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MORPHOMETRIC STUDY OF THE TIBIAL TUBEROSITY IN NORTH INDIAN POPULATION

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ABSTRACT

Background: The main objective of the present study was to determine the prominence of tibial tuberosity and the morphometry. Morphometric parameters of tibial tuberosity can be used to guide treatment and monitor outcome of total knee replacement surgery. Tibial tuberosity being a tractional apophysis can be site for recurrent avulsion fractures.

Material and Methods: The present study was carried out on fifty (25 right and 25 left) adult fully ossified dry tibiae of unknown sex were taken from the Department of Anatomy and Morphometric measurements of tibial tuberosity were taken by using a Vernier caliper. Statistical analysis of the parameters was done.

Result: Present study, the mean distance between tibial tuberosity from anterior border of intercondylar area, length of upper smooth part, length of lower rough part, breadth of upper smooth, breadth of lower rough part 14.55 ± 2.11, 23.57 ± 3.55, 46.31 ± 4.98, 20.15 ± 1.52 and 21.47 ± 2.11 mm respectively.

Conclusion: The result of this study will be helpful for anatomist, ortrhopedicians, radiologists, rehabilitation specialist and sports medicine specialists in evaluating anterior knee pain syndrome.

KEYWORDS: Knee, Tibia, Tibial Tuberosity, Total knee replacement

INTRODUCTION

The tibial tuberosity is a bony landmark present at the proximal end of tibia. It is the truncated apex of a triangular area, where the anterior condylar surface merges. It varies from a faint elevation to a prominent part of bone which instigates 2cm below the anterior marginof tibial plateau. It is one of the bony points to measures the quadriceps angle (Q angle) for assessing pateofemoral mechanics. The tibial tuberosity is an apophysis and develops in traction [1].

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Development of the tubercle has been divided into four stages: cartilaginous, apophyseal, epiphyseal and bony. The tibial tuberosity begins ossification at between seven and nine years in a distal focus. This progressively enlarges proximally and anteriorly, while the proximal tibia epiphysis concomitantly expands downward into the tuberosity [2]. The tibialtuberosity projects only little and is divided into distal rough and proximal smooth region. The patellar tendon is attached to the proximal smooth area while distal end is palpable [3]. An abnormal lateral position of tibial tuberosity cause distal misalignment of the extensor mechanism of the knee and can lead to lateral tracking of the patella which causes anterior knee pain or objective patellar instability and is mainly characterized by recurrent dislocation[4]. This injury can pressure the limb circulation, secondary to vascular compromise or compartment syndrome, and it should be treated as an alarming situation. The aim of treatment is anatomical reduction and stabilization in order to prevent significant soft tissue injury, malunion and growth arrest [5]. It is important for surgeons and radiologists to acquaint themselves with relevant knowledge penetrating to the morphometry of tibial tuberosity and its clinical significance. An accurate and repeatable tibial tuberosity measurement system aids in definition of tibial deformity and improvement of tibial prosthesis design for unicompartmental and total knee arthoplasty.

MATERIALS AND METHODS

The present study was carried out on 50 dry tibiae (25 right and 25 left) unknown sex obtained from the Department of Anatomy. All bones were adult type and without any signs of erosion. Each tibia was assigned a serial number. Data was collected by verniercaliper. Descriptive statistical methods like Mean ± SD was used for depicting and analysing data.

Following parameters were recorded in a proforma:

1. Distance of tibial tuberosity from anterior border of intercondylar area showing in figure1A and B
2. Length of upper smooth part of tibial tuberosity was showing in figure 1C
3. Length of lower rough part of tibial tuberosity was showing in figure 1D
4. Breadth of upper smooth part of tibial tuberosity was showing in figure 1E
5. Breadth of lower rough part of tibial tuberosity was showing in figure 1F

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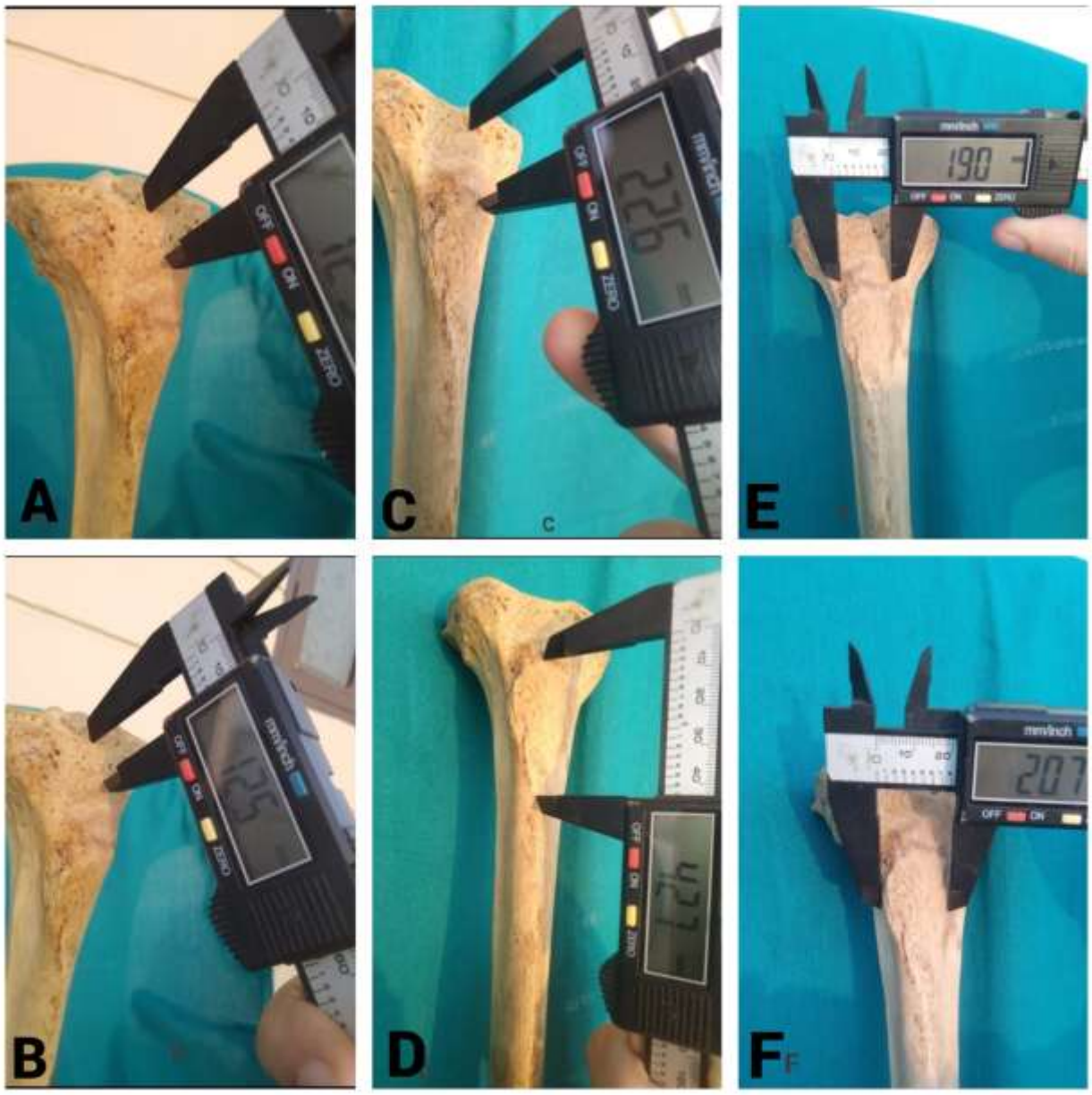

Figure 1: Distance of tibial tuberosity from anterior border of intercondylar area showing in figure 1A and B. Length of upper smooth part of tibial tuberosity wasshowing in Figure 1C. Length of lower rough part of tibial tuberosity was showing in Figure 1D. Breadth of upper smooth part of tibial tuberosity was showing in Figure 1E. Breadth of lower rough of tibial tuberosity was showing in Figure 1F.

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RESULTS

This morphometric study was conducted on adult humane tibiae of North Indian population revealed the under mentioned important observations.

Table 1 depicted the mean distance of tibial tuberosity from the anterior border of intercondylar area was found to be 14.34±2.33 mm (Range=11.6-17.7 mm) on right side, 14.76±2.33 mm (Range= 11.2-21.2 mm) on left side. Total mean distance of tibial tuberosity from the anterior border of intercondylar area was found to be 14.55±2.11 mm. When compared between two sides, it was more on left side but the difference was statistically insignificant (p-value=0.574).

The mean length of upper smooth part of tibial tuberosity was found to be 23.60±3.89 mm (Range=17.5-29.6 mm) on right side, 23.54±3.25 mm (Range=15.2-31.1 mm) on left side. Total mean length of upper smooth part of tibial tuberosity was found to be 23.57±3.55 mm. When compared between two sides it was found to be more on right side but the difference was statistically insignificant (p-value=0.560)

The mean length of lower rough part of tibial tuberosity was found to be 45.85±5.13 mm (Range= 36.4-55.4 mm) on right side, 46.78±5.09 mm (Range=34.7-51.9 mm). Total mean length of lower rough part of tibial tuberosity was found to be 46.31±4.98 mm. When compared between two sides it was found to be more on left side but the difference was statistically insignificant (p-value=0.728). When compared between the lengths of upper smooth and lower rough part of tibial tuberosity, it was more in lower rough part of tibial tuberosity on both sides in North Indian population.

The mean breadth of upper smooth part of tibial tuberosity was found to be 20.29±1.45 mm (Range= 16.2-22.6 mm) on right side, 20.02±1.52 mm (Range= 16.3-22.3 mm) on left side. Total mean breadth of upper smooth part of tibial tuberosity was found to be 20.15±1.52mm. When compared between two sides, it was found to be more on right side, but the difference was statistically insignificant (p-value=0.405).

The mean breadth of lower rough part of tibial tuberosity was found to be 21.05±2.27 mm (Range= 16.5-24.8 mm) on right side, 21.89±1.90 mm (Range= 16.7-25.9 mm) on left side. Total mean breadth of lower rough part of tibial tuberosity was found to be 21.47±2.11 mm. When compared between two sides, it was found to be more on left sided but the difference was statistically insignificant (p-value=0.248).

On comparison both upper smooth as well as lower rough part of tibial tuberosity is marginal longer on right side.

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Table-1: Showing Mean, Range and p-value of all parameters of right, left and total tibia

Parameters	Mean ± SD			Range			P value
	Right	Left	Total	Right	Left	Total	
Distance of tibial tuberosity from anterior border of intercondylar area (mm)	14.34 ± 1.89	14.76 ± 2.33	14.55 ± 2.11	11.6-17.7	11.2-21.2	11.2-21.7	0.574
Length of upper smooth part of tibial tuberosity (mm)	23.60 ± 3.89	23.54 ± 3.25	23.57 ± 3.55	17.5-29.6	15.2-31.1	15.2-31.1	0.560
Length of lower rough part of tibial tuberosity (mm)	45.84 ± 5.13	46.78 ± 5.09	46.31 ± 4.98	36.4-55.4	34.7-51.9	34.7-55.4	0.728
Breadth of upper smooth part of tibial tuberosity (mm)	20.29 ± 1.54	20.02 ± 1.52	20.15 ± 1.52	16.2-22.6	16.3-22.3	16.2-22.6	0.405
Breadth of lower rough part of tibial tuberosity (mm)	21.05 ± 2.27	21.89 ± 1.90	21.47 ± 2.11	16.5-24.8	16.7-25.9	16.5-25.9	0.284

DISCUSION

Various studies have been carried out on morphometry of tibial tuberosity of tibia. Following tables present the comparison of means of the various previous studies with that of the present study.

Table-2: Comparison of distance of tibial tuberosity from the anterior border of intercondylar area, length and breadth of upper smooth and lower rough part of tibial tuberosity with previous studies (mm)

Study	Year	Population Range	Distance of tibial tuberosity from anterior border of intercondylar area	Length of upper smooth part of tibial tuberosity	Length of lower rough part of tibial tuberosity	Breadth of upper smooth part of tibial tuberosity	Breadth of lower rough part of tibial tuberosity
			Mean ± SD	Mean ±SD	Mean ± SD	Mean ± SD	Mean ± SD

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Hughes & Sunderland[6]	1946	Australian	20	-	-	-	-
Simriti[7]	2019	North Indian	R: 11.86 ± 3.01 L: 12.92 ± 2.28	R: 22.31 ± 4.06 L: 22.03 ± 4.71	R: 48.68 ± 6.96 L: 48.56 ± 7.13	R: 20.04 ± 1.68 L: 20.50 ± 1.56	R: 20.51 ± 2.26 L: 19.82 ± 2.72
Present Study	**2021**	**North Indian**	**R: 14.34 ± 1.89 L: 14.76 ± 2.33**	**R: 23.60 ± 3.89 L: 23.54 ± 3.25**	**R: 45.84 ± 5.13 L: 46.78 ± 5.09**	**R: 20.29 ± 1.54 L: 20.02 ± 1.52**	**R: 21.05 ± 2.27 L: 21.89 ± 1.90**

It was evident from the above table 2 that the findings of [distance of tibial tuberosity from the anterior border of intercondylar area] present study was consonance with Simriti[7] but result was different from Hughes & Sunderland[6]. It was evident from above table that the findings of length of upper smooth part of tibial tuberosity in present study was consonance with Simriti[7]. It was evident from above table that the findings of length of lower rough part of tibial tuberosity in present study was consonance with Simriti[7]. It was evident from the above table that the findings of breadth of upper smooth part of tibial tuberosity in present study was consonance with Simriti[7]. It was evident from the above table that the findings of [breadth of lower rough part of tibial tuberosity] present study was consonance with Simriti[7].

In present study the most prominent point on tibial tuberosity was 14 mm from intercondylar area, whereas in study done by Rashmi was 6.8 mm and Simriti 13 mm and is located in the proximal part of the tibial tuberosity, the site of attachement of patellar tendon. Therefore the concept of traction apophysis that it is caused by the force of ligamentum patella can be confirmed. The tibial tuberosity is regarded as one of the reliable rotational landmark for the tibial component in total knee arthoplasty. The success of total knee arthoplasty depends on proper alignment of prosthesis component because small alignment errors can predispose to loosening of prosthesis which further becomes the main cause of revision of surgery.

Furthermore, these injuries should be differentiated from conditions like Osgood-schlatter disease where apophysis of tibial tuberosity occurs due to recurrent traction by the patellar tendon on the secondary ossification centre of tibial tubercle [8]. Arthroscopic assisted open fixation has become the gold standard treatment in recent times.

Earlier, only Hughes and Sunderland had measured the distance of tibial tuberosity from anterior border of intercondylar area to be 20 mm in Australian population but on irrespective of side and

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sex. This distance could be of great significance for intramedullary nailing which becomes the successful treatment for tibial fractures. The surgeons and orthopedicians should be aware of complications of proximal nailing in cases of high tibial fractures as it may cause injury to intraarticular structures [9].

According to Hughes and Sunderland, there are various descriptions regarding the insertion of ligamentum patellae. The tendon usually inserts into the distal rough part of the tuberosity [10]. It can alternatively insert into the proximal smooth part of the tibial tuberosity and can also send some prolongations to the roughened part of the tibial tuberosity [11]. Squatters are known to show certain adaptation features in the lower extremities. One of the effects of squatting is the greater range of flexion at the knee joint. This greater range of flexion may produce some effects on the upper end of the tibia due to increased pressure of the quadriceps tendon against it [12].

According to Parson's [13], traction epiphysis develops as a result of sesamoid structures. The upper smooth part of tibial tuberosity develops as a result of chondrification in the deeper part of ligamentum patellae. So, it was documented that it had a sesamoid origin phylogenetically [14]. The apophyseal nature of the tibial tuberosity can predispose it to tractional injuries. Avulsion fractures of tibial tuberosity are uncommon injuries with a reported incidence of 0.4% to 2.7% which usually occur in young adolescents due to activities like jumping and springing where knee extensors are forcefully contracted. These types of injuries are more predominant in males owing to their greater involvement in athletics and also due to physiologic physiodesis of the proximal tibia in males at a later age. As a result they acquire strong quadriceps which further leads to higher traction stresses (6).

CONCLUSION

The anatomic data collected in this study provides a comprehensive data about the morphometry of dry adult tibial tuberosity, which will provide the basis for most prominent point on tibial tuberosity from anterior border of intercondylar area is of significant importance to the orthopaedic, radiologist, rehabilitation specialists and sports medicine specialists. Tibial tuberosity avulsion fractures are uncommon injury occurring due to strong contraction of quadriceps femoris muscle during leg extension, ultimately causing failure of the physis at the patellar tendon insertion. Data will necessitate further study with clinicians who deal with adolescent injuries around the knee.

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