Estimation Of Stature From Percutaneous Length Of Tibia

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ABSTRACT:

Background: Due to increase events of mass disaster and brutal murders, dismembered body parts are sent for post-mortem examination every now and then. Estimation of stature from dismembered body parts can play a vital role for identification of persons. This study can be helpful in such cases to estimate stature from the percutaneous length of Tibia, when an isolated lower limb is found. **Aims & Objectives:** Present study was carried out to derive a regression formula and multiplication factor to estimate stature from the percutaneous length of Tibia for population in and around the Rajkot region of Gujarat. **Methods:** Total 100 male and 100 female cases were randomly selected from cadavers brought for post-mortem examination at mortuary of P. D. U. Govt. Medical College and Hospital, Rajkot. Stature was measured with measuring tape and a percutaneous length of Tibia was measured by Sliding caliper after breaking Rigor mortis, if developed. Collected data were statistically analysed using software like Epi info 7 and Microsoft excel 2007. **Results:** There was no significant bilateral difference in percutaneous length of the Tibia ($p>0.05$). Mean stature as well as mean percutaneous length of Tibia were significantly higher for male than for female ($p<0.05$). Regression formula and multiplication factor derived from the present study are useful for population in and around the Rajkot region of Gujarat to estimate stature from the percutaneous length of Tibia.

Key-words: Forensic anthropology, Anthropometry, Biological profile, Stature, Percutaneous length of Tibia

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INTRODUCTION:

Forensic anthropology is branch of physical anthropology, which for forensic purposes deals with the identification and analysis of skeletal remains known to be or suspected of being human.[1] Anthropometry is a basic tool of forensic anthropology which has a long tradition of use in the discipline of forensic medicine. Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of the human body and skeleton[2], which can be used for the purpose of identification of skeletal remains. Due to increase events of mass disaster and brutal murders, dismembered body parts are sent for post-mortem examination every now and then. Identification of deceased from such dismembered body parts is a difficult task for crime investigative agencies. Autopsy surgeons can play a major role there as they can provide a tentative identification of unknown remains by formulating a 'biological profile' by using anthropometric techniques. Such biological profile involves the estimation of sex, stature, age and ethnicity.[3] Among these 'big fours' of the biological profile, estimation of stature is considered as one of the main parameters of personal identification in forensic examinations. It can be measured by anatomical or Fully method and mathematical method. Anatomical or Fully method reconstructs stature by summing the measurements of the skeletal elements that contribute to stature and adding a correction

factor for the soft tissues. Mathematical method derives a regression formula and multiplication factor to estimate stature from bone or body part. Mathematical method is most useful for forensic purpose as it can be applied even when only part of body is available. However, due to difference in body proportions between populations such as the relative lengths of the limbs and trunk, population-specific regression formula and multiplication factor should be used for this purpose.[4] Keeping this in view, the present study was carried out to derive a regression formula and the multiplication factor to estimate stature from the percutaneous length of Tibia for population in and around Rajkot region.

MATERIALS AND METHODS:

This study was carried out on 100 male and 100 female cases randomly selected from cadavers brought for post-mortem examination at mortuary of P. D. U. Govt. Medical College and Hospital, Rajkot. Age group selected for the study was more than 20 years as till the age of 20 year epiphyseal union is completed in Tibia, so after 20 years of age percutaneous length of Tibia do not change.[5] Cadavers with any injury, disease or anomaly that affects percutaneous length of Tibia or stature were excluded from the study. Decomposed, charred or mutilated bodies were also excluded from the study. Measurements were taken up to the nearest 0.1 cm as below after breaking rigor mortis, if developed.

Stature: The body was placed in supine position on a flat, hard surfaced autopsy table. The Head was fixed in such way that the Frankfort plane remains at right angle to autopsy table. Frankfort plane is defined as plane adjoining the upper margin of the ear openings and lower margin of the orbit of the eyes.[6] Knee and hip joints were kept extended, and the neck and feet were kept in neutral position. Stature (Total Body Length) was measured between the vertex of the head and the heel using a measuring tape.

Percutaneous length of Tibia: Knee joints of the deceased were kept extended. Percutaneous length of Tibia was measured as a straight distance between the most prominent palpable portion of medial condyle of Tibia and the tip of the medial malleolus by sliding caliper.

Statistical Analysis: All the measurements were statistically analyzed using software like Epi info 7 and Microsoft Excel 2007. The data were analyzed for male and female cases separately as well as for total cases i.e. both sexes together. The Result of the data analyses for total cases can be applied to estimate stature from percutaneous length of Tibia, when sex cannot be determined. Pearson correlation coefficient (r) was calculated to assess the correlation of stature with percutaneous length of Tibia. Independent samples T-test was applied to determine statistical significance of bilateral differences in percutaneous length of Tibia as well as to determine statistical significance of gender differences in stature and in percutaneous length of Tibia. P-value of less than 0.05 was considered significant. Regression formula and multiplication factors were derived to estimate stature from percutaneous length of Tibia.

RESULTS:

Table-1 is showing descriptive statistics of all the cases. It is evident from the table that the mean of stature and of percutaneous length of both Tibia is higher for male than for female. Gender differences in stature as well as in percutaneous length of both Tibia is statistically confirmed by applying T-test as shown in table-2 ($p<0.05$). It is evident from the table-1 that mean of percutaneous length of right Tibia is more than mean of left Tibia. However, statistically there is no significant bilateral difference in the percutaneous length of the Tibia as shown in table-3 ($p>0.05$).

In the present study, it is found that percutaneous length of Tibia of both sides is positively and significantly correlating with stature in both sexes ($r=0.748$ and 0.743 for right and left Tibia respectively, for males, $r=0.734$ and 0.719 for right and left Tibia respectively, for females, $p<0.001$).

SIMPLE REGRESSION FORMULA WHEN SEX IS KNOWN:

- **FOR MALE**

1. FROM PCL OF RIGHT TIBIA
STATURE = 88.148 + 2.000 X PCL TIBIA
2. FROM PCL OF LEFT TIBIA
STATURE = 88.767 + 1.992 X PCL TIBIA

- **FOR FEMALE**

1. FROM PCL OF RIGHT TIBIA
STATURE = 64.148 + 2.446 X PCL TIBIA
2. FROM PCL OF LEFT TIBIA
STATURE = 68.112 + 2.364 X PCL TIBIA

SIMPLE REGRESSION FORMULA WHEN SEX CANNOT BE DETERMINED:

1. FROM PCL OF RIGHT TIBIA
STATURE = 48.400 + 2.973 X PCL TIBIA
2. FROM PCL OF LEFT TIBIA
STATURE = 49.832 + 2.946 X PCL TIBIA

MEAN MULTIPLICATION FACTOR WHEN SEX IS KNOWN:

- **FOR MALE**

1. FROM PCL OF RIGHT TIBIA
STATURE = **4.29** X PCL TIBIA
2. FROM PCL OF LEFT TIBIA
STATURE = **4.30** X PCL TIBIA

- **FOR FEMALE**

1. FROM PCL OF RIGHT TIBIA
STATURE = **4.29** X PCL TIBIA
2. FROM PCL OF LEFT TIBIA
STATURE = **4.31** X PCL TIBIA

MEAN MULTIPLICATION FACTOR WHEN SEX CANNOT BE DETERMINED:

1. FROM PCL OF RIGHT TIBIA
STATURE = **4.29** X PCL TIBIA
2. FROM PCL OF LEFT TIBIA
STATURE = **4.31** X PCL TIBIA

Table-4 is showing comparison of stature estimated by regression formula with stature estimated by a mean multiplication factor. Standard deviation (SD) measures the amount of dispersion from the mean value. It is evident from the table that mean stature estimated by regression formula as well as by multiplication factor are very nearer to mean measured stature. However, SD of stature estimated by mean multiplication factor is higher than SD of stature estimated by regression formula, which means stature estimated by mean multiplication factor is showing more dispersion from its mean value. So, though both regression formula and multiplication factor estimate stature nearly similar to actual measured stature, regression formula measures stature more precisely than mean multiplication factor. Moreover, there is very little difference between statures estimated from the percutaneous length of Tibia of right side and left side, which means that there is no need to derive side specific regression formula and mean multiplication factor.

DISCUSSION:

The main objective of this study is to find out the correlation between the percutaneous length of the Tibia with stature and to use result of this study as a base for developing stature estimation standards specifically for population in and around the Rajkot region of Gujarat. Several such studies have been carried out by many researchers for the population of different parts of India as well as of the world.

Hallikeri VR et al.[7] studied 300 South Indian students (150 males and 150 females) of age group between 20 to 30 years. They found a positive correlation between stature and the percutaneous length of Tibia in both sexes ($r=0.820$ and 0.865 for right and left Tibia respectively, for males, $r=0.734$ and 0.751 for right and left Tibia respectively, for females, $p<0.001$). They did not find statistically significant bilateral differences in percutaneous length of Tibia in both sexes ($p>0.05$), but they found statistically significant gender difference in stature as well as in percutaneous length of the Tibia ($p<0.001$).

Trivedi A et al.[8] studied 540 medical students of Gwalior-Madhya Pradesh (270 males and 270 females) of age group between 18 to 21 years. They found a positive correlation between stature and percutaneous length of Tibia in both sexes ($r=0.4168$ and 0.4416 for right and left Tibia respectively, for males, $r=0.5699$ and 0.6036 for right and

left Tibia respectively, for females, $p<0.0001$). They did not find statistically significant bilateral differences in percutaneous length of Tibia in both sexes ($p>0.05$), but they found statistically significant gender difference in stature as well as in percutaneous length of the Tibia ($p<0.001$).

Bhavna et al.[9] studied 1011 Shia Muslims of Delhi (503 males and 508 females) of age group between 20 to 40 years. They took percutaneous length of only left Tibia for the study. They found a positive correlation between stature and percutaneous length of Tibia in both sexes ($r=0.765$ in males and $r=0.717$ in females). They found statistically significant gender difference in stature as well as in percutaneous length of the Tibia ($p<0.001$).

Mohanty NK et al.[10] studied 1000 adults of Oriya Population, 500 males of age range 20 to 77 years and 500 females of age range 20 to 80 years. They took percutaneous length of only right Tibia for the study. They found a positive correlation between stature and percutaneous length of Tibia in both sexes ($r=0.9518$ in males and $r=0.9392$ in females, $p<0.01$).

Sah RP et al.[11] studied 150 males and 150 females, born and brought up in Nepal of age group between 20 to 30 years. They took the percutaneous length of only right Tibia for the study. They found a positive correlation between stature and percutaneous length of Tibia in both sexes ($r=0.562$ in males and $r=0.710$ in females). They found that stature as well as the percutaneous length of Tibia were more in male than in female.

It is evident from the comparison of these studies that all researchers have found a positive correlation between the percutaneous length of the Tibia and stature, which means that the percutaneous length of Tibia is a useful parameter to estimate stature. None of the researcher has found significant bilateral differences in percutaneous length of Tibia. All the studies show significant gender differences in mean stature as well as in mean percutaneous length of Tibia. Table-5 shows a comparison of mean stature and mean percutaneous length of both Tibia in these studies. It is evident from the table that all the researchers have found different mean stature and mean percutaneous length of Tibia. This finding substantiates well known fact that different population shows the difference in stature as well as in body proportions, so population and sex specific regression formula and multiplication factor are required for accurate stature reconstruction from the percutaneous length of the Tibia.

CONCLUSION:

In the present study, mean stature estimated by regression formula as well as by multiplication factor are similar to mean measured stature in both sexes, however, the regression formula measures stature more precisely than mean multiplication factor. So, regression formula and multiplication factors derived from the present study can be used to estimate stature of deceased persons from the percutaneous length of Tibia when dismembered lower limb is found, but regression formula will give a more accurate result than multiplication factors.

There is no significant bilateral difference in percutaneous length of Tibia, so there is no need to derive side specific regression formula and mean multiplication factor.

Mean stature as well as mean percutaneous length of Tibia is significantly higher for male than for female, so sex specific regression formula and mean multiplication factor should be derived. The present study has derived regression formula and multiplication factors for male and female cases separately as well as for total cases i.e. both sexes together. Regression formula and multiplication factor derived for total cases can be applied to estimate stature from the percutaneous length of Tibia, when an isolated lower limb is found and its sex cannot be determined. However, sex specific regression formula and multiplication factors can estimate sex more accurately.

As different population show difference in stature as well as in body proportions, the results of the present study are applicable to population in and around Rajkot region.

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TABLE-1 DESCRIPTIVE STATISTICS (MEAN ± SD)

PARAMETER	MALE	FEMALE	TOTAL CASES
STATURE	165.57 ± 6.59	151.02 ± 5.69	158.30 ± 9.53
PCL OF RIGHT TIBIA	38.71 ± 2.46	35.22 ± 1.69	36.97 ± 2.74
PCL OF LEFT TIBIA	38.57 ± 2.46	35.07 ± 1.73	36.82 ± 2.75

PCL=PERCUTANEOUS LENGTH & SD=STANDARD DEVIATION

TABLE-2 COMPARISON FOR GENDER DIFFERENCES IN STATURE AND IN PERCUTANEOUS LENGTH OF TIBIA

PARAMETER	MEAN		T VALUE	p VALUE*
	MALE	FEMALE		
STATURE	165.57	151.02	16.712	0.000 (S)
PCL OF RIGHT TIBIA	38.71	35.22	11.671	0.000 (S)
PCL OF LEFT TIBIA	38.57	35.07	11.638	0.000 (S)

PCL=PERCUTANEOUS LENGTH & S=SIGNIFICANT

*p Value<0.05 is significant and p Value<0.001 is highly significant.

TABLE-3 COMPARISON FOR BILATERAL DIFFERENCE IN PERCUTANEOUS LENGTH OF TIBIA

SEX	MEAN PCL OF		T VALUE	p VALUE*
	RIGHT TIBIA	LEFT TIBIA		
MALE	38.71	38.57	0.918	0.669 (NS)
FEMALE	35.22	35.07	0.644	0.520 (NS)

PCL=PERCUTANEOUS LENGTH & NS= NOT SIGNIFICANT
*p Value<0.05 is significant

TABLE-4 COMPARISON OF STATURE ESTIMATED BY REGRESSION FORMULA AND BY MEAN MULTIPLICATION FACTOR (MEAN ± SD)

PARAMETER	MALE	FEMALE	TOTAL CASES
MEASURED STATURE	165.57 ± 6.59	151.02 ± 5.69	158.30 ± 9.53
STATURE ESTIMATED BY REGRESSION FORMULA			
PCL OF RIGHT TIBIA	165.58 ± 4.93	151.01 ± 4.18	158.31 ± 8.15
PCL OF LEFT TIBIA	165.59 ± 4.89	151.01 ± 4.09	158.29 ± 8.10
STATURE ESTIMATED BY MEAN MULTIPLICATION FACTOR			
PCL OF RIGHT TIBIA	166.08 ± 10.57	151.11 ± 7.27	158.60 ± 11.76
PCL OF LEFT TIBIA	165.83 ± 10.56	151.14 ± 7.46	158.68 ± 11.85

PCL=PERCUTANEOUS LENGTH & SD=STANDARD DEVIATION

TABLE-5 COMPARISON OF PRESENT STUDY WITH OTHER SIMILAR STUDIES

AUTHOR	MEAN STATURE (MEAN ± SD)		MEAN PCL OF TIBIA (MEAN ± SD)			
			MALE		FEMALE	
	MALE	FEMALE	RIGHT	LEFT	RIGHT	LEFT
Hallikeri VR et al.[7]	171.4 ± 5.51	160.3 ± 6.04	39.6 ± 2.19	39.1 ± 2.21	36.6 ± 3.02	36.5 ± 3.02
Trivedi A et al.[8]	164.5 ± 8.26	155.3 ± 5.85	38.26 ± 2.45	39.22 ± 2.29	36.10 ± 2.43	36.03 ± 2.62
Bhavna et al.[9]	167.66 ± 5.69	154.40 ± 4.91	-	36.48 ± 1.91	-	33.66 ± 1.50
Mohanty NK et al.[10]	161.92 ± 9.21	152.0 ± 9.87	37.08 ± 2.34	-	35.03 ± 2.60	-
Sah RP et al.[11]	165.03 ± 7.81	154.59 ± 5.61	37.57 ± 2.16	-	34.90 ± 1.75	-
Present Study	165.57 ± 6.59	151.02 ± 5.69	38.71 ± 2.46	38.57 ± 2.46	35.22 ± 1.69	35.07 ± 1.73

PCL=PERCUTANEOUS LENGTH & SD=STANDARD DEVIATION