

## Original Research Article

# The morphologic relationship of the lesser trochanter with the femoral neck and greater trochanter

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## ABSTRACT

**Background:** The anatomy of the proximal femur comprises important landmarks for many orthopedic surgical procedures. However, this area exhibits morphological differences depending on race, gender and age. Besides being the insertion area of the hip flexor muscles, the lesser trochanter is also used as an angular reference in many orthopedic surgical procedures. The aim of this study is to investigate the morphologic relationship of the lesser trochanter with the femoral neck and greater trochanter.

**Methods:** Around 67 dry femur bones (32 left, 35 right) belonging to humans of unknown gender that belong to the Ankara University Medical Faculty, Department of Anatomy were used in this study. The morphologic relationship of the lesser trochanter (TRMI) with the femoral neck (FN) and greater trochanter (TRMJ) was studied and the results were provided in a table.

**Results:** The measured mean lesser trochanter and greater trochanter tip distance was  $67.5 \pm 4.9$  mm (60 mm-75 mm). The angle between the tip of the lesser trochanter and the center of the femoral neck was measured as  $35.05^\circ \pm 5.06^\circ$  ( $29^\circ$ - $42^\circ$ ) degrees. The distance between the tip of the lesser trochanter and the center of the femoral neck was measured as  $15 \pm 2.8$  mm (10 mm-20 mm).

**Conclusions:** In addition to the angular relationship of the lesser trochanter with the femoral neck, its relationship in terms of distance with the greater trochanter and femoral neck are the anatomic relationships that are noteworthy for the lesser trochanter, which is used as a landmark during orthopedic surgical procedures.

**Keywords:** Femoral neck, Greater trochanter, Lesser trochanter

## INTRODUCTION

The anatomy of the proximal femur comprises important landmarks for many orthopedic surgical procedures. However, this area exhibits morphological differences depending on race, gender and age. The essentially tubular structure of the proximal femur has become complex due to various curves and torsional changes. In

this regard, the literature contains many important studies especially on the morphologic relationship between the femoral head, neck and the proximal shaft that were conducted since very old times.<sup>1</sup>

The early studies on this area were focused on investigating the femoral neck-shaft angle and neck version that are still commonly used. According to these

studies, although the femoral neck angle exhibited differences depending on race, a theoretical mean degree (125 - 140<sup>0</sup>) and version were described.<sup>2-6</sup>

Even though the neck-shaft angle and neck height exhibit variations, the center of the femoral head passes through the tip of the greater trochanter (TRMJ). Lateralization of the hip abductors takes place depending on the distance between the center of the femoral head and the tip of TRMJ. This directly affects the strength of the hip abductors.

Although there are many studies concerning the TRMJ, neck and head of the proximal femur, the number of studies investigating the relationship of the lesser trochanter (TRMI), which is one of the other important anatomic structures of the proximal femur, in this area is very limited. The aim of this study is to reveal the morphologic relationship between the (1) TRMJ and TRMI (2) femoral neck (FN) and TRMI, and to investigate the rotational relationship between the (3) TRMI and FN.

## METHODS

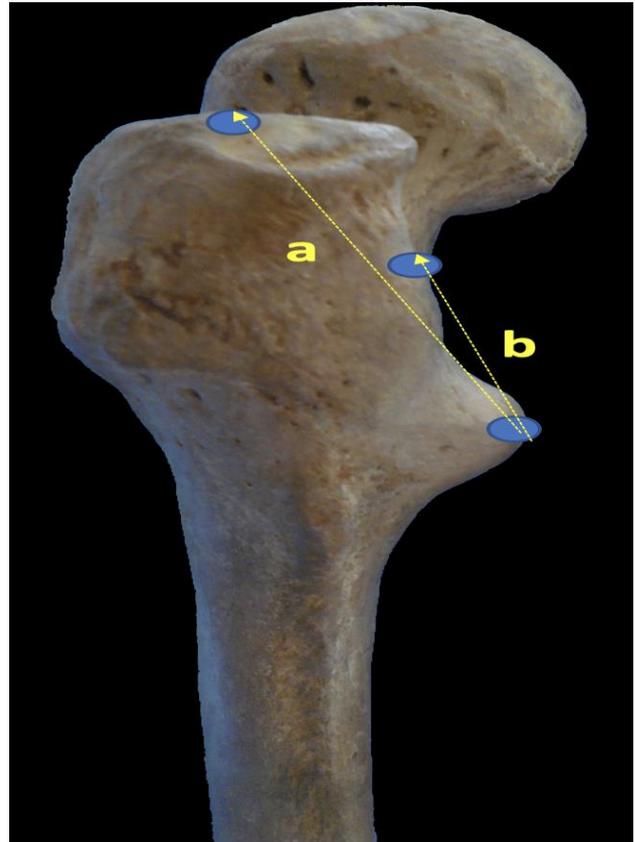
Around 67 dry femur bones (32 left, 35 right) belonging to humans of unknown gender that belong to the Ankara University Medical Faculty, Department of Anatomy were used in this study. The study period was determined as the time period between January 2018 and May 2018, during which the measurements of all dry bones that met the inclusion criteria were completed. The inclusion criteria for dry bones were as follows: 1) belonging to adult patients, 2) absence of deformities in the femoral head and neck, lesser trochanter and greater trochanter, 3) no history of fractures in the proximal femoral area. The exclusion criteria were as follows: 1) presence of bony tissue erosion that prevents conducting measurements, 2) deformities of bony tissue as a result of the measurements, 3) presence of fracture sequela in the proximal femur that could prevent the measurements. The anatomical landmarks (tip of the TRMJ, tip of the TRMI, center of the FN) were first determined on all bones. Then the distance between the tip of TRMJ and TRMI was measured in millimeters (mm) (Figure 1), followed by the measurement of the angle between the center of the FN and the tip of TRMI (Figure 2). Finally, the distance between the center of the FN and the tip of TRMI was measured in mm (Figure 1). A sliding caliper set to 0.1mm and a goniometer were used in the measurements.

### Statistical analysis

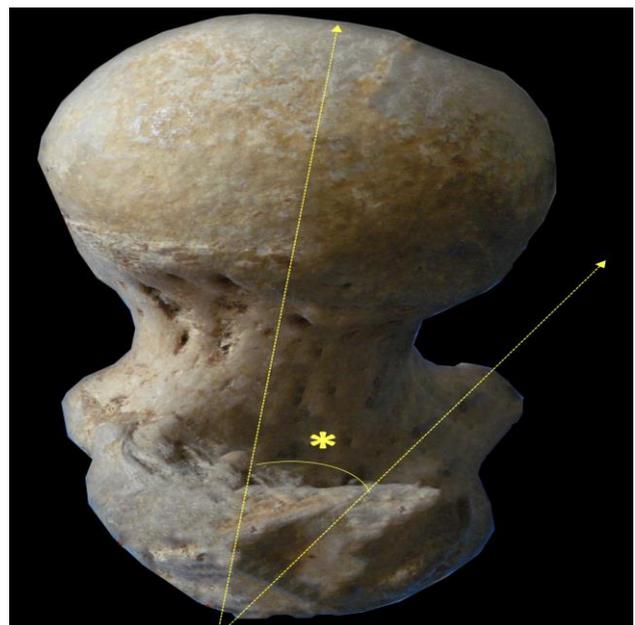
#### Descriptive statistics

Descriptive statistics were used to summarize the properties of dry bones. Numerical parameters were summarized by using mean, standard deviation, minimum and maximum values. The threshold for statistical

significance (p) was determined to be 0.05. SPSS ver. 17.0 software was used for statistical analyses.



**Figure 1: (A) the distance between the tip of greater trochanter (TRMJ) and lesser trochanter (TRMI), (B) the distance between the center of the femur neck (FN) and the tip of lesser trochanter (TRMI).**



**Figure 2: The angle between the center of the femur neck and the tip of lesser trochanter (TRMI) (\*).**

Secondary comparisons

Paired sample T test was used as the parametric test to compare the data. The Pearson correlation test was used to determine the correlation between the data.

RESULTS

According to the measurements conducted on 67 dry human femurs, i.e. 32 left and 35 right, included in the study and investigating of the morphologic relationship of the lesser trochanter with FN and TRMJ, the mean distance between the tips of TRMJ and TRMI was

measured to be (a) 67.5±4.9mm (60mm-75mm). The mean angle between TRMI and FN was measured to be (b) 35.05±5.06° (29°-42°) degrees. The mean distance of TRMI with respect to the center of FN was measured and it was found that TRMI was at 15±2.8mm (10mm-20mm) distal position (Table 1).

Comparison of the distance, angle and height measurements with each other (TRMI-TRMJ Distance-TRMI-FN Angle, TRMI-TRMJ Distance-TRMI-FN Height, TRMI-FN Angle-TRMI-FN Height) revealed statistically significant differences (p<0.001) and these are provided in Table 2.

Table 1: The distance, angle and height measurements.

	Average±SD (n=67)	Minimum-Maximum (n=67)
TRMI-TRMJ distance (mm)	67.5±4.9	60-75
TRMI-FN Angle (Degree °)	35.05±5.06°	29° - 42°
TRMI-FN Height (mm)	15.0±2.8	10-20

Table 2: Statistically analysis of the distance, angle and height measurements.

Distance, angle and height measurements	p
TRMI-TRMJ Distance-TRMI-FN Angle	<0.001
TRMI-TRMJ Distance-TRMI-FN Height	<0.001
TRMI-FN Angle-TRMI-FN Height	<0.001

The correlation between distance, angle and height values was also studied. There was a weak negative correlation between distance and angle, height, however this correlation was not statistically significant (p>0.05). There was a very weak positive correlation, i.e. not statistically significant, between angle and height. Results of the correlation values are provided in detail in Table 3 and Figure 3.

Table 3: The distance, angle and height measurements correlations.

	TRMI-TRMJ distance	TRMI-FN angle	TRMI-FN height
TRMI-TRMJ distance	r	-0.327	-0.183
	p	0.160	0.439
TRMI-FN angle	r	-0.327	0.081
	p	0.160	0.733
TRMI-FN height	r	-0.183	0.081
	p	0.439	0.733

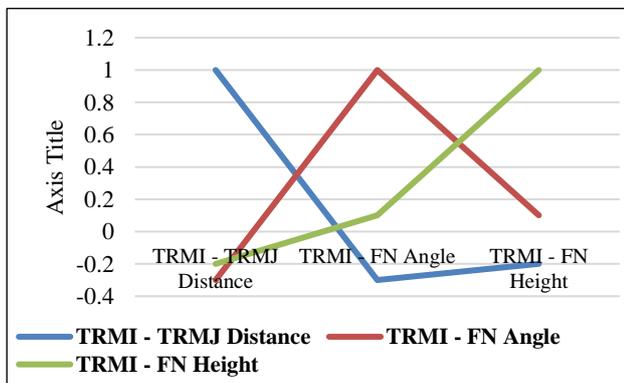


Figure 3: Results of the correlation values.

DISCUSSION

Although there are many studies on the anatomy of the proximal femur in the literature, the number of studies on the morphologic evaluation of the lesser trochanter, which is an important landmark that is commonly used especially in orthopedic surgical procedures, in this area is very limited.<sup>3-5,7-10</sup> In this respect, comparative evaluation of the lesser trochanter according to the proximal femur landmarks will provide contributions to the literature.

The lesser trochanter is an important landmark in the rotational positioning of the femoral stem during femoral

neck fracture and total hip arthroplasty procedures.<sup>9,11-13</sup> However, rotational variations that can be observed in the lesser trochanter could cause various errors during the mentioned positioning. From this point of view, descriptions for this area, which has variations that depend on race, age and gender, gain importance.<sup>14-17</sup>

In a study by Toogood et al, conducted on 375 dry femur bones in 2009, it was reported that there were many age-dependent variations in the femoral neck-shaft angle, besides the variations in FN version, and that these variations could be the secondary cause of the increase in some embryonic or developmental disorders.<sup>18</sup> In the light of this study, it is apparent that the variations in the FN could also cause changes in terms of the angular relationship between the lesser trochanter.

In a study by Labronici et al, carried out in 2011, 42 patients diagnosed with unilateral hip osteoarthritis were investigated and a morphological evaluation of the proximal femoral area was conducted from the tomography scans of the hip. It was reported that the femoral neck-shaft angle and femoral anteversion did not have a significant relationship with the development of hip osteoarthritis.<sup>19</sup> Therefore, it is known that the variations in the proximal femur do not have a relationship with arthrosis of the hip joint and that such conditions only cause anatomical changes. Worlicek et al, conducted a study in 2016 and showed that femoral anteversion was not a suitable reference that can be used during surgery on patients who underwent total hip replacement.<sup>20</sup>

Reviewing the data in our study, TRMI has a measurement interval between 29° and 42° degrees with respect to the FN. Therefore, it is possible to say that TRMI has rotational variations that differ between individuals. Moreover, we showed that this rotational variation was affected by the TRMJ-TRMI tip distance and distance with respect to the center of the FN. In the view of all this data, rotational variations of the TRMI should be considered during orthopedic surgical procedures, and especially those employing a femoral stem.

## CONCLUSION

There are many morphologic variations in the proximal femoral area where various disorders are encountered in the pediatric and adult patient groups. Therefore, an assessment with detailed investigation should be conducted in patients who will undergo hip surgery.

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