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Weight of talus – A Useful Metrical Feature for the Sex Determination

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ABSTRACT

Introduction: Talus is the only bony union between leg and foot bones, having important role in weight transmission. Various studies have been done over the morphological features of the talus on the basis of sexual dimorphism. In this study, weight of talus is used for the same. Material and method: In the present study, 221 dry adult human talus of known sex were used, obtained from the Department of Anatomy, M P Shah Medical College, Jamnagar. Mean weight of male talus and mean weight of female talus of both, right and left side, were taken. Identification point and Demarcating points were calculated. Results: Male tali were heavier than the female tali. Also the mean weight of right talus was higher than the left talus, for both male as well as female. Conclusion: Weight of talus is a useful metrical feature of talus for the sex determination.

Keywords : Weight of talus, Identification point, Demarcating point. Weight of talus, Identification point, Demarcating point.

INTRODUCTION

Determination of sex by using the available bone of the human skeleton has remained the area of interest for the forensic experts, anatomists as well as physical anthropologists. Various bones or part of the bones have been used to identify the sex of the human, like head of the femur[1], mid shaft circumference of the femur[2], sacrum[3], sternum[4], pelvis[5], clavicle[6], skull[7], scapula[8], mandible[9] etc. Combined use of both, bony pelvis and skull, for the sex determination, give no more than 90-95% of accuracy[10].

In the human foot, seven tarsal bones occupy the proximal half of the 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 body weight.[11] It is the second largest tarsal bone after calcaneus.[12] It is homologous with the scaphoid.[13] Talus is the key bone of the human foot. It is unique in the sense that it has no muscular or tendinous attachments.[14]

All human populations show at least some sexual dimorphic features regarding talus. These features are population specific and show racial variations also. In the present study, weight of talus of known sex has been taken and tried to analyse on the basis of sexual dimorphism.

MATERIAL AND METHOD

Present study was conducted on 221 dry adult human talus of known sex. The bones were obtained from the dead bodies donated to the Department of Anatomy, M P Shah Medical College, Jamnagar. Out of total 221 talus, 127 were of male and 94 were of female. Out of 127 male talus, 57 were of right side and 70 were of left side. Out of 94 female talus, 44 were of right side and 50 were of left side. Pathological, fractured or talus of unknown sex were excluded from the study. Only fully ossified, adult and talus of known sex were included in the study.

Digital weighing machine having air tight chamber was used to weigh the talus. Each talus was put over the weighing machine turn by turn. Weight of each talus was obtained in the gram with the accuracy of 0.01 gm.

By using computer and statistical aids, mean, standard deviation, range(minimum-maximum), identification point, number and percentage of bones weighing beyond identification point, mean ±3SD, demarcating point, number and percentage of bones weighing beyond demarcating point, were calculated.

PHOTOGRAPH 1: showing the method of measurement of weight of talus by using digital weighing machine

Identification Point (IP) for the weight of the talus

Identification Point was calculated by using the minimum and maximum limit (range) of the weight of the talus. Identification

Point for right male talus was the maximum weight recorded for the right female talus, while Identification Point for right female talus was the minimum weight recorded for the right male talus.

All bones having weight more than the Identification Point for male were correctly identified as males and all bones having weight less than the Identification Point for female were correctly identified as females.

Demarcating Point (DP) for the weight of the talus
Demarcating Point was calculated by using mean ±3SD (calculated range → which will cover 99.75% of the sample). Maximum weight recorded for the female talus by using calculated range was the Demarcating Point for male talus and the minimum weight recorded for the male talus by using the calculated range was the Demarcating Point for female talus.

All bones having weight more than the Demarcating Point for male were correctly identified as males and all bones having weight less than the Demarcating Point for female were correctly identified as females.

Student "t" test was applied and p value was calculated for comparison between weight of male and female talus.

OBSERVATION
Observations found in this study, are shown in the table 1:

SEX→	MALE		FEMALE	
SIDE→	RIGHT	LEFT	RIGHT	LEFT
No	57	70	44	50
MEAN (gm)	20.53	20.42	15.53	14.74
SD (gm)	4.00	3.98	4.42	4.23
MIN-MAX (gm)	10.74-28.26	10.91-31.60	7.26-27.51	6.46-26.33
IP (gm)	>27.51	>26.33	<10.74	<10.91
%IP (No)	3.51% (2)	8.57% (6)	15.91% (7)	18% (9)
MEAN±3SD (gm)	8.53-32.53	8.49-32.35	2.26-28.79	2.05-27.43
DP (gm)	>28.79	>27.43	<8.53	<8.49
%DP (No)	0% (0)	2.86% (2)	2.27% (1)	6% (3)

TABLE 1: showing the weight of male (right and left) and female (right and left) talus (gm) and its statistical analysis

Mean weight of right male talus was 20.53 gm (range→10.74-28.26 gm), while mean weight of right female talus was 15.53 gm (range→7.26-27.51 gm). Mean weight of left male talus was 20.42 gm (range→10.91-31.60 gm), while mean weight of left female talus was 14.74 gm (range→6.46-26.33 gm).

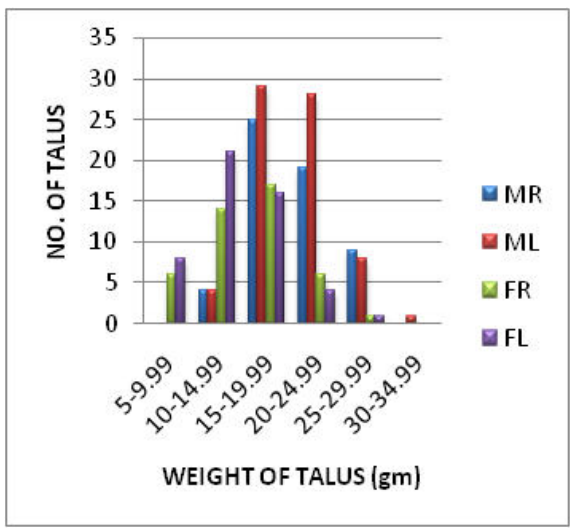
IP for the weight of right male talus was >27.51 gm while that for right female talus was <10.74 gm. 3.51% of right male talus were correctly identified as right male and 15.91% of right female talus were correctly identified as right female by using IP. IP for the weight of left male talus was >26.33 gm while that for left female talus was <10.91 gm. 8.57% of left male talus were correctly identified as left male and 18% of left female talus were correctly identified as left female by using IP.

DP for the weight of right male talus was >28.79 gm while that for right female talus was <8.53 gm. None of the right male talus was correctly identified as right male and 2.27% of right female talus were correctly identified as right female by using DP. DP for the weight of left male talus was >27.43 gm while that for left female talus was <8.49 gm. 2.86% of left male talus were correctly identified as left male and 6% of left female talus were correctly identified as left female by using DP.

The male tali are heavier than the female, for both right as well as left side, in the Gujarati population of present study. Also the mean weight of right talus is heavier than the left, for both male as well as female. p value <0.01 for right male and right female talus weight as well as for left male and left female talus weight.

RANGES-WEIGHT OF TALUS (gm)	NUMBER OF TALUS			
	MALE		FEMALE	
	RIGHT	LEFT	RIGHT	LEFT
5-9.99	0	0	6	8
10-14.99	4	4	14	21 (42%)
15-19.99	25 (43.86%)	29 (41.42%)	17 (38.63%)	16
20-24.99	19	28	6	4
25-29.99	9	8	1	1
30-34.99	0	1	0	0

TABLE 2: Frequency distribution table showing the distribution of male (right and left) and female (right and left) talus according to their weight.



GRAPH 1: Bar diagram showing the distribution of male (right and left) and female (right and left) talus according to their weight.

As shown in graph 1, there are 25 right male talus (43.86% of total right male talus) fall in the range of 15 to 19.99 gm while 17 right female talus (38.63% of total right female talus) fall in the same range for the weight parameter in the Gujarati population of present study. 29 left male talus (41.42% of total left male talus) fall in the range of 15 to 19.99 gm while 21 left female talus (42% of total left female talus) fall in the range of 10 to 14.99 gm for the weight parameter in the Gujarati population of present study.

DISCUSSION
Weight of talus was also measured by **Singh S et al[15] and Ahmad R et al[16].** Findings of present study are tabulated, compared and discussed with findings of these workers.

Mean weight of right male, left male, right female and left female talus in the Varanasi population are 24.06 gm, 23.09 gm, 15.66 gm and 15.03 gm respectively. All these findings are higher as compared to the findings of the talus of Gujarati population of present study.

By using IP of the weight of talus, Singh S et al had correctly identified 77% of the right male talus(IP >20.50 gm), 71% of left male talus(IP >20.00 gm), 46% of right female talus(IP <15.10 gm) and 42% of left female talus(IP <15.20 gm), while these findings in the present study are 3.51% for the right male talus(IP >27.51 gm), 8.57% for the left male talus(IP >26.33 gm), 15.91% for the right female talus(IP <10.74 gm) and 18% for the left female talus(IP <10.91 gm).

Details	Varanasi population (Singh S et al)				Gujarati population (Present study)			
	Male		Female		Male		Female	
	Right	Left	Right	Left	Right	Left	Right	Left
No	60	56	24	24	57	70	44	50
Mean(gm)	24.06	23.09	15.66	15.03	20.53	20.42	15.53	14.74
Range (gm)	15.10-36.80	15.20-34.60	6.00-20.50	6.00-20.00	10.74-28.26	10.91-31.60	7.26-27.51	6.46-26.33
IP(gm)	>20.50	>20.00	<15.10	<15.20	>27.51	>26.33	<10.74	<10.91
%IP	77%	71%	46%	42%	3.51%	8.57%	15.91%	18%

TABLE 3: Comparison of data of present study (Gujarati population) with those of Singh S et al (Varanasi population) (IP and %IP)

Details	Varanasi population (Singh S et al)				Gujarati population (Present study)			
	Male		Female		Male		Female	
	Right	Left	Right	Left	Right	Left	Right	Left
No	60	56	24	24	57	70	44	50
Mean(gm)	24.06	23.09	15.66	15.03	20.53	20.42	15.53	14.74
SD(gm)	4.90	4.94	3.70	3.49	4.00	3.98	4.42	4.23
Mean ± 3SD	9.36-38.76	8.27-37.91	4.56-26.76	4.56-25.50	8.53-32.53	8.49-32.35	2.26-28.79	2.05-27.43
DP(gm)	>26.76	>25.50	<9.36	<8.27	>28.79	>27.43	<8.53	<8.49
%DP	28%	32%	4%	8%	0%	2.86%	2.27%	6%

TABLE 4: Comparison of data of present study (Gujarati population) with those of Singh S et al (Varanasi population) (DP and %DP)

By using DP of the weight of talus, Singh S et al had correctly identified 28% of the right male talus(DP >26.76 gm), 32% of left male talus(DP >25.50 gm), 4% of right female talus(DP <9.36 gm) and 8% of left female talus(DP <8.27 gm), while these findings in the present study are 0% for the right male talus(DP >28.79 gm), 2.86% for the left male talus(DP >27.43 gm), 2.27% for the right female talus(DP <8.53 gm) and 6% for the left female talus(DP <8.49 gm).

Details	Pakistani population (Ahmad R et al)				Gujarati population (Present study)			
	Male		Female		Male		Female	
	Right	Left	Right	Left	Right	Left	Right	Left
No	52	44	24	30	57	70	44	50
Mean(gm)	29.23	28.76	22.25	22.15	20.53	20.42	15.53	14.74
Range (gm)	22.40-34.20	22.20-36.98	20.99-23.50	20.49-23.11	10.74-28.26	10.91-31.60	7.26-27.51	6.46-26.33
IP(gm)	>23.50	>23.11	<22.40	<22.20	>27.51	>26.33	<10.74	<10.91
%IP	85.7%	85.7%	61%	50%	3.51%	8.57%	15.91%	18%

TABLE 5: Comparison of data of present study (Gujarati population) with those of Ahmad R et al (Pakistani population) (IP and %IP)

Details	Pakistani population (Ahmad R et al)				Gujarati population (Present study)			
	Male		Female		Male		Female	
	Right	Left	Right	Left	Right	Left	Right	Left
No	52	44	24	30	57	70	44	50
Mean(gm)	29.23	28.76	22.25	22.15	20.53	20.42	15.53	14.74
SD(gm)	3.68	4.45	0.68	0.71	4.00	3.98	4.42	4.23
Mean ± 3SD	18.18-40.28	15.41-42.11	20.49-24.61	20.02-24.28	8.53-32.53	8.49-32.35	2.26-28.79	2.05-27.43
DP(gm)	>24.61	>24.28	<18.18	<15.41	>28.79	>27.43	<8.53	<8.49
%DP	85.7%	71.4%	0%	0%	0%	2.86%	2.27%	6%

TABLE 6: Comparison of data of present study (Gujarati population) with those of Ahmad R et al (Pakistani population) (DP and %DP)

Mean weight of right male, left male, right female and left female talus in the Pakistani population are 29.23 gm, 28.76 gm, 22.25 gm and 22.15 gm respectively. All these findings are higher as compared to the findings of the talus of Gujarati population of present study.

By using IP of the weight of talus, Ahmad R et al had correctly identified 85.7% of the right male talus(IP >23.50 gm), 85.7% of left male talus(IP >23.11 gm), 61% of right female talus(IP <22.40 gm) and 50% of left female talus(IP <22.20 gm), while these findings in the present study are 3.51% for the right male talus(IP >27.51 gm), 8.57% for the left male talus(IP >26.33 gm), 15.91% for the right female talus(IP <10.74 gm) and 18% for the left female talus(IP <10.91 gm).

By using DP of the weight of talus, Ahmad R et al had correctly identified 85.7% of the right male talus(DP >24.61 gm), 71.4% of left male talus(DP >24.28 gm), 0% of right female talus(DP <18.18 gm) and 0% of left female talus(DP <15.41 gm), while these findings in the present study are 0% for the right male talus(DP >28.79 gm), 2.86% for the left male talus(DP >27.43 gm), 2.27% for the right female talus(DP <8.53 gm) and 6%

for the left female talus(DP <8.49 gm).

As compared to IP, when we use DP, percentages of correctly identified bones are reduced or remain same. DP is the more accurate method for correctly identifying sex as compared to IP.

The weight of talus of Gujarati population is less than the weight of talus of Varanasi as well as Pakistani population.

SUMMARY AND CONCLUSION

The present study was undertaken on 221 talus. Out of 221 talus, 127 were male talus (57 right + 70 left) and 94 were female talus (44 right + 50 left).

In the Gujarati population of present study, mean weight of right male talus is 20.53 gm and of left male talus is 20.42 gm, while mean weight of right female talus is 15.53 gm and of left female talus is 14.74 gm. In Gujarati population, if the weight of right talus is >28.79 gm than it is definitely male talus and if it is <8.53 gm than it is definitely female talus by using Demarcating Point. In Gujarati population, if the weight of left talus is >27.43 gm than it is definitely male talus and if it is <8.49 gm than it is definitely female talus by using Demarcating Point.

The male tali are heavier than the female tali, for both right as well as left side, in the Gujarati population of present study. Also the mean weight of right talus is higher than the left talus, for both male as well as female. Mean weight of talus of Gujarati population, for both right as well as left side, are less as compared to weight of talus of Varanasi and Pakistani population.

Thus, the weight of the talus is a very important parameter for making models of bones of foot (particularly talus); and both male and female tali can be artificially made by considering the data of the present study for the routine study purpose in the department of anatomy and orthopaedics.

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