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# Four odontometric parameters as a forensic tool in stature estimation

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## Abstract

**Objective:** The study was conducted to investigate the possibility of predicting the height of an individual using selected odontometric parameters as a forensic tool. **Materials and Methods:** The study sample consisted of 100 subjects (50 male and 50 female). Measurements of intercanine width (IC), interpremolar width (IP), mesiodistal dimension of six permanent maxillary anterior teeth (CW), and arch length (AL, canine to canine) were made directly on the subject. The data collected were subjected to statistical analysis and a linear regression formula was obtained against each odontometric parameter. **Results:** Highly significant correlation was observed between height and intercanine width, interpremolar width ($P < 0.0001$), whereas correlation between height and the combined width of six anterior teeth and arch length was found to be not significant. The linear regression equation using formula $y = c + mx$ was obtained for each odontometric parameter and also for combined parameters. **Conclusion:** Hence the study concludes that the two odontometric parameters such as intercanine width and interpremolar width can be used successfully to calculate the stature of an individual from fragmentary remains.

**Key words:** Arch length, arch width, intercanine width, interpremolar width, odontometric parameters, stature estimation

## Introduction

Stature is the height of a person in the upright posture. In the identification of unknown human remains, stature estimation is a preliminary investigation. In cases where identification has to be performed based on skeletal remains, the most common stature estimates are derived from long bones.[1,2] These are based upon the principle that the various long bones correlate positively with stature.[3] Stature correlation to skull and jaw dimensions has been frequently reported among various populations. However, few studies have been done correlating various odontometric parameters with the height of an individual.[4]

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This study was undertaken to investigate the relationship of the height of a person with odontometric parameters like intercanine width of maxillary arch, interpremolar width, combined mesiodistal width of six permanent maxillary anterior teeth and arch length.

## Materials and Methods

The study sample consisted of 100 subjects (50 males and 50 females) selected from the OPD of D.J. College of Dental Sciences and Research, Modinagar, Uttar Pradesh, India. The subjects were selected based on the following criteria:

- Age 20-30 years
- A complete set of fully erupted, periodontally healthy, noncarious, intact, satisfactorily aligned maxillary teeth
- No history or clinical evidence of cleft palate, crown restoration, orthodontic treatment, and trauma
- No history or clinical features suggestive of endocrinal disorders, metabolic disorders, developmental disorders, or history of prolonged illness.

After obtaining informed consent from the subjects selected, the mesiodistal crown width of the six permanent

anterior maxillary teeth, the arch length (AL) of maxillary arch (from canine to canine), the interpremolar width (IP), the intercanine width (IC) were measured and recorded.

The maximum mesiodistal width of each tooth was measured at the level of anatomic contact points directly on the subject, with the help of a digital vernier caliper accurate to 0.01 mm (Mitutoyo Digital Caliper, Japan) with the instrument held parallel to the occlusal plane. The combined mesiodistal width of the maxillary anterior teeth (CW) in each case was obtained by summation of the individual mesiodistal widths of each maxillary permanent anterior tooth. If it was difficult to place the vernier caliper, a manual divider with very fine tips was used to measure the dimension; later we measured the divider distance with the same digital vernier caliper [Figure 1]. Hence the combined mesiodistal width of the maxillary permanent anterior teeth was added to get a combined value (CW).

Intercanine width was measured as the horizontal distance between the cusp tip of right side canine to the cusp tip of left side canine, whereas the interpremolar width was measured as the horizontal distance between the buccal cusp tips of maxillary first premolar from right side to left side [Figure 2]. Arch length was measured using a sterilized wire which was closely adapted from the distal surface of canine from one side to the distal surface of canine on the opposite side at the middle third of each tooth [Figure 3]; later the wire was straightened and length was measured using a scale.

The height of each subject was measured as the vertical distance from the vertex to the floor using a standard anthropometer. Measurements were taken by making the subject stand erect on a horizontal resting plane barefooted. Anthropometer was placed in straight vertical position behind the subject with the head oriented in Frankfurt plane and shoulder blocks and buttocks touching the vertical limb of the instrument. The movable rod of the anthropometer was brought in contact with the vertex in the midsagittal plane.

All the measurements were done by a single examiner to eliminate inter-observer error. All the dimensions were measured three times for each tooth and the average was recorded in order to minimize the intra-observer error. The data collected were subjected to statistical methods for correlation and the linear regression formula was obtained for each parameter separately and in combination with other parameters. The SPSS software package version 17 was used for statistical analysis.

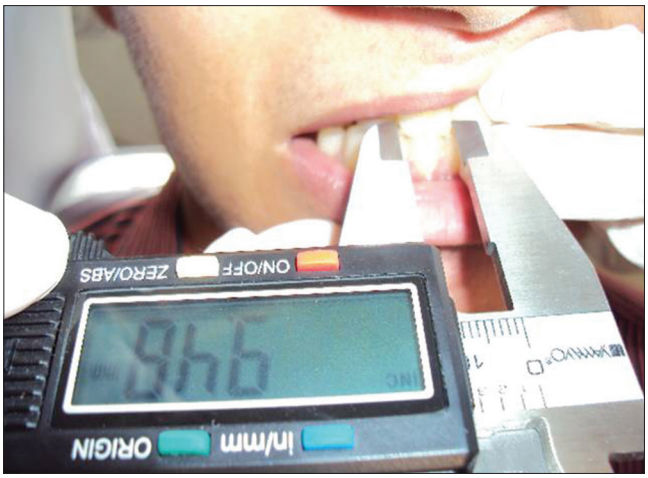


**Figure 1:** Measuring the mesiodistal dimension of maxillary anterior teeth clinically on a patient with an electronic vernier caliper


**Figure 2:** Measuring the interpremolar width with the help of a vernier caliper

**Figure 3:** Measuring the arch width (from canine to canine) with the help of a wire

## Results

Table 1 shows a detailed description of each parameter taken up for the study such as maximum value, minimum value, mean value, standard deviation, and *P* value. Table 2 shows the correlation coefficient of all the parameters with the height of individuals along with their respective *P* value.

**Table 1: Minimum, maximum, and mean values of each odontometric parameter**

| Parameter | Minimum | Maximum | Mean | SD | *P* value | Significance |
|---|---|---|---|---|---|---|
| Height | 14360.00 | 18400.00 | 16410.90 | 905.06 | 0.000508 | S |
| CW | 39.40 | 59.50 | 45.79 | 3.15 | 0.120438 | NS |
| IC | 29.07 | 42.99 | 36.64 | 2.53 | 0.006028 | S |
| IP | 38.30 | 53.08 | 44.38 | 2.85 | 0.005489 | S |
| AL | 44.00 | 69.00 | 55.20 | 4.07 | 0.119565 | NS |
| CW+IC | 71.98 | 96.31 | 82.43 | 4.72 | 0.00819 | S |
| CW+IP | 78.83 | 107.15 | 90.17 | 4.92 | 0.007309 | S |
| CW+AL | 89.18 | 120.50 | 100.99 | 6.28 | 0.103774 | NS |
| IC+IP | 68.61 | 96.07 | 81.02 | 5.09 | 0.005364 | S |
| IC+AL | 78.22 | 111.99 | 91.84 | 5.59 | 0.008927 | S |
| IP+AL | 84.10 | 122.08 | 99.58 | 5.67 | 0.007866 | S |
| CW+IC+IP | 110.69 | 147.47 | 126.81 | 6.93 | 0.006293 | S |
| CW+IC+AL | 123.55 | 163.39 | 137.63 | 7.74 | 0.009773 | S |
| CW+IP+AL | 130.28 | 173.48 | 145.37 | 7.82 | 0.008836 | S |
| IC+IP+AL | 118.32 | 165.07 | 136.22 | 7.63 | 0.006632 | S |
| CW+IC+IP+AL | 164.69 | 216.47 | 182.01 | 9.65 | 0.007371 | S |

S=Significant, NS=Non-significant

**Table 2: Correlation coefficient between height and odontometric parameters**

| Parameter | Correlation coefficient | *P* value |
|---|---|---|
| CW | 0.121 | NS |
| IC | 0.289 | 0.01 |
| IP | 0.351 | 0.01 |
| AL | 0.112 | NS |
| CW+IC | 0.236 | 0.05 |
| CW+IP | 0.281 | 0.01 |
| CW+AL | 0.133 | NS |
| IC+IP | 0.340 | 0.01 |
| IC+AL | 0.213 | 0.05 |
| IP+AL | 0.257 | 0.01 |
| CW+IC+IP | 0.305 | 0.01 |
| CW+IC+AL | 0.203 | 0.05 |
| CW+AP+AL | 0.235 | 0.05 |
| IC+IP+AL | 0.287 | 0.01 |
| All combined | 0.266 | 0.01 |

NS=Non-significant

The statistical analysis showed that out of the four selected odontometric parameters, intercanine width and interpremolar width were found to show significant correlation with height. However, when the combined width of six anterior teeth and arch length was plotted against height, no statistically significant correlation was found between them.

When two or more than two parameters were combined and correlated to the height, the gradient of the trend line improved indicating elevated correlation. The most significant correlation was observed when all four odontometric parameters were added and regressed against height. This combination category provided the most reliable stature estimates.

The regression equations were derived using all four parameters separately and also in combination. The following regression equation was used to calculate the height of an individual, i.e.:

$$y = c + mx$$

where y = predicted height of the individual, c = constant for that parameter, m = regression coefficient, and x = value of parameter used for calculation of stature. Table 3 shows the value of constant (c) and regression coefficient (m) for each parameter or combination of parameters along with regression formula for estimating the stature of an individual.

With application of Z test, no statistically significant difference was seen between the predicted height of individual and actual height of individual when intercanine width and interpremolar width were used for calculation of the height of an individual for both males and females separately as well as together [Table 4].

## Discussion

With an increasing frequency of mass disasters, the identification of a person, especially from fragmentary remains, has become an important aspect in forensic investigations.

Age, sex, and stature are significant parameters in establishing the identity of an unknown individual because whenever it is possible to predict the stature, identification is simplified because then the missing persons of only that stature need to be considered.[5]

Estimation of stature has been done by using various anthropometric parameters such as length of long bones, sternum, foot length, hands, knee height, and vertebral

**Table 3: Value of constant (c) and regression coefficient (m) for each parameters and regression formula**

| Parameter | Constant (c) | Regression coefficient (m) | *t*-value | *P* value | Regression formula Y=c+mx | Significance |
|---|---|---|---|---|---|---|
| CW | 14825.56 | 34.624 | 1.203 | 0.232 | 14825.56+34.624x | NS |
| IC | 12620.97 | 103.44 | 2.993 | 0.004* | 12620.97+103.44x | S |
| IP | 11453.12 | 111.70 | 3.717 | 0.0001* | 11453.12+111.70x | S |
| AL | 15033.86 | 24.946 | 1.118 | 0.266 | 15033.86+24.946x | NS |
| CW+IC | 12688.41 | 45.161 | 2.400 | 0.018* | 12688.41+45.161x | S |
| CW+IP | 11755.46 | 51.629 | 2.895 | 0.005* | 11755.46+51.629x | S |
| CW+AL | 14468.05 | 19.239 | 1.333 | 0.186 | 14468.05+19.239x | NS |
| IC+IP | 11508.03 | 60.511 | 3.584 | 0.001* | 11508.03+60.511x | S |
| IC+AL | 13241.98 | 34.505 | 2.158 | 0.033** | 13241.98+34.505x | S |
| IP+AL | 12327.24 | 41.007 | 2.633 | 0.010* | 12327.24+41.007x | S |
| CW+IC+IP | 11355.08 | 39.869 | 3.172 | 0.002* | 11355.08+39.869x | S |
| CW+IC+AL | 13149.84 | 23.695 | 2.050 | 0.043** | 13149.84+23.695x | S |
| CW+IP+AL | 12455.69 | 27.208 | 2.394 | 0.019* | 12455.69+27.208x | S |
| IC+IP+AL | 11771.01 | 34.061 | 2.967 | 0.004* | 11771.01+34.061x | S |
| All Combined | 11863.64 | 24.983 | 2.736 | 0.007* | 11863.64+24.983x | S |

*Significant at 1% level, **Significant at 5% level, S=Significant, NS=Non-significant, x=Value of parameter

**Table 4: Application of *Z* test to test for difference in actual and predicted height**

| Pairs of parameters | Karl-pearson correlation coefficient | Significance | |
|---|---|---|---|
| Actual height and predicted height with IC | 0.2921 | *P*>.01 | NS |
| Actual height and predicted height with IP | 0.3515 | *P*>.01 | NS |

NS=Not significant

column.[6-11] The use of long bones was used based on the principle that they their length would positively correlate with stature but their use in case of fragmentary remains is limited.[1] So other parameters such as foot length and cranial sutures have been used for stature estimation.[4]

Teeth are resistant to damage and odontometric parameters remain constant over time. The methods using teeth have several advantages as the anatomical landmarks are standard, well-defined and easy to locate.[12]

As there are differences in odontometric features in specific populations, even within the same population in the historical and evolutional context, it is necessary to determine specific population values in order to make identification possible on the basis of dental measurements.[13] Thus the study evaluated all odontometric parameters of the North Indian population.

Doris *et al*. have indicated that the early permanent dentitions provide the best sample for tooth size measurements because early adulthood dentition has less mutilation and less attrition in most individuals. Consequently, the effect of these factors on the actual dimension tooth parameters would be minimum.[14] Thus, only subjects in the 20-30 years' age group were included in the study sample.

Odontometric parameters, such as arch width and intercanine width, have been used widely in orthodontics for assessment of space available for tooth movement.[15] Arch width has been used to evaluate the size of artificial teeth in a denture for a particular patient.[16] Intercanine width and arch width have been used to estimate the mouth width of an individual.[17]

Four odontometric parameters namely the combined width of six maxillary anterior teeth, intercanine width, interpremolar width, and arch length were evaluated to determine if there is a significant correlation between these parameters and the height of an individual.

Use of odontometric parameters for stature estimation is limited. Out of the four odontometric parameters selected for the study, only the combined width of six maxillary anterior teeth has been used for estimation of stature by Kalia *et al*. in 2008 and only small statistically significant correlation between height and combined mesiodistal width of six anterior maxillary teeth had been reported.[4] However, in this study it has been found that there is no significant correlation between these two parameters.

Prabhu *et al*. have done a study in 2013 to ascertain the usefulness of tooth crown measurements in stature prediction. They used buccolingual and mesiodistal dimensions of all teeth (except third molars) and stature measurements were obtained from 95 living adults (47 females, 48 males). Ridge regression was performed for the dentition, which revealed a moderate but statistically significant correlation to stature (R = 0.68; $P < 0.0001$). They concluded that the dentition may be used only as a supplement to more robust indicators of stature.[18]

In our study, odontometric parameters were considered singly and in various sets of combinations.

When each odontometric parameter was correlated singly with the height of an individual, only intercanine width and interpremolar width were found to be statistically significant. The other two parameters namely arch width and combined width of six anterior teeth were not found to be statistically significant when plotted against height.

When combinations of two odontometric parameters (CW + AL, CW + IC, CW + IP, AL + IC, AL + IP, IC + IP) were correlated with height, then statistically significant correlations were obtained in all cases except in the case of arch length + combined mesiodistal width of the maxillary anterior teeth which did not show any correlation with height.

When combinations of odontometric parameters in sets of three or all four parameters taken together were correlated with height, all the combinations were found to be statistically significant. The regression equations were derived for each odontometric parameter singly and in sets of various combinations.

The regression equations thus obtained could be used for stature estimation. In each instance correlation was found to be highly significant statistically at 1% of level except in the case of AL, CW, and AL + CW. The most significant correlation was seen when height was regressed against four odontometric parameters considered together.

On using the regression equations for significant parameters such as intercanine width and interpremolar width, when the actual height of individual was blind folded, no statistically significant difference was observed between the actual height and predicted height of an individual using regression formula at 1% level of significance indicating that both intercanine width and interpremolar width can be used successfully for predicting the height of an individual.

The selected odontometric parameters can be used singly or in combination successfully in the estimation of the stature of an individual. Thus the study proposes the importance of various odontometric parameters, which have not been studied earlier, as a forensic tool for stature estimation from fragmentary remains.

## Conclusion

The study was initiated as a review of literature revealed that common odontometric parameters have not been evaluated as forensic tools in stature estimation. Out of four selected odontometric parameters used the intercanine width and interpremolar width can be used successfully to calculate the stature of an individual. However, further studies are required to estimate the accuracy of estimating the stature of an individual using these regression equations for the selected odontometric parameters.

The reliability of using odontometric parameters in combination improves the predictability of estimating stature rather than when a single parameter is used alone in fragmentary remains. Thus the odontometric parameters can provide a reliable method for predicting the height of an individual.

## References


1. 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;11:260-6.
2. Didia BC, Nduka EC, Adele O. Stature estimation formulae for Nigerians. J Forensic Sci 2009;54:20-1.
3. Simmons T, Jantz RL, Bass WM. Stature estimation from fragmentary femora: A revision of the Steele method. J Forensic Sci 1990;35:628-36.
4. Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry and skull anthropometry. Indian J Dent Res 2008;19:150-4.
5. Dahlberg AA. Dental traits as identification tools. Dent Prog 1963;3:155-60.
6. Pelin IC, Duyar I. Estimating stature from tibia length: A comparison of methods. J Forensic Sci 2003;48:708-12.
7. Menezes RG, Kanchan T, Kumar GP, Rao PP, Lobo SW, Usyal S, *et al*. Stature estimation from the length of the sternum in South Indian males: A preliminary study. J Forensic Leg Med 2009;16:441-3.
8. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK. Stature estimation from foot length using universal regression formula in a North Indian population. J Forensic Sci 2010;55:163-6.
9. 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.
10. Ozer BK, Gültekin T, Sağir M. Estimation of stature in Turkish adults using knee height. Anthropol Anz 2007;65:213-22.
11. Pelin C, Duyar I, Kayahan EM, Zağyapan R, Ağildere AM, Erar A. Body height estimation based on dimensions of sacral and coccygeal vertebrae. J Forensic Sci 2005;50:294-7.
12. Whittaker DK, MacDonald DG. A Colour Atlas of Forensic Dentistry. 1st ed. England: Wolfe Medical Publications Ltd; 1989. p. 58-66.
13. Işcan MY, Kedici PS. Sexual variation in bucco-lingual dimensions in Turkish dentition. Forensic Sci Int 2003;137:160-4.
14. Doris JM, Bernard BW, Kuftinec MM, Stom D. A biometric study of tooth size and dental crowding. Am J Orthod 1981;79:326-36.
15. Paulino V, Paredes V, Gandia JL, Cibrian R. Prediction of arch length based on intercanine width. Eur J Orthod 2008;30:295-8.
16. Cesario VA Jr, Latta GH Jr. Relationship between the mesiodistal width of the maxillary central incisor and interpupillary distance. J Prosthet Dent 1984;52:641-3.
17. Stephan CN, Henneberg M. Predicting mouth width from inter-canine width-a 75% rule. J Forensic Sci 2003;48:725-7.
18. Prabhu S, Acharya AB, Muddapur MV. Are teeth useful in estimating stature? J Forensic Leg Med 2013;20:460-4.


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