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THE INCIDENCE OF TROCHANTER TERTIUS IN DRY FEMORA -AN INSTITUTIONAL STUDY

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Abstract

Background: The third trochanter (TT), also known as the trochanter tertius or innominate tubercle, is a non-metric anatomical variant observed on the proximal femur. It serves as an attachment site for the gluteus maximus muscle and is associated with functional adaptations and variations in the femur's morphology. Understanding its incidence and morphometry is essential for clinical and orthopedic applications, particularly in surgical planning and fracture management.

Aims and Objectives: This study aimed to investigate the TT's incidence, morphological characteristics, and morphometric measurements in dry femoral specimens from the Department of Anatomy at Government Medical College, Srinagar.

Materials and Methods: A total of 110 dry human femora were analyzed. Femora with proximal damage were excluded. The incidence of the TT was recorded, and its length and breadth were measured using a digital caliper. Measurements were compared between right and left femora using independent samples t-tests to identify any significant differences.

Results: The incidence of the TT was 37.2% (41/110), with a slightly higher prevalence on the right femur (38%) compared to the left (36.1%). The mean length and breadth of the TT were 16.8 ± 5.1 mm and 7.31 ± 2.4 mm, respectively. No statistically significant differences were found in the TT's length ($t = 0.768$, $p = 0.44$) or breadth ($t = -0.261$, $p = 0.80$) between right and left femora.

Conclusion: The TT was present in 37.2% of the analyzed femora, with slight right-sided predominance. Its development is influenced by the mechanical pull of the gluteus maximus muscle and may impact fracture patterns in the proximal femur. Knowledge of the TT is critical in orthopedic practice, particularly for surgical access and the design of pre-contoured femoral plates. Further studies focusing on genetic and biomechanical factors can provide deeper insights into its development and clinical implications.

Keywords: Femur. Third Trochanter, Orthopaedics

Introduction:

The third trochanter, also referred to as the trochanter tertius or innominate tubercle, is an additional bony protrusion situated on the proximal femur. It is typically positioned lateral to the axis along the tip of the greater trochanter, concurrent with the superior bifurcation of the linea aspera(1). In

anthropometric evaluations of diverse ethnic populations, the third trochanter represents the most commonly observed non-metric variation in the post-cranial skeleton(2).

The trochanter tertius typically occurs as a single protrusion, but in some cases, two or three trochanters may be observed(3). The reported incidence of the trochanter tertius ranges from 17% to 72%(3). It has been observed to exhibit diverse morphological features, including oblong, round, and conical shapes(4). In certain instances, the trochanter tertius may appear continuous with the gluteal ridge, which is defined as a linear elevation along the gluteal tuberosity(5)[(5)]. The gluteal tuberosity serves as an attachment site for the gluteus maximus muscle and develops as a traction epiphysis(4–6). The trochanter tertius can be considered a modification of the gluteal tuberosity, with its superior portion exhibiting enhanced development.

The trochanter tertius increases the surface area of attachment for the gluteus maximus muscle, thereby enhancing the muscle's contractile efficiency(7). This increased pull of the gluteus maximus is believed to be one of the contributing factors in the formation of the trochanter tertius. Additionally, the trochanter tertius functions as a trochlea, altering the direction of the gluteus maximus tendon before it inserts into the gluteal tuberosity(7). The trochanter tertius first appears during the fifth month of gestation and continues to increase in size until the onset of puberty, at which point it begins to diminish(8). The development of the TT has been associated with various genetic factors, with the Hoxa10 and Hoxd10 genes playing a crucial role in regulating skeletal growth and innervation of the hindlimb, underscoring the importance of HOX genes in this process(9).

The existing literature has described the presence of an ossification center for the trochanter tertius in both human and non-human species, as well as a distinct epiphysis associated with this anatomical feature(10). According to previous reports, the femoral shaft serves as the long axis of the epiphyseal plate for the TT, which is characterized by a flat and short morphology.

The objective of the current study was to investigate the incidence of the TT in a collection of dry femoral specimens obtained from our institution.

Materials and Methods.

This study was conducted in the Department of Anatomy at the Government Medical College, Srinagar, utilizing a total of 110 dry femoral specimens. The precise age and sex of the bones were unknown, and any femurs with damage to the proximal region were excluded from the analysis. The sample size aligns with previous investigations into the prevalence and morphology of the third trochanter in similar populations [Chhaparwal et al.(3): 50 femurs; Nayak et al.(11): 60 femurs; Rajad R et al.(12): 100 femurs; Sadaf et al.(7): 56 femurs]. While smaller than some studies (Aziz et al.(13): 150 femurs; Muthukumaravel N and Manjunath K(14): 153 femora), our sample size was deemed sufficient to provide meaningful insights into the occurrence and characteristics of the third trochanter within our specific target population.

Figure 1: Measurement of length of third trochanter of Femur

Figure 2: Measurement of breadth of third trochanter of Femur

Results

Out of 110 femurs examined, 41 (37.2%) exhibited the presence of a third trochanter.

- **Right Femurs:** 24 out of 63 (38%) exhibited a TT.
- **Left Femurs:** 17 out of 47 (36.1%) exhibited a TT.

Morphometric Analysis

The mean length and breadth of the TT were calculated, along with separate measurements for right and left femurs:

Table 1; Average Length and Breadth of Third Trochanter across all femurs with respective standard deviations

Bones	Number	Mean Length (mm)	Mean Breadth (mm)
Right Femurs	24	16.33 ± 4.5	7.3 ± 2.8
Left Femurs	17	17.64 ± 5.9	7.1 ± 2
Total	41	16.8 ± 5.1	7.31 ± 2.4

The distribution of the length and breadth of the TT on various bones is seen in the graphs below:

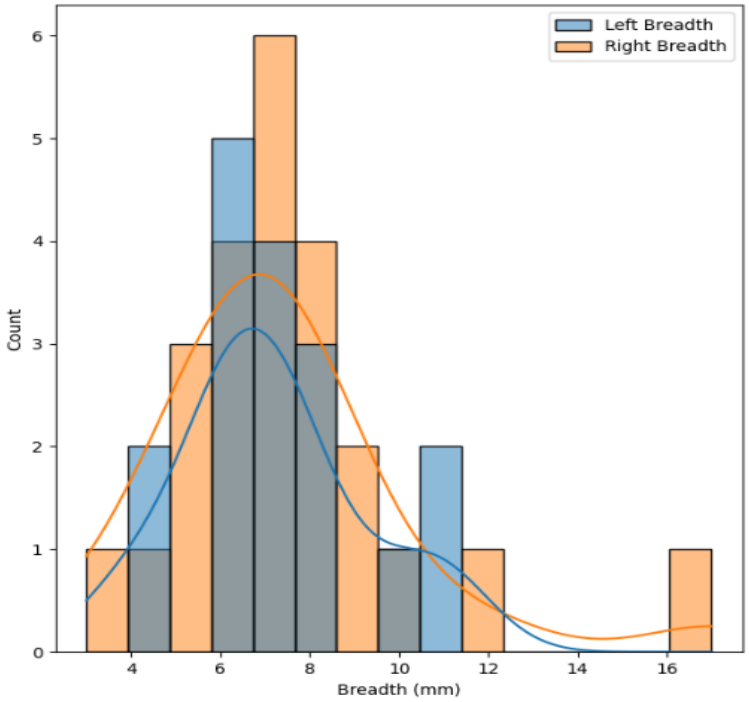

Figure 3: Distribution of Third Trochanter Breadth Across Various Femurs

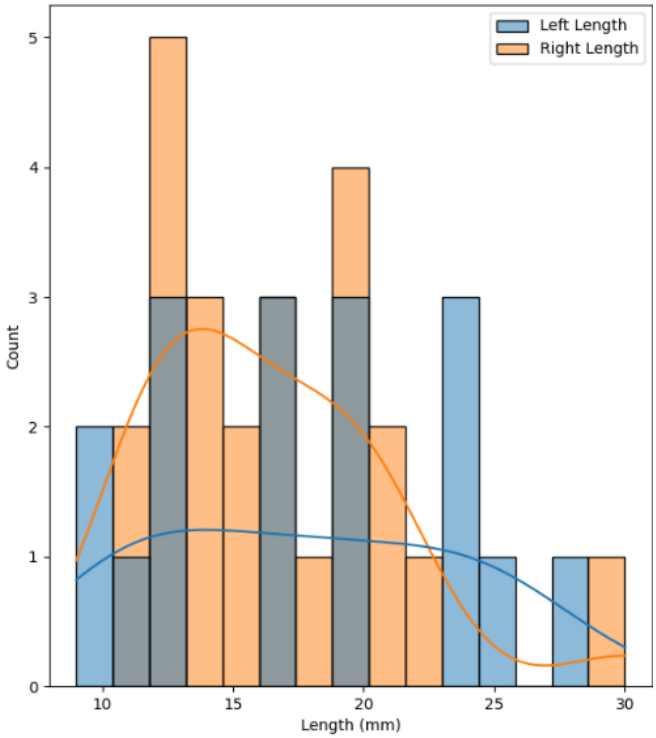

Figure 4: Distribution of Trochanter Length Across Various Femurs

Statistical Analysis

Independent samples t-tests were conducted to compare the length and breadth of the TT between right and left femurs.

- **Length:** No significant difference was found between the right and left sides ($t = 0.768$, $p = 0.44$).
- **Breadth:** No significant difference was found between the right and left sides ($t = -0.261$, $p = 0.80$)

Discussion

The more pronounced superior aspect of the gluteal tuberosity is known as the trochanter tertius, or the TT of the femur. It is defined as a bony prominence or protuberance located in the superior region of the gluteal tuberosity.

The incidence of the TT in the present study was 37.2%, with a left-sided predominance. This incidence differs from the lower frequencies reported in other studies. Bolanowski et al.(1) observed a 6.6% incidence with left-sided predominance, while Muthukumaravel and Manjunath(14) reported a right-sided predominance of 15.7% on the right side and 12.04% on the left side. Nayak et al(11). reported a comparable incidence of 21.66% with a left-sided predominance.

The present study reported an average length and breadth of the trochanter tertius to be 17.5 mm and 7.41 mm respectively. Additionally, the length of the trochanter was found to be greater on the left-sided femora compared to the right side. These measurements are lower than the values reported by Nayak et al.(11) but higher than those reported by Chhaparwal et al(3).

Various intrinsic and extrinsic factors, such as age, sex, and nutritional status, can influence non-metric anatomical features in individuals(1). For instance, the force of muscle contraction contributes to the formation of bony prominences, ridges, and tuberosities in bones. According to Aziz et al.(13), the concentrated distribution of gluteus maximus muscle fibers within a defined region may play a role in the development of the trochanter tertius. Thus, the presence of the TT may result from the adaptation of the gluteus maximus muscle in response to postural and bipedal locomotor activities(1).

Knowledge of the occurrence of the TT on the femur is significant, as it is associated with functional differences in the gluteal maximus muscle and is crucial in the diagnosis and management of peritrochanteric femur fractures. As reported by Rajad et al.(12), the presence of the TT can influence the fracture patterns in the pertrochanteric region, and its consideration is important when designing pre-contoured femoral plates for the treatment of these fractures. During open surgical procedures, the wire should be positioned approximately two fingerbreadths distal to the trochanter tertius, which is situated lateral to the greater trochanter and serves as a reliable anatomical landmark for surgical access(15).

Conclusion:

The present study aimed to assess the incidence and morphometry of the third trochanter in a collection of dry femora. The study found that 37.2% of the femora examined exhibited the presence of a third trochanter, with a slight right-sided predominance. The average length and breadth of the third trochanter were 16.8 mm and 7.31 mm, respectively, with no statistically significant difference in size between right and left femora.

The third trochanter's development appears to be influenced by the attachment and mechanical pull of the gluteus maximus muscle, contributing to functional differences in muscle contraction and bony adaptation. Understanding the presence and morphology of the third trochanter is crucial in orthopedic practice, particularly in the diagnosis and treatment of peritrochanteric femur fractures. Its presence can influence fracture patterns and should be considered when designing surgical procedures and pre-contoured femoral plates. Further research into the genetic and biomechanical factors involved in its development could provide a more comprehensive understanding of this anatomical variant.

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