ORIGINAL ARTICLE

Incidence of Third Trochanter/Crista Glutei in Human Femora in Central Indian Population

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Abstract:

Background: The third trochanter is a rounded bony projection which may be present along the superior border of the gluteal tuberosity of the femur. Sometime there is linear elevation along the gluteal tuberosity called as crista glutei. If conical projection is present in the gluteal tuberosity, it is called as third trochanter. *Aim and Objectives*: To undertake the study of incidences of third trochanter and crista glutei in central Indian population this study was undertaken and to compare it with occurrence in other series. *Material and Methods*: Fifty dry adult human femora collected from the Department of Anatomy and examined carefully. The third trochanter was considered to be present only if distinct oval elevation was separate from gluteal ridge. When there is linear elevation along the gluteal tuberosity we considered it as crista glutei. This classification was distinguished from that of a gluteal tuberosity. The length and width was measured using a digital vernier caliper. *Results:* The total incidence of third trochanter (oval elevation) and crista glutei (linear elevation) were found to occur in 14% and 24% with left sided predominance. *Conclusion:* Important findings of present work highlight the morphometric indices of third trochanter and crista glutei. Parameters that have been studied in the present work can be utilized for anthropometric, comparative and functional studies.

Keywords: Third Trochanter, Crista Glutei, Gluteal Tuberosity, Trochanter Tertius

Introduction:

The femur is known for being the largest and longest bone in the human skeleton. This bone supports all of the weight of the body during standing, walking and running. Femur is the most measured and reported bone of the human skeleton. Researchers have great work on human femora because it separates humans greatly from primates and early hominids. It also play great role in biological and forensic science. The structural function of the femur requires that it endure these mechanical loads, by changing its shape, size and mass. The architecture of each of the femur parts change to meet the functional demands placed on it during daily activity patterns [1]. The gluteal tuberosity may be an elongated depression or a ridge. It may at times be prominent enough to merit the unofficial title of "Third Trochanter" [2]. This third trochanter is also referred to as the trochanter tertius [1]. In some cases distinct third trochanter is present. This bony knob if present will be located lateral to the lesser trochanter [1]. The third trochanter is a rounded bony projection which may be present along the superior border of the gluteal tuberosity of the femur [3]. This skeletal variant, when present, occurs as an oblong, rounded or conical bony elevation which may be continuous with the gluteal ridge and is manifested as a distinct femoral entity [4]. Due to the paucity of literature

on the incidences of third trochanter in central Indian population this study was undertaken and to compare it with occurrence in other series.

However, factors governing the etiology and expression of the third trochanter are not well delineated. The structure is defined as an osseous prominence, tubercle or, alternatively, as a variation of the gluteal tuberosity with its superior part better developed [5]. Sometime there is linear elevation along the gluteal tuberosity called as crista glutei. If conical projection is present in the gluteal tuberosity, it is called as third trochanter [6]. The importance of the third trochanter in pertrochanteric fractures have been recently hypothesized to be correlated with the fracture break lines in pertrochanteric fractures. The third trochanter may function to provide increased skeletal mass as a reinforcement mechanism for the proximal diaphysis in response to increased ground reaction force [7]. The third trochanter functions to provide an attachment area for the ascending tendon of the gluteus maximus. Femoral attachment of the gluteus maximus suggest a strong mechanical effort of the joint in extension, lateral stabilization and control of the thigh indicating medio-lateral reinforcement to resist high mechanical stress in erect posture and locomotion [7]. The third trochanter may perhaps serve to increase attachment surface area for the gluteal musculature thereby providing greater efficiency of contraction. Gluteus maximus function may exert a mechanical loading on the third trochanter thereby altering surface morphology. The presence of bony crests, ridges and tuberosities are directly correlated to the function of contiguous muscle activity [8]. In some species of laboratory mammals the third trochanter plays an important role as a useful landmark for biomechanical studies and densitometry and as the access point of choice for the medullar cavity [8].

Material and Methods:

The experimental sample consisted of 50 dry adult human femora (25 right sided and 25 left sided) of unknown age and sex collected from the Department of Anatomy, Sri Aurobindo Medical College and Post Graduate Institute, Indore, Madhya Pradesh, India. All the femurs were examined carefully to see the presence of third trochanter. The length and width of the third trochanter wherever found were measured using a digital vernier caliper (Fig.1). The shape of the third trochanter was noted and positive findings were photographed. We also measured the length of gluteal tuberosity of femur with scale. The third trochanter was considered to be present only if distinct oval elevation was separate from gluteal ridge. When there is linear elevation along the gluteal tuberosity we considered it as crista glutei (Fig. 2). This classification was distinguished from that of a gluteal tuberosity.

Results:

The total incidence of third trochanter (oval elevation) is 14%. Although the incidence was higher on the left side which was about 16% and on right side it was about 12% (Table 1). The average length of third trochanter is about 7.69 mm and width is 4.90 mm on right side. The average length of third trochanter is about 15.48 mm and width is 7.52 mm on left side (Table 2). The total incidence of crista glutei (linear elevation) was 24% with left sided predominance. The incidence of crista glutei was 16% on right side and 32% on left side. The average length of crista glutei was about 22.15 mm on right side and 20.15 mm on left side. The average width of crista glutei was about 5 mm on right side and 5.5 mm on left side. The average length of gluteal tuberosity was about 5.46 cm on right side and 4.8 cm on left side (Table 2).

Table 1: Incidence of Third Trochanter/ Crista Gluei / Gluteal Tuberosity

Observations	Percentage
Gluteal Tuberosity	R – 100 L – 100
Third Trochanter (Oval elevation)	R –12 L – 16
Crista Glutei (linear elevation)	R –16 L – 32

R - Right, L - Left

Table 2: Measurements of Third trochanter/ Crista gluei/ Gluteal tuberosity

Observations	Length of Gluteal Tuberosity (cm)	Length / Width of Third Trochanter-Oval Elevation (mm)	Length / Width of Crista Glutei-linear Elevation (mm)
Maximum	R – 9 L – 8.5	R – 13.15/7.60 L – 17.28/8.17	R – 38.80/ 6.85 L – 30.90/8.60
Minimum	R – 3 L – 2	R – 4.76/3.46 L – 10.56/6.72	R – 9.54/2.27 L – 9.48/4.30
Average	R – 5.46 L – 4.8	R – 7.69/4.90 L – 15.48/7.52	R – 22.15/5 L – 20.15/5.5

R - Right, L - Left

Fig. 1: Showing Measurement of Third Trochanter with Digital Vernier Caliper

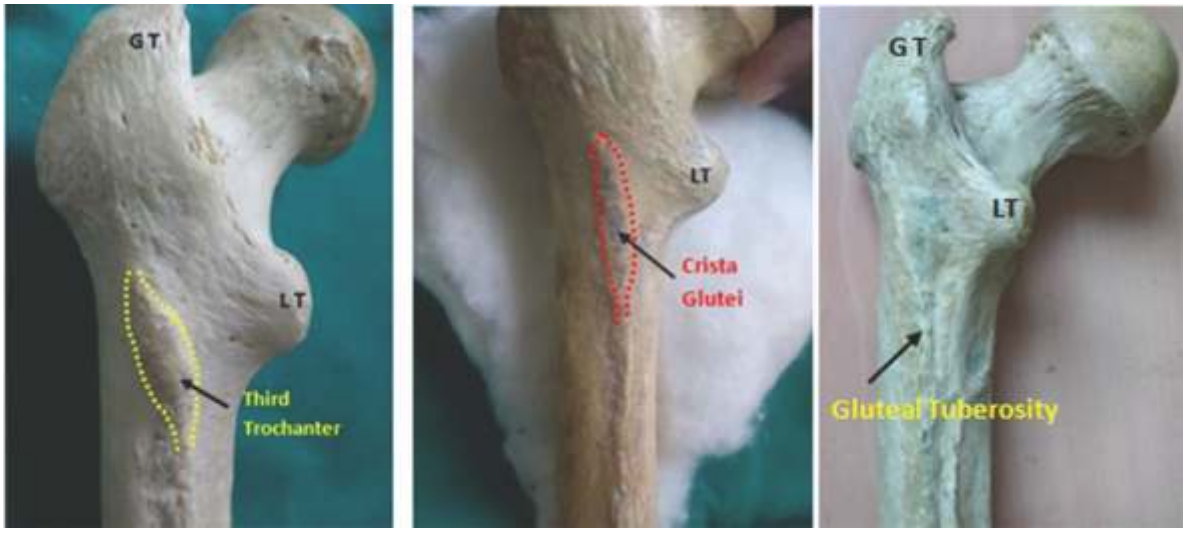

Fig. 2: Showing Third Trochanter/Crista Gluei/Gluteal Tuberosity (GT-Greater Trochanter, LT- Lesser Trochanter)

Discussion:

Different varieties of impressions are seen at the site of the insertion of gluteus maximus ranging from rounded or oblong tubercle, third trochanter, to a ridge or a prolonged elevation, or gluteal tuberosity [7].

The third trochanter is defined as the osseous tubercle in the superior part of the gluteal tuberosity of the femur. It is localized in the majority of cases lateral to the line connecting the tip of greater trochanter with the superior bifurcation of the linea aspera. The third trochanter has been commonly used as a non-metric variant of the post cranial skeleton in anthropometric studies of various populations [9].

The majority of authors describe the role of the third trochanter as the insertion area for the gluteus maximus muscle. Its presence, therefore, would be the consequence of the relative strengthening of this muscle in humanoids in comparison with other primates. An additional role of the third trochanter is probably to alternate the direction of the insertion tendon of the gluteus maximus muscle. In this case the prominent structure at the superior end of the gluteal tuberosity serves as the trochlea, alternating the direction of the tendon before it inserts to the other parts of the tuberosity [9].

The definition of the third trochanter used in this study was the osseous tubercle in the superior part of the gluteal tuberosity of the femur and when there is linear elevation along the gluteal tuberosity we considered it as crista glutei. This could explain the difference between the results of our study and those performed on other populations of the same area. No other workers have mentioned such type of classification of elevation.

Previous literatures in central Indian populations on the third trochanter are scanty. Ghosh *et al.* (2014) [7] described the incidence of the third trochanter in their study which was 6.6% with left sided predominance. In their article, they have cited the work of Finnegan (1978) which reported the side variations in Whites and Negroes,

documented higher incidence on the right side in the White and on the left side in the Negro population. They also cited a study done on excavated femora by Bolanowski *et al*. (2005) from Poland. They found third trochanter in 6.2% [7]. Sylvia *et al*. (2015) reported the incidence of the third trochanter in North Karnataka region which was 4.43% with right sided predominance [8]. Muthukumaravel (2015) observed the incidence of the third trochanter in 13.72% with right sided predominance [9]. Faruqi (2006) described that the third trochanter is present in 20% of Indian femora [6]. Our study found it significant enough to report the incidence in central Indian population. The total incidence of the third trochanter in our study is 14% with left sided predominance. The incidence of the third trochanter in our study is higher than that reported in previous works.

Muthukumaravel (2015) [9] described the occurrence of third trochanter in the femora in Northern Tamil Nadu region which was 15.71% on right sided femora and 12.04% on left sided femora. But in present study it was almost opposite; the incidence of third trochanter on left side was about 16% and on right side it was about 12%. Muthukumaravel (2015) also described the average vertical length which was found to be higher on right side (R-20.10mm/ L- 19.45 mm); which was not correlated with our study. In our study the average vertical length of third trochanter is 7.69mm on right side and 15.48mm on left side. The probable reason for the difference in length can be accounted for the differences in the races, age and height of two groups studied.

The width of third trochanter described by Muthukumaravel (2015) [9] ranges between 5-10mm (7.13 mm on right side and 8.18mm on left side). In the present study the width of third trochanter ranges between 4.5-10mm. (4.90 mm on right side and 7.52mm on left side). The variability in the width can be accounted for the level at which it is measured.

Ajita *et al*. (2015) [10] reported a case of right femur with third trochanter which is 17mm long. In present study the maximum length of third trochanter of right sided femora is about 13.15 mm. Other workers in this field have not given this particular measurement hence it could not be compared.

Ghosh *et al*. (2014) [7] documented the incidence of gluteal tuberosity which was 40.1%. In present study gluteal tuberosity is present in all the femora; hence the incidence is 100%. The average length of gluteal tuberosity is 5.46 cm on the right side and 4.8cm on the left side. No other workers have made a mention of the length of gluteal tuberosity; hence no comparable data was available.

A relationship between third trochanter incidence and a specific femoral morphology implies that this discrete trait shares a common developmental basis with size and/or shape components of femoral development and growth. By extension, the third trochanter would thus appear to possess high information content with respect to underlying hereditary factors among human populations [3]. Expression of the third trochanter may be affected by mechanical stress exerted by the gluteus maximus. The third trochanter may perhaps serve to increase attachment surface area for the gluteal musculature thereby providing greater efficiency of contraction. Gluteus maximus function may exert a mechanical loading on the third trochanter thereby altering surface morphology. The presence of bony crests, ridges and tuberosities are directly correlated to the function of contiguous muscle activity [7].

Recent researches indicate the significance of various biological and environmental factors such as age, sex, nutritional status or side dependence influencing the manifestation of certain non metric traits in non human and human populations [8].

Third trochanter is an important feature for describing general morphological pattern of the human diaphysis. Hence, the third trochanter should prove useful when included in batteries of non metric traits for discrimination among human populations [3].

Exact aetiology still remains obscure as to why in certain cases a ridge or elevation is found. This spectrum of ridge, trochanter and tuberosity may possibly represent a microevolutionary trend. Hence our study took into account the incidence of these traits in central Indian femora, not mentioned in any previous study.

Conclusion:

Total incidence of the third trochanter in central Indian population was found to be 14%. Important findings of present work highlight the morphometric indices of third trochanter/ crista glutei and throw new light on its functional significance. Various parameters that have been studied in the present work in central Indian population can be utilized for anthropometric, comparative and functional studies.

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