

Sexual Dimorphism and Racial Differences in the Various Parameters of Head and Neck of Talus in Gujarati Population

Javia Mayankkumar D.¹, Patel Mital M.²

Abstract

Introduction: Talus is the key tarsal bone of the foot. It is unique in the sense that it has no muscular attachments. Sexual dimorphism and racial differences in the talus is utmost important for the forensic experts, anatomists as well as physical anthropologists. The purpose of the present study was to determine whether sex or race related morphometric differences in the various parameters of head and neck of talus could be demonstrated, and if so whether they are useful for the identification of individuals of unknown sex and race or not. *Material and Method:* Current study was done on the 221 dry adult human talus. The parameters of head and neck of talus included in the study are length, breadth and height of head of talus as well as head-neck length of talus. *Results:* Findings of all four parameters of head and neck of talus in male were more as compared to those of female in the Gujarati population of present study. *Discussion:* Findings of present study were compared with the findings of other researchers who measured the same parameters in the different populations. *Conclusion:* All four parameters of head and neck of talus included in the study are useful for the sexual dimorphism of talus in the Gujarati population of present study as well as they are useful for the identification of individuals of unknown race.

Keywords: Head and Neck of Talus; Gujarati Population; Sexual Dimorphism; Racial Differences.

Introduction

Seven tarsal bones occupy the proximal half of the human foot. The tarsal bones of the foot and the carpal bones of the hand are homologous, but the tarsal elements are larger, reflecting their role in supporting and distributing the body weight [1]. Talus is the key tarsal bone of the human foot. It is unique in the sense that it has no muscular or tendinous attachments [2]. Talus (the tarsal bone of the foot) is homologous with the scaphoid (the carpal bone of the hand) [3].

Determination of sex and race of the unknown individual by using the available bone of the human skeleton has remained the area of interest for physical

anthropologists, forensic experts as well as anatomists. Different bones or part of bones have been used to identify the sex and race of unknown individual, like pelvis [4], sacrum [5], skull [6], mandible [7], femur [8,9], sternum [10], clavicle [11], scapula [12] etc. Patella, talus and calcaneus, the robust bones which are often recovered intact, can be used for the same [13]. All human populations show at least some sexual dimorphic features regarding talus. These features are population specific and show racial variations also. The purpose of the present study was to determine whether sex or race related morphometric differences in the various parameters of head and neck of talus could be demonstrated, and if so whether they are useful for the identification of individuals of unknown sex and race or not.

Aims and Objectives

- To determine the normal range of the values of various parameters of head and neck of talus
- To determine; whether these parameters are useful for the sexual dimorphism of talus or not

Author's Affiliation: ¹Assistant Professor, Department of Anatomy, Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, India. ²Professor and head, Department of Anatomy, Shree M P Shah Government Medical College, Jamnagar, Gujarat, India.

Corresponding Author: Javia Mayankkumar D, Assistant Professor, Department of Anatomy, Gujarat Adani Institute of Medical Sciences, G K General Hospital Campus, Opposite Lotus Colony, Bhuj 370001 Gujarat.
E-mail: drjaviamd@gmail.com

Received | 19.05.2017, Accepted | 13.06.2017

- To determine; whether these parameters are useful for the identification of individuals of unknown race or not.

Material and Method

Present study was conducted on 221 dry adult human talus during the period of five years from 2011 to 2015. The bones were obtained from the dead bodies donated to the Department of Anatomy, Shree M P Shah Government Medical College, Jamnagar. Out of total 221 talus, 127 were of male and 94 were of female. Pathological, fractured or talus of unknown sex were excluded from the study. Only fully ossified talus of known sex were included in the study.

Following parameters of head and neck of talus were taken in the present study:

Length of Head of Talus

Length of head of talus was measured as the distance between both the end points of longitudinal axis of navicular articular surface of head of talus. The surface of navicular fibrocartilage is also included in this measurement.



Fig. 1: Showing the measurement of length of head of talus

Instrument used: Sliding Caliper [14]

Breadth of Head of Talus

Breadth of head of talus was measured as the greatest breadth at right angle to the longitudinal axis. In some simian groups, it is difficult to determine the lower margin of the articular surface, where it merges into the anterior articular surface of the calcaneus.



Fig. 2: Showing the measurement of breadth of head of talus

Instrument used: Sliding Caliper [14]

Height of Head of Talus

Height of head of talus was measured as the height of perpendicular on the chord joining the end points of the middle longitudinal curve of the navicular articular surface of the head of talus.



Fig. 3: Showing the measurement of height of head of talus

Instrument used: Co-ordinate Caliper [14]

Head-neck Length of Talus

Head-neck length of talus was measured as the projective distance from the furthestmost point of navicular articular surface to the anterior end of the midsagittal curve of trochlea in the longitudinal axis of the neck and projected to lower surface of the bone.

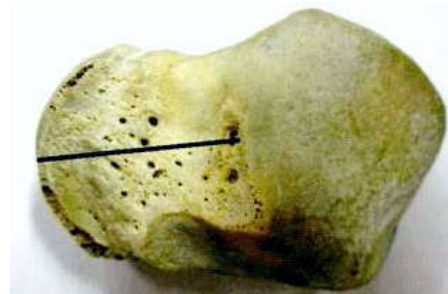


Fig. 4: Showing the measurement of head-neck length of talus

Instrument used: Sliding Caliper with movable arms [14]

To avoid intra-observer variation, each measurement was taken at three different times and the mean of all three readings was taken as the final reading.

Student t test was applied and p value was calculated at 95% confidence interval by using statistical aids (SPSS-Statistical Package for the Social Sciences) for the comparison of various parameters of head and neck of talus between male and female.

If 'p value' of a particular parameter for male and female is >0.05, there is no statistically significant difference for that particular parameter between male and female.

If 'p value' is between 0.05-0.01, there is statistically significant difference for that particular parameter between male and female.

If 'p value' is between 0.01-0.005, it will suggest statistically highly significant difference.

If 'p value' is <0.005, it will suggest statistically very highly significant difference [15].

Results

As we can see in the Table 1, in the Gujarati population of present study, mean length of head of talus in male is 28.92 mm, SD is 3.78 mm, range from 21 mm to 38 mm, mean±SD from 25.14 mm to 32.70 mm and mean±3SD from 17.58 mm to 40.26 mm. Mean length of head of talus in female is 27.63 mm, SD is 4.34 mm, range from 18 mm to 36 mm, mean±SD from 23.29 mm to 31.97 mm and mean±3SD from 14.34 mm to 40.65 mm.

Mean breadth of head of talus in male is 23.05 mm, SD is 2.45 mm, range from 18 mm to 33 mm, mean±SD from 20.60 mm to 25.51 mm and mean±3SD from 15.68

mm to 30.43 mm. Mean breadth of head of talus in female is 21.82 mm, SD is 1.96 mm, range from 18 mm to 28 mm, mean±SD from 19.86 mm to 23.80 mm and mean±3SD from 15.93 mm to 27.73 mm.

Mean height of head of talus in male is 20.07 mm, SD is 1.83 mm, range from 16 mm to 25 mm, mean±SD from 18.24 mm to 21.90 mm and mean±3SD from 14.58 mm to 25.56 mm. Mean height of head of talus in female is 19.17 mm, SD is 1.58 mm, range from 16 mm to 24 mm, mean±SD from 17.59 mm to 20.75 mm and mean±3SD from 14.43 mm to 23.91 mm.

Mean head-neck length of talus in male is 23.54 mm, SD is 1.86 mm, range from 19 mm to 30 mm, mean±SD from 21.68 mm to 25.40 mm and mean±3SD from 17.96 mm to 29.12 mm. Mean head-neck length of talus in female is 21.81 mm, SD is 1.74 mm, range from 17 mm to 26 mm, mean±SD from 20.07 mm to 23.55 mm and mean±3SD from 16.59 mm to 27.03 mm.

Mean length, breadth and height of head of talus as well as mean head-neck length of talus in male are more as compared to female in Gujarati population of present study.

As we can see in Table 2, (for both- with equal variances assumed as well as equal variances not assumed) p value for the length, breadth and height of head of talus as well as head-neck length of talus are 0.000, which suggest statistically very high significant difference between the male and female talus for these parameters.

Discussion

As we can see in Table 3, various parameters of head and neck of talus of different races (White and Black South Africans, Americans, and Korean) have been studied by the various researchers.

Table 1: Showing the Sex-Male/Female, N-number of bones taken, Mean, SD-Standard deviation, Standard error of mean, Range (minimum-maximum), Mean±SD, Mean±3SD of various parameters of head and neck of talus of Gujarati population of present study

Para-Meters	SEX	N	Mean (mm)	SD (mm)	Std. Error Mean (mm)	Range (min-max) (mm)	Mean±SD (mm)	Mean±3SD (mm)
Length of Head of Talus (MM)	male	127	28.92	3.78	0.33606	21-38	25.14-32.70	17.58-40.26
	female	94	27.63	4.34	0.44866	18-36	23.29-31.97	14.34-40.65
Breadth of Head of Talus (MM)	male	127	23.05	2.45	0.21802	18-33	20.60-25.51	15.68-30.43
	female	94	21.82	1.96	0.20273	18-28	19.86-23.80	15.93-27.73
Height of Head of Talus (MM)	male	127	20.07	1.83	0.16301	16-25	18.24-21.90	14.58-25.56
	female	94	19.17	1.58	0.16335	16-24	17.59-20.75	14.43-23.91
Head-Neck Length of Talus (MM)	male	127	23.54	1.86	0.16535	19-30	21.68-25.40	17.96-29.12
	female	94	21.81	1.74	0.17958	17-26	20.07-23.55	16.59-27.03

Table 2: Showing the statistical analysis and the results of independent samples test applied to various parameters of head and neck of talus of Gujarati population of present study

		Independent Samples Test								
		Levene's Test for Equality of Variances			t-test for Equality of Means					
		F	sig	t	DF	Sig. (2-tailed)	Mean Difference	Standard Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Length of head of talus (mm)	Equal variances assumed	5.305	.022	2.336	219	.000	1.28296	.54910	.20076	2.36517
	Equal variances not assumed			2.289	183.903	.000	1.28296	.56056	.17700	2.38892
Breadth of head of talus (mm)	Equal variances assumed	3.234	.074	3.983	219	.000	1.22533	.30768	.61894	1.83172
	Equal variances not assumed			4.116	217.642	.000	1.22533	.29771	.63857	1.81209
Height of head of talus (mm)	Equal variances assumed	.705	.402	3.851	219	.000	.90853	.23593	.44354	1.37351
	Equal variances not assumed			3.937	213.891	.000	.90853	.23077	.45364	1.36341
Head-neck length of talus (mm)	Equal variances assumed	.259	.612	6.992	219	.000	1.72416	.24661	1.23813	2.21018
	Equal variances not assumed			7.063	207.470	.000	1.72416	.24411	1.24290	2.20542

Table 3: Showing the comparison of various parameters of head and neck of talus of Gujarati population of present study with the findings of the other researchers

No	Researchers	Populations	Sample size	Sex	PARAMETERS			
					Length of head of talus (mm) (Mean \pm SD)	Breadth of head of talus (mm) (Mean \pm SD)	Height of head of talus (mm) (Mean \pm SD)	Head-neck length of talus (mm) (Mean \pm SD)
1	Bidmos and Dayal (2003) ¹³	White south Africans	60	Male	-	-	28.45 \pm 2.50	23.89 \pm 2.50
			60	Female	-	-	27.37 \pm 2.30	21.43 \pm 1.80
2	Bidmos and Dayal (2004) ¹⁶	Black south Africans	60	Male	-	-	25.33 \pm 1.77	20.85 \pm 2.38
			60	Female	-	-	21.84 \pm 2.00	19.56 \pm 2.21
3	Ferrari J et Al (2004) ¹⁷	Americans	114	Male	29.52 \pm 2.53	19.23 \pm 2.25	-	-
			113	Female	26.13 \pm 2.05	17.26 \pm 1.54	-	-
4	Lee UY et al (2012) ¹⁸	Korean	70	Male	-	-	26.74 \pm 2.35	20.99 \pm 2.13
			70	Female	-	-	25.30 \pm 1.94	19.28 \pm 1.64
5	Present study (2017)	Gujarati	127	Male	28.92 \pm 3.78	23.05 \pm 2.45	20.07 \pm 1.83	23.54 \pm 1.86
			94	Female	27.63 \pm 4.34	21.82 \pm 1.96	19.17 \pm 1.58	21.81 \pm 1.74

In 2003 Bidmos and Dayal measured the height of head of talus and head-neck length of talus in 60 male and 60 female White South Africans. In their study, mean height of head of talus in male White South Africans was 28.45 mm with SD 2.50 mm and

in female White South Africans was 27.37 mm with SD 2.30 mm. In their study, mean head-neck length of talus in male White South Africans was 23.89 mm with SD 2.50 mm and in female White South Africans was 21.43 mm with SD 1.80 mm. In the present study

of Gujarati population we found mean height of head of talus 20.07 mm with SD 1.83 mm in male and 19.17 mm with SD 1.58 mm in female. By comparing the above findings, we can say that mean height of head of talus in male as well as in female Gujarati population of present study are less as compared to the findings of male and female White South Africans studied by Bidmos and Dayal, while the mean head-neck length of talus in male as well as female Gujarati population of present study are coinciding with the findings of male and female White South Africans studied by Bidmos and Dayal respectively.

In 2004 Bidmos and Dayal measured the height of head of talus and head-neck length of talus in 60 male and 60 female Black South Africans. In their study, mean height of head of talus in male Black South Africans was 25.33 mm with SD 1.77 mm and in female Black South Africans was 21.84 mm with SD 2.00 mm. In their study, mean head-neck length of talus in male Black South Africans was 20.85 mm with SD 2.38 mm and in female Black South Africans was 19.56 mm with SD 2.21 mm. By looking at these findings, we can say that mean height of head of talus in male as well as in female Gujarati population of present study are less as compared to the findings of male and female Black South Africans studied by Bidmos and Dayal, while the mean head-neck length of talus in male as well as female Gujarati population of present study are more as compared to the findings of male and female Black South African talus studied by Bidmos and Dayal respectively.

In 2012 Lee UY et al measured the height of head of talus and head-neck length of talus in 70 male and 70 female Koreans. In their study, mean height of head of talus in male Korean was 26.74 mm with SD 2.35 mm and in female Koreans was 25.30 mm with SD 1.94 mm. In their study, mean head-neck length of talus in male Koreans was 20.99 mm with SD 2.13 mm and in female Koreans was 19.28 mm with SD 1.64 mm. By looking at these findings, we can say that mean height of head of talus in male as well as in female Gujarati population of present study are less as compared to the findings of male and female Koreans studied by Lee UY et al, while the mean head-neck length of talus in male as well as female Gujarati population of present study are more as compared to the findings of male and female Koreans studied by Lee UY et al respectively.

In 2004 Ferrari J et al measured the length and breadth of head of talus in 114 male and 113 female Americans. In their study, mean length of head of talus in male Americans was 29.52 mm with SD 2.53 mm and in female Americans was 26.13 mm with SD 2.05 mm. In their study, mean breadth of head of talus

in male Americans was 19.23 mm with SD 2.25 mm and in female Americans was 17.26 mm with SD 1.54 mm. By looking at these findings, we can say that mean length of head of talus in male Gujarati population of present study is less as compared to the findings of male Americans, while the mean length of head of talus in female Gujarati population of present study is more as compared to the findings of female Americans studied by Ferrari J et al. We can also say that mean breadth of head of talus in male as well as female Gujarati population of present study are more as compared to the findings of male and female Americans studied by Ferrari J et al respectively.

Differences in the findings of various parameters of head and neck of talus of different populations may be due to racial variations or may be due to differences in measuring techniques or may be due to coincidence. Similarities in the findings of various parameters of head and neck of talus of different populations may be due to migrating populations or may be due to coincidence.

Conclusion

In the present study, we determined the normal range of the values of various parameters of head and neck of talus in the Gujarati population. Values of these parameters (length of head of talus, breadth of head of talus, height of head of talus, head-neck length of talus) can be used for the sexual dimorphism of talus with statistically very highly significant differences between the male and female talus. These findings can be used in the identification of individuals of unknown race.

References

1. Standring S. Gray's anatomy: The Anatomical Basis of Clinical Practice. 40th ed. Elsevier- Churchill Livingstone; 2008:1433.
2. Breathnach AS. Frazer's Anatomy of Human Skeleton. 6th ed. J and A Churchill Ltd; 1965:147.
3. McGregor AL, Du Plessis DJ. A Synopsis of Surgical Anatomy. 10th ed. K M Varghese Company, Bombay; 1969:244.
4. Bruzek J. A Method for Visual Determination of Sex using the Human Hip Bone. Am J Phys Anthropol. 2002;117:157-168.
5. Patel MM, Gupta BD, Singel TC. Sexing of sacrum by sacral index and Kimaru's base-wing index. J Indian Acad Forensic Med. 2005;27(1):5-9.

6. Laeeque M, Nirmale VK, Diwan CV. Derivation of demarcating points for sex determination from skull. *International Journal of Recent Trends In Science And Technology*. 2013;6(1):56-59.
 7. Giles E. Sex determination by discriminant function analysis of the mandible. *Am J Phys Anthropol*. 1964; 22(2):129-135.
 8. Pandya AM, Gupta BD, Singel TC et al. A Study of Sexual Dimorphism of Femoral Head in Gujarat Region. *J Indian Acad Forensic Med*. 2012;34(1): 20-23.
 9. Maske SS, Kamble P, Joshi DS. Sexing the femora from Marathwada region using demarcating point method. *International J of Healthcare and Biomedical Research*. 2012;(1):13-16.
 10. Mukhopadhyay PP. Determination of Sex from Adult Sternum by Discriminant Function Analysis on Autopsy Sample of Indian Bengali Population: A New Approach. *J Indian Acad Forensic Med*. 2010;32(4): 321-324.
 11. Patel JP, Shah RK, Merchant SP et al. Sexing of the human adult clavicle in Gujarat zone. *GMJ*. 2009;64(2): 40-46.
 12. Di Vella G, Campobasso CP, Dragone M et al. Skeletal sex determination by scapular measurements. *J Biol Res*. 1994;70(12):299-305.
 13. Bidmos MA, Dayal MR. Sex determination from the talus of South African Whites by discriminant function analysis. *Am J Forensic Med Pathol*. 2003;24(4): 322-328.
 14. Singh IP, Bhasin MK. A manual of biological anthropology. Delhi, India Kamla Raj enterprises; 2004:93-94.
 15. Das R, Das PN. Biomedical research methodology including biostatistical applications. 1st ed. Jaypee brothers' medical publishers (P) LTD; 2011:123.
 16. Bidmos MA, Dayal MR. Further evidence to show population specificity of discriminant function equations for sex determination using the talus of South African blacks. *J Forensic Sci*. 2004;49(6):1-6.
 17. Ferrari J, Hopkinson DA and Linney AD. Size and Shape Differences between Male and Female Foot Bone, *J Am Podiatr Med Assoc*, 2004;94(5):434-452.
 18. Lee UY, Han SH, Park DK et al. Sex determination from the talus of Koreans by discriminant function analysis. *J Forensic Sci*. 2012;57(1):166-171.
-