

# Calcaneal Facet of Talus: An Osseo-morphological Study in the Population of West Bengal, India

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## ABSTRACT

**Introduction:** Calcaneal articular facet of talus plays an important role in joint stability as well as in mobility. In many diseases of foot viz., talocalcaneal arthritis, coalition, intra-articular fracture, congenital flatfoot, valgus deformity; as well as in different surgical procedures viz., triple arthrodesis, internal and external fixation, osteotomy, and anatomic reduction; the size and shape of bones, the inter-relationship of talus and calcaneum with other bones of foot is an important clinical consideration.

**Aim:** To explore the variability of the types of the calcaneal facets of talus in population of West Bengal, India.

**Materials and Methods:** An observational descriptive study was conducted with dry specimens of tali preserved in Department of Anatomy of medical teaching institutions of Kolkata for six months; with 144 tali of unknown age and sex (69 right and 75 left-sided), collected from bone libraries of seven different medical colleges of West Bengal by non probability sampling. The borders of the calcaneal articular

facets were traced with colour sketch pen, following which authors unanimously agreed upon the 'type' of the calcaneal facets on visual impression as was guided in the mostly used classification standard method as described by Arora AK et al., and Kaur M et al. Data was extrapolated and analysed in Microsoft excel software 2010.

**Results:** Out of 144 tali (right=69, left=75) maximum number of type II (47.92%) was observed. For right-side, type I, II and V facets in 47.83%, 43.48% and 8.70% were observed respectively. On left-side, type I- 36%, type II- 52%, type III, IV, V 4% was observed each. Authors did not find any type III or type IV on right-side.

**Conclusion:** Maximum prevalence of the type II articular facet was found and absence of type III/IV facets in the right-side in the current study population provides us a reflection of the anthropometric data for the population of West Bengal, but there remains scope of further study with larger sample size supported by imaging facilities.

**Keywords:** Ankle, Calcaneum, Specimens, Subtalar joint, Tarsal bone, Weight bearing

## INTRODUCTION

In Latin 'taxillus' means ankle bone of a horse. From taxillus, word talus have been derived [1]. One of the major weight bearing joints of the body is talocrural joint [2]. Talus is one of the important tarsal bones of human body. This corner stone of medial longitudinal arch transmits body weight from tibio-fibular joint to plantar arch below. This second largest tarsal bone which is situated between tibia-fibular mortice superiorly and calcaneum inferiorly, has no muscular and tendinous attachment [2,3].

Ankle is frequently injured joint in the body [4]. Injuries are due to uneven weight distribution and excessive use of this unstable subtalar joint [5]. Patients with fracture neck of talus even without necrosis of body has enough risk for developing osteoarthritis in subtalar joint [6]. This complex joint has been topic of interest for decades to the anatomists, orthopaedicians and sports-physiotherapist for advancement and modification of management of clinical cases [7]. Subtalar joint is formed by anterior, middle and posterior talocalcaneal joints. Inferior surface of body of talus presents posterior calcaneal articular facet separated from the middle one by sulcus tali [8]. On the undersurface of neck of the talus middle calcaneal facet may or may not be separated from the anterior one which is located on the undersurface of head of this bone [9]. Joint mobility significantly varies, depending upon the number of articular facets engaged in subtalar joint formation [10].

In India, previous studies from south, north and west India respectively have revealed variation in calcaneal articular facets [11-14]. Till date, no study has been published from West Bengal on morphological classification of talus.

Variation in the subtypes of calcaneal articular facet of talus may be due to different postural habit, gait, built and racial diversity all

over the world. Knowledge of this variation is not only helpful for anthropological or forensic purpose but also in clinical management and sports-medicine field [13,14].

The aim of the present study was to study and explore the variability of the types of the calcaneal facets of talus in population of West Bengal so that the data can help to enrich the source in the field of anthropology, forensic medicine and surgery.

## MATERIALS AND METHODS

The present study was a institution-based observational descriptive study conducted for eight months duration from December 2020 -July 2021 in the Department of Anatomy, IPGME&R, Kolkata, West Bengal, India. Institutional and Ethical Committee's (IEC) permission (IEC Letter no. IPGME&R/IEC/2021/595) was taken for the study. A total of 144 dry human tali of unknown age and sex from seven different medical colleges of West Bengal were included, with due permission from the heads of the respective Departments of Anatomy.

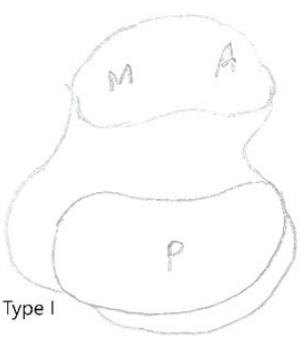
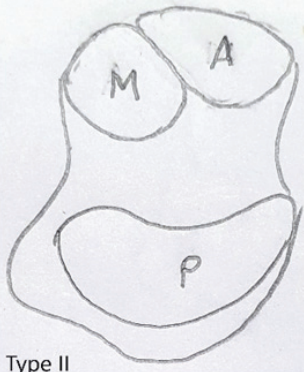
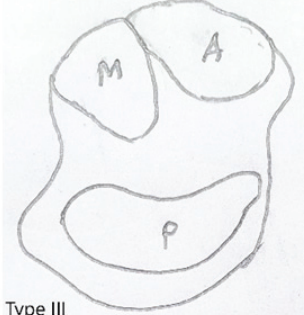
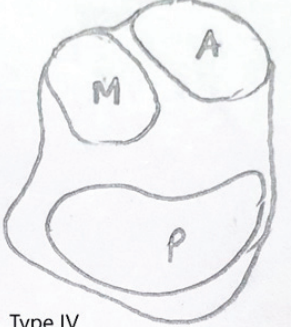

**Inclusion criteria:** The bones were collected from donated cadavers from population of West Bengal and adjacent states. Thus, 69 right-sided and 75 left-sided tali were included by non probability (convenience) sampling.

**Exclusion criteria:** Unossified or damaged bony specimens. Authors conscientiously noticed calcaneal articular facets of each talus.

In the present study, to distinguish different configuration types the classification given by Arora AK et al., and Kaur M et al., [11,13] were followed.

Each bone was numbered, articular margin of each facet was marked with colour sketch pen and photographs were taken by Moto e7 smartphone with 13 MP camera. Frequency and percentage of different types of calcaneal articular facets of talus were calculated.

Calcaneal articular facet of talus were classified in following types [Table/Fig-1].

|                  |   |  |
|------------------|---|--|
| <p>Type I:</p>   | <p>Anterior and middle articular facets are fused; posterior articular facet is separated</p>                                 |  <p>Type I</p>    |
| <p>Type II:</p>  | <p>Anterior facet separated from middle facet by ridge, posterior facet is separated from anterior and middle.</p>            |  <p>Type II</p>   |
| <p>Type III:</p> | <p>Anterior facet separated from middle facet by ridge and groove, posterior facet is separated from anterior and middle.</p> |  <p>Type III</p> |
| <p>Type IV:</p>  | <p>Anterior, middle and posterior facet are separated from each other</p>   |  <p>Type IV</p> |
| <p>Type V:</p>   | <p>Anterior, middle and posterior facet are fused with each other.</p>  |  <p>Type V</p>  |

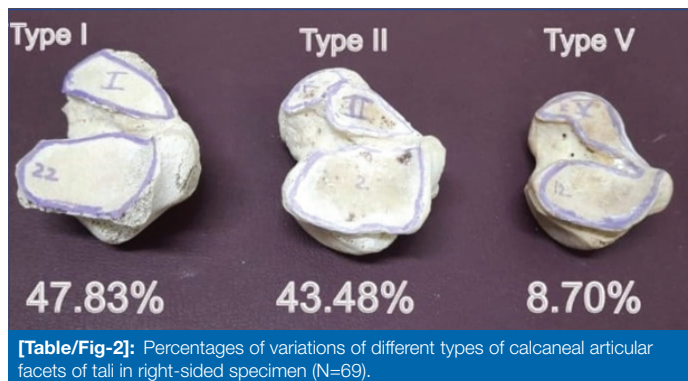
**[Table/Fig-1]:** Different types of calcaneal articular facet of talus (diagrams were hand-drawn by author). Classification given by Arora AK et al., and Kaur M et al., [11,13]

### STATISTICAL ANALYSIS

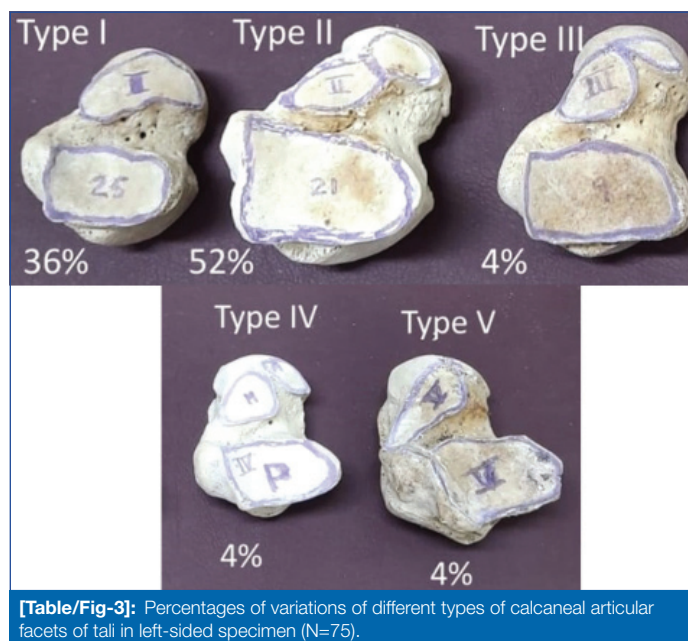
After collection, data was entered in Microsoft excel software 2010, and percentage of each type of talus was calculated.

### RESULTS

According to the availability of the specimens following inclusion and exclusion criteria, 144 tali were studied. A total of 69 of 144 samples (47.9%) belonged to specimen of right-side and 75 (52.1%) were of left-side. Among right-sided tali, 47.83% of facets were type I variety. 43.48% were of type II variety and 8.70% were of type V. In present study authors did not find type III and IV variety among right-sided tali [Table/Fig-2].



In case of left-sided tali our result has shown 36% of type I variety, 52% of type II variety and 4% for each type III, IV and V varieties, respectively [Table/Fig-3].



Maximum number of type II articular facet (47.92%) as a whole was observed. But in case of right-side type I variety was more (47.83%), whereas type II was more (52%) on left. None type III or type IV on right-side was found, but for left-side all the variants were observed. Frequency and percentage of different type has been depicted in [Table/Fig-4].

| Type of facet | Right (n=69) |                | Left (n=75) |                | Total (n=144) |                |
|---------------|--------------|----------------|-------------|----------------|---------------|----------------|
|               | Number (n)   | Percentage (%) | Number (n)  | Percentage (%) | Number (n)    | Percentage (%) |
| Type I        | 33           | 47.83          | 27          | 36             | 60            | 41.67          |
| Type II       | 30           | 43.48          | 39          | 52             | 69            | 47.92          |
| Type III      | ----         | ---            | 3           | 4              | 3             | 2.08           |
| Type IV       | ----         | ----           | 3           | 4              | 3             | 2.08           |
| Type V        | 6            | 8.70           | 3           | 4              | 9             | 6.25           |

**[Table/Fig-4]:** Frequency distribution and percentage of different types of calcaneal articular facets in present study.

## DISCUSSION

In present study, authors have examined different types of calcaneal articular facets of talus to measure incidence of different types of tali on the basis of variation of calcaneal articular facets. In the present study grossly, type II variety showed highest incidence (47.92%) followed by type I (41.67%). Type II was more on the left-side (52%) in comparison with right (43.48%). In contrast, type I was more common (47.83%) on the right-side that left (36%).

Study on 500 sample of tali of Indian population by Arora AK et al., in 1979 revealed 78% of type II variety followed by 16% of type I, 1%, 3% and 2% of type II, IV and V respectively [11]. Type II variety was found maximum in number among population of Karnataka in study by Bilodi AK in 2006 [12]. Out of the 240 samples studied, they got 50% of type II, 16.66% of type III, 18.41% of type V, type IV 5% and minimum percentage of type I (10%). Kaur M et al., found highest proportion of type I variety in their study among north Indian population [13]. They found 45% of type I, 24% of type II, 9% of type III, 5 and 17% of type IV and V, respectively [13].

Present study observation was comparable with study done by Garg R et al., in 2013 [14]. In 2013, Garg R et al., studied total 300 talion population of Jaipur in Rajasthan and they found maximum variety of type II (43.7%), followed by type I (39%), type III (6%), Type IV (5.3%) and type V [14]. This result was close to present study result as present study also found maximum variety 47.92% of type II tali as a whole, followed by type I (41.67%). Philip XC and Prabavathy G conducted a study on 200 specimens of tali in Puducherry, where they found 42% of type I, 30% of type II, 4% of type III, 3% of type IV and 21% of type V [15]. In year 2017, Namburu BSP et al., got maximum number of type I tali in their study with total 84 tali from population of Andhra Pradesh, where they got Type I 52.4%, II Total 32.1%, III 1.2%, IV 3.6%, Type V 10.7% [16].

In 2020, Patil SS and Kotli AN found maximum number of type II variety tali among population of Karnataka with 200 sample size. They found where they found type I 20.5%, type II 74%, type III 1.5%, type IV 3.5% and type V 0.53% [17]. Present study for type III and IV (2.08%) has shown similar result with studies, done in population of Puducherry, Andhra Pradesh, North India and Rajasthan [Table/Fig-5] [11-17].

Present study results were also compared with other studies done outside India [Table/Fig-6] [11,18-20].

Barbix E et al., studied on 122 specimens in Belgium, where they found 21% of type I, 22% of type II, 6% of type III, 39% of type IV. In their study, they did not find any type V variety [18]. Out of 50 tali specimen among Nepalese, Bilodi AKS and Agarwal BK found only four types. They got 10% of type I, 14% of type II, 20% of type III and maximum percentage (56%) of type V. They did not report about any type IV variety [19]. Lee JY et al., had a study on 76 Korean tali in 2012, where they found almost equal percentage of type I (30%) and type II (31.6%) variety [20]. Though they got 28.9% of type III and 9.2% of type IV variety, but did not have any type V variety. Like present study, maximum number of type II pattern were also found in Korean population by Lee JY et al., [20]. In Nepal, type V talus was maximum (56%), where they have got only 6.25% of it. In Belgium, Barbix E et al., found maximum number of type IV talus (39%) [18]. Bilodi AKS and Agarwal BK did not find any type IV talus in their study whereas type V variety was not found in Korean population by Lee JY et al., [Table/Fig-6] [19,20].

Types of tali were bilaterally compared in few literatures among different states of India [14,17]. Garg R et al., studied on total specimens of 300, of which 150 of either side in 2013 in Rajasthan [14]. They found 39.3% of type I on right-side and 38.7% on left. For type II their results for right and left-sides were 38.7% and 48.7% respectively. Patil SS and Kotli AN collected 200 specimens from North Karnataka region in 2020 and found 21.27% on right-side and 19.8% on left-side of type I variety and 73.40% and 74.52% of type II variety on right and left-side respectively [17]. Present study findings were close to the findings among Rajasthani population, but differed from that done by Patil SS and Kotli AN [17] in 2020 among Karnataka population [Table/Fig-7].

Variations in results may be due to genetic, regional and racial differences among sample population. Geographical variations along with postural habit, occupation might be other contributory factors.

Bruckner J stated that stability of subtalar joint depends on the number of articular facets present between first two largest tarsal bones [10]. Higher is the number of articular facets, greater would be the stability. They also stated that mobility of subtalar joint is also directly proportional to the articular surface area of two

| SI | Author                          | Year | Sample size             | Country                     | Type I (%) | Type II (%) | Type III (%) | Type IV (%) | Type V (%) |
|----|---------------------------------|------|-------------------------|-----------------------------|------------|-------------|--------------|-------------|------------|
| 1  | Arora AK et al., [11]           | 1979 | T=500                   | India                       | 16         | 78          | 1            | 3           | 2          |
| 2  | Bilodi AK [12]                  | 2006 | T=240                   | South India -Karnataka      | 10         | 50          | 16.6         | 5           | 18.4       |
| 3  | Kaur M et al., [13]             | 2011 | T=100                   | North India                 | 45         | 24          | 9            | 5           | 17         |
| 4  | Garg R et al., [14]             | 2013 | T=300                   | Western India- Rajasthan    | 39         | 43.7        | 6            | 5.3         | 6          |
| 5  | Philip XC and Prabavathy G [15] | 2014 | T=200<br>R=100<br>L=100 | South India- Puducherry     | 42         | 30          | 4            | 3           | 21         |
| 6  | Namburu BSP et al., [16]        | 2017 | T=84<br>R=40<br>L=44    | South India- Andhra Pradesh | 52         | 32          | 1            | 3.6         | 10.7       |
| 7  | Patil SS and Kotli AN [17]      | 2020 | T=200                   | South India -Karnataka      | 20.5       | 74          | 1.5          | 3.5         | 0.53       |
| 8  | Present study                   | 2022 | T=144<br>R=69<br>L=75   | Eastern India – West Bengal | 41.67      | 47.92       | 2.08         | 2.08        | 6.25       |

[Table/Fig-5]: Comparison of talar subtypes explored in studies conducted in different states of India [11-17].

T: Total; R: Right-sided; L: Left-sided

| SI | Author                          | Year | Sample size (n) | Country | Type I (%) | Type II (%) | Type III (%) | Type IV (%) | Type V (%) |
|----|---------------------------------|------|-----------------|---------|------------|-------------|--------------|-------------|------------|
| 1  | Arora AK et al., [11]           | 1979 | 500             | India   | 16%        | 78%         | 1%           | 3%          | 2%         |
| 2  | Barbix E et al., [18]           | 2000 | 122             | Belgium | 21         | 22          | 6            | 39          | 12         |
| 3  | Bilodi AKS and Aggarwal BK [19] | 2004 | 50              | Nepal   | 10         | 14          | 20           | ---         | 56         |
| 4  | Lee JY et al., [20]             | 2012 | 76              | Korean  | 30.3       | 31.6        | 28.9         | 9.2         | ---        |
| 5  | Present study                   | 2022 | 144             | India   | 41.67      | 47.92       | 2.08         | 2.08        | 6.25       |

[Table/Fig-6]: Comparison of talar subtypes explored in studies conducted in different countries [11,18-20].

| Author                           | Place       | Type I      |            | Type II     |             | Type III  |           | Type IV   |          | Type V    |          |
|----------------------------------|-------------|-------------|------------|-------------|-------------|-----------|-----------|-----------|----------|-----------|----------|
|                                  |             | Rt          | Lt         | Rt          | Lt          | Rt        | Lt        | Rt        | Lt       | Rt        | Lt       |
| Garg R et al., [14], 2013        | Rajasthan   | 59 (39.3%)  | 58 (38.7%) | 58 (38.7%)  | 73 (48.7%)  | 12 (8%)   | 6 (4%)    | 9 (6%)    | 7 (4.7%) | 12 (8%)   | 6 (3.9%) |
| Patil SS and Kotli AN [17], 2020 | Karnataka   | 20 (21.7%)  | 21 (19.8%) | 69 (73.4%)  | 79 (74.52%) | 1 (1.06%) | 2 (1.88%) | 3 (3.19%) | 4 (3.7%) | 1 (1.06%) | ---      |
| Present study, 2022              | West Bengal | 33 (47.83%) | 27 (36%)   | 30 (43.48%) | 39 (52%)    | ---       | 3 (4%)    | ---       | 3 (4%)   | 6 (8.70%) | 3 (4%)   |

**[Table/Fig-7]:** Comparison of bilateral talar subtypes explored in studies conducted earlier [14,17].

bones. In a single fused facet, area of gliding is more, so subtalar joint mobility would increase. In 1993, Verhagen FD also found single facet morphology of talus make subtalar joint unstable one [5]. Calcaneal articular facets on talus form subtalar joint, which is involved in inversion-eversion movement of foot. Inclination of the axis of subtalar joint determines the height of longitudinal arches of foot which maintain stability of subtalar joint. High arch is responsible for more stability. Morphological variations of these facets will predispose individual to joint instability, laxity of ligaments as well as severe arthritic changes. Unstable joints are more predisposed to trauma due to uneven distribution of body weight. Detailed anatomical knowledge will act as a baseline in advance surgical reconstruction procedure and rehabilitation management of talo-calcaneal coalition, intra-articular fracture and arthritic changes of this particular joint [21].

### Limitation(s)

Bony specimens were collected from museum archive. In present study, authors did not consider age and sex and bilateral dimorphism of bony specimen. If authors could use specimen of tali just after dissection from cadaver, that might be much more acceptable. Further studies taking care of this along with radiological modalities involving large sample sizes are recommended for more meaningful comparisons.

### CONCLUSION(S)

Present study showed variation in the prevalence of different types of calcaneal articular facets in population of West Bengal. We found maximum number of type II articular facet as a whole. But in case of right-side type I variety was more, whereas type II was more on left. We did not find any type III or type IV on right-side, but for left-side we got all the variants.

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