203-15.
10. Krishan K. Anthropometry in forensic medicine and forensic science-'Forensic Anthropometry', The Internet Journal of Forensic Science 2007 DOI: 10.5580/1dce [cited 2014 Nov 05].
11. Sheta A, Hassan M, Elserafy M. Stature estimation from radiological determination of humerus and femur lengths among a sample of Egyptian adult,. Bull Alex Fac Med. 2009; 45: 479-86.
12. Whittaker DK, MacDonald DG. A Colour Atlas of Forensic Dentistry. 1st ed. England: Wolfe Medical Publications Ltd; 1989. p.58-66.
13. Sekhon H, Singh R, Barwa J. Determination of sex from mandibular canine index in Delhi population. Medico-Legal Update 2017; 17(2): 156-9.
14. Boaz K, Gupta C. Dimorphism in human maxillary and mandibular canines in establishment of gender. J Forensic Dent Sci 2009;1:42-4.
15. Kaushal S, Patnaik VV, Agnihotri G. Mandibular canines in sex determination. J Anat Soc India 2003;52:119-24.
16. Anderson DL, Thompson GW. Inter-relationship and sex differences of dental and skeletal measurements. J Dent Res 1973; 52; 431-8.
17. Kiesu JA. Human adult odontometrics:the study of variation in adult tooth size. Cambridge:University Press; 1990.
18. Kiran CS, Khaitan T, Ramaswamy P, Sudhakar S, Smitha B, Uday G. Role of mandibular canines in establishment of gender. Egyptian Journal of Forensic Sciences (2014) 4, 71–4.
19. Ayoub F, Shamseddine L, Rifai M, Cassia A, Diab R, Zaarour I. Mandibular Canine Dimorphism in Establishing Sex Identi-ty in the Lebanese Population. Int J Dentistry. 2014;1:1–4.
20. Hashim HA, Murshid ZA. Mesiodistal tooth width – a comparison between Saudi males and females. Egypt Dent J 1993;39:343–6.
21. Hemani S, Balachander S, Kumar R, Rajkumar K. Dental dimorphism in ethnics of tamilnadu: Aid in forensic identification. J Forensic Odontol 2008;1;37-45.
22. Legovic M, Novosel A, Legovic A. Regression equations for determining mesiodistal crown

diameters of canines and premolars. Angle Orthodontist 2003;73:314–8.

23. Vishwakarma N, Guha R. A study of sexual dimorphism in permanent mandibular canines and its implications in forensic investigations. Nepal Med Coll J 2011;13(2):96–9.
24. Kaushal S, Patnaik VV, Agnihotri G. Mandibular canine in sex determination. J Anat Soc India 2003;52:119–24.
25. Patil HS, Alane UY. Estimation of stature in local Beed (Maharashtra) population : An odontometric approach. Journal of Dental and Medical Sciences 2017; 6(9): 80-4.
26. Gondivkar SM, Gadbail AR, Vedpathak PR, Sarode S, Sarode G, Mankar M, Patil S. Odontometric and Skull Anthropometric Parameters as a Forensic Tool in Stature Estimation: A Cross-sectional Analysis. World J Dent 2017;8(3):202-206
27. Gupta A, Kumar K, Shetty DC, Wadhwan V, Jain A, Khanna KS. Stature and gender determination and their correlation using odontometry and skull anthropometry. J Forensic Dent Sci 2014 May;6(2):101-106.
28. Khangura RK, Sircar K, Grewal DS. Four odontometric parameters as a forensic tool in stature estimation. IOSR J Forensic Dent Sci. 2015;7(2):132–136.
29. Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry and skull anthropometry. Indian J Dent Res 2008;19:150-4.
30. Yadav AB , Yadav SK , Kedia NB , Singh AK. An Odontometric Approach for Estimation of Stature in Indians: Cross- Sectional Analysis. Journal of Clinical and Diagnostic Research. 2016 Mar;10(3):24-6.
31. Prabhu S, Acharya AB, Muddapur MV. Are teeth useful in estimating stature? J Forensic Leg Med 2013; 20: 460-4.
32. Hossain MZ, Munawar KM, Rahim ZH, Bakri MM. Can stature be estimated from tooth crown dimensions? A study in a sample of South-East Asians.Arch Oral Biol**.** 2016 Apr;64:85-91
33. Sunitha J, Ananthalakshmi R, Sathiya JJ, Nadeem J, Dhanarathnam S. Prediction of anthropometric measurements from tooth length – A Dravidian study. J Forensic Odontostomatol 2015;33:18-25.