Original Research Article

Morphological Traits at Distal End of Femur

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Abstract

Bony changes in the form of facets and imprints due to squatting are more often seen at the lower end of femur than at the upper end. Because of a particular lifestyle and behaviour of various population groups, incidences of these traits differ. Such morphological traits should be understood as they could be a contributing risk factor for osteoarthritis and other rotational malalignment dysfunction of knee joint. Charles' facet, tibial imprint and osteochondritic imprint are known to occur at the distal end of femur as a sequelae of squatting posture. This study was conducted to determine the prevalence of these facets and imprints on 152 adult femur of Indian origin in the Department of Anatomy, Maulana Azad Medical College, New Delhi, India. The significance of correlation between their occurrence with the side and gender of bone was determined using Chi-square test. The analysis of data indicated that Charles' facet and medial tibial imprint occurred more often on right side with 100% incidence. Lateral tibial imprint showed a significant result with 84.2% incidence on the right side and 68.4% on the left side. Osteochondritic imprint also had a predominant occurrence on the right side. Charles' facet was equally present in both male and female femora, however, imprints had a higher predominance in male femora with no significant results notified for gender variation.

Keywords: Non-metric trait, squatting, distal femur, facet, imprint

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Introduction

Osseous non metric features observed at the lower end of femur have been long discussed in previous studies to be related to evolution, micro evolutionary trends, posture, gait and muscular biomechanics around the knee joint (1,2,3,4,5). A large number of morphological features at the lower end of femur are functionally related to the squatting posture. These skeletal manifestations are of interest in clinical, forensic and archaeological settings (6,7). Repetitive strain because of postural adaptation will likely produce chronic or permanent changes consistent with bone remodeling in response to a change in biomechanics. Morphological traits will help in understanding the aetiology of Tibio-Femoral rotational dysfunction (8) and osteoarthritis of knee joint commonly seen now-a-days. Knee osteoarthritis is known to occur because of congenital or acquired torsional deformity of femur (9,10,11,12). Several studies have suggested that risk of osteoarthritis of knee joint is increased by work which entails prolonged bending (13,14,15). Such posture is commonly required during squatting assumed by Orientals working as field labour, or engaged in culinary operations, or pursuing the avocations of an artisan (2).

Various morphological traits at lower end of femur have been described in different population groups (1,2,3,4,5,16,17). In Indians, the femur has become highly remodeled to cope with the intricate biomechanical dynamics of the squatting posture. We considered Charles' facet, Medial Tibial imprint, Lateral Tibial imprint and Osteochondritic imprint, in this present study.

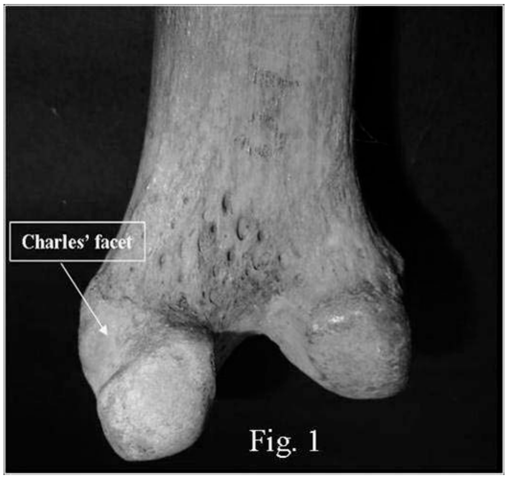

Figure 1: Male femur, right side showing Charles' facet.

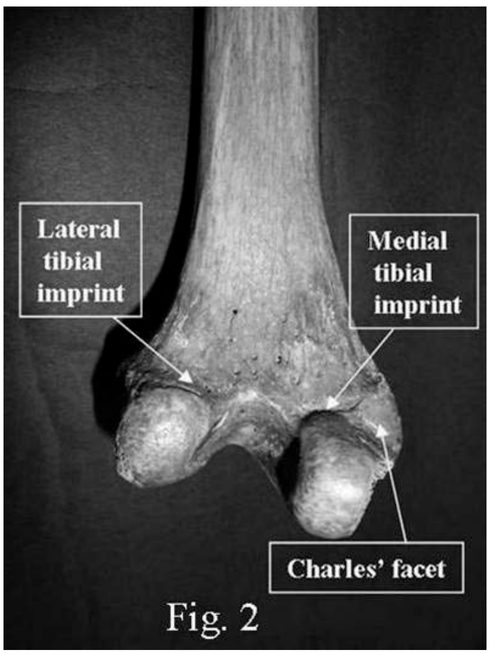

Figure 2: Female femur, left side showing Charles' facet and the tibial imprints.

Charles' facet: It appears as an extension of the articular cartilage of the posterior aspect of the condylar surface at the lower end of the femur as seen in Figure 1 and 2. It is present postero-superior to the medial epicondyle extending to the adductor tubercle.

Medial Tibial imprint: It is a depressed, roughened thumb print impression above the posterior aspect of the medial condyle as depicted in Figure 2 and 3. It borders the Charles' facet and may be continuous with its cartilage.

Lateral Tibial imprint: It is observed as a depressed, roughened impression seen above the posterior aspect

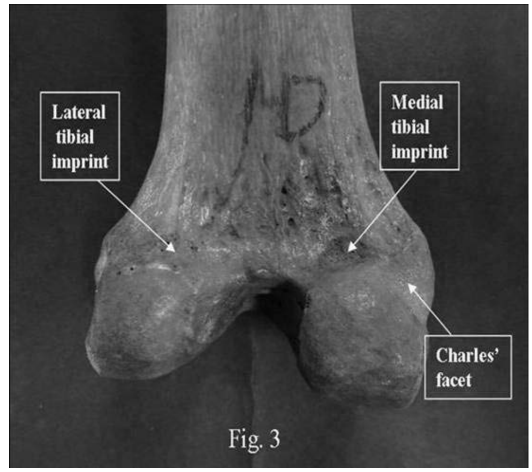

Figure 3: Male femur, left side showing Charles' facet and the tibial imprints.

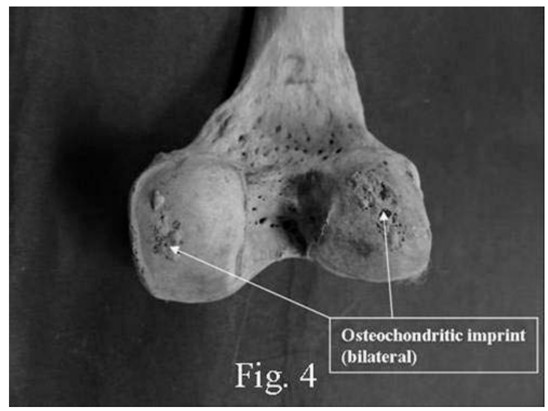

Figure 4: Male femur, left side showing bilateral osteochondritic imprint.

of the lateral condyle. Figure 2 and 3 shows its presence in female and male femur respectively.

Osteochondritic imprint: It is a hole or plaque like bony excrescence present on the upper posterior part of the lateral condyle. The former may range from a pin-hole to an excavated area containing sclerotic bony debris. It is usually bilateral as present in a male femur shown in Figure 4.

The aim of the study was to determine the incidence of these bony markers on Indian femur to provide a comprehensive picture of their occurrence in population acquiring squatting posture.

Materials and Methods

The study was conducted on a sample of 152 adult femur collected from osteology museum in Department of Anatomy, Maulana Azad Medical

College, New Delhi, India. The selected traits were observed and photographs were taken by Sony digital camera HX7. The study material consisted of 76 bones each from right and left side and 76 male and female bones each. All the above mentioned morphological traits were analysed notifying the side and gender of femur and the results were assessed using SPSS version 17.0 for significance of the findings using the Chi-square test.

Results

The results were tabulated as shown below.

Table 1 shows the percentage incidence of each trait on right and left side.

Of the 152 bones observed, the Charles' Facet and Medial tibial imprint were found in 98.7% of the femora with a predisposition on right side. For lateral tibial imprint an incidence of 76.3% was noticed. Osteochondritic imprint with an incidence of 38.2% was reported with a slightly higher predisposition on right side. Hence, it was observed that all the imprints and facets were more common on the right side.

Table 2 showing the Chi-square results (significant upto 5%) depicts that lateral tibial imprint is present more commonly on the right side with a significant side variation.

Table 3 presents the percentage incidence of all the traits in male and female femora. It is evident that all imprints are slightly more common in males.

As presented in Table 4, the Chi-square test did not reveal any significant difference in the occurrence of these traits in each gender.

Discussion

This study provides evidence of variable morphological traits occurring on Indian femur due to squatting. Studies have shown that sequelae of squatting in the form of bone changes (facets and imprints) are more evident at the lower than at the upper end of the femur (1). Tibial imprints are known to occur due to contact with lateral part of posterior border of the medial tibial condyle (18). Deep imprints may be associated with prominent tubercles on tibial condyles. Imprints may thus, also be the result of pressure by these tubercles in acute flexion of knee joint (1). Such flexion occurs in squatting posture. In our study the medial tibial imprint was seen in 98.7% of the bones studied, while lateral tibial imprint was found in 76.3%. However, a statistically significant side variation in lateral tibial imprint was noticed with 84.2% incidence on right side. Previous study done on femur of Western Nigerian population showed the presence of tibial imprints in 51% of female femora without any significant difference in right and left side (1). Any side variation in the occurrence of such imprints might reflect constitutional anatomic or physiologic differences between right and left femur. Structural and functional factors produce joint compression, tissue shortening and lengthening due to variable activity patterns of certain muscle groups influencing the knee joint. Since, both the knee joints are not equally influenced by the biomechanical forces acting on it, side variation in the occurrence of imprints could be explained by unequal positional strain acting at the knee joint. Such positional strain is known to be the reason for tibiofemoral rotational dysfunction occurring because of neuromuscular diseases seen nowadays (8).

Table 1: Percentage Incidence of each trait with the side of bone

Trait		Side of Bone		Total
		Left	Right	
Charles' Facet	Absolute No.	74	76	150
	Incidence	97.4%	100%	98.7%
Medial tibial imprint	Absolute No.	74	76	150
	Incidence	97.4%	100%	98.7%
Lateral tibial imprint	Absolute No.	52	64	116
	Incidence	68.4%	84.2%	76.3%
Osteochondritic imprint	Absolute No.	24	34	58
	Incidence	31.6%	44.7%	38.2%

Table 2: Chi-Square test and significance of right-left variation

Trait		Side of bone		Chi-Square	Significance
		Left	Right		
Charles' Facet	Present	74	76		
	Absent	2	0	0.34	0.56
	Total	76	76		
Medial tibial imprint	Present	74	76		
	Absent	2	0	0.34	0.56
	Total	76	76		
Lateral tibial imprint	Present	52	64		
	Absent	24	12	5.241	0.022*
	Total	76	76		
Osteochondritic imprint	Present	24	34		
	Absent	52	42	2.788	0.095
	Total	76	76		

*Significant at 5% level of significance

Table 3: Percentage incidence of non-metric traits at distal end of femur in male and female

Trait		Gender of bone		Total (152)
		Male (76)	Female (76)	
Charles' Facet	Absolute No.	75	75	150
	Incidence	98.7%	98.7%	
Medial tibial imprint	Absolute No.	76	74	150
	Incidence	100%	97.3%	
Lateral tibial imprint	Absolute No.	60	56	116
	Incidence	78.9%	73.7%	
Osteochondritic imprint	Absolute No.	31	27	58
	Incidence	68%	55%	

Table 4: Chi-Square test and significance of gender variation of non-metric trait at distal end of femur

Trait		Gender		Chi-Square	Significance
		Male	Female		
Charles' Facet	Present	75	75		
	Absent	1	1	0.00	1
	Total	76	76		
Medial tibial imprint	Present	76	74		
	Absent	0	2	2.027	0.155
	Total	76	76		
Lateral tibial imprint	Present	60	56		
	Absent	16	20	0.582	0.445
	Total	76	76		
Osteochondritic imprint	Present	31	27		
	Absent	45	49	0.446	0.504
	Total	76	76		

*Significant at 5% level of significance

The articular surface of medial femoral condyle extends more onto the upper surface in squatters (2). This prolongation described as Charles' facet in our study was seen to be present in almost all the femur with equal frequency on right and left side. Also, it was equally observed in both male and female femora. These results are comparable to the study done by Kostick on Western Nigerian population (1). Charles' facet allows for extreme flexion of the knee with full security from luxation as required during squatting posture (2). Hence, it can be regarded as a peculiar morphological non-metric trait uniformly seen in femur of squatting races.

As stated earlier that squatting as an occupational physical activity is a risk factor for knee osteoarthritis (19,20). Osteochondritis dessicans affecting the femoral condyle leads to osteoarthritis of the knee (21). Osteochondritic imprint seen at the plane of contact between tibial and femoral condyles in acutely flexed knee joint in squatting posture marks the undescribed site of osteochondritis dessicans of adult type (22). Osteochondritic imprint was observed more on the right side (44.7%) in a higher percentage when compared with the data observed from Kostick's study in which its incidence was 27%, on right femur. At the knee joint the osteophyte scores, which are a marker for osteoarthritis, were found to be greater on the right side (23). Also, there is a significant tendency towards arthroplasty on right side in patients undergoing total knee replacement for primary osteoarthritis (24). Hence, prolonged or repetitive bending could be having a more deleterious effect on right knee joint.

There is a much higher percentage of occurrences of osteochondritic imprint in male femora when compared with the observations from Kostick's study in which it was seen in 24% male and in 29% female femur. In Indians male population is usually engaged with more strenuous physical activity and heavy lifting at work. This occupational behaviour although not independently influencing the appearance of skeletal marker, appears to augment the occurrence of osteoarthritis with squatting posture (19). Thus other factors apart from the usual squatting posture have a role in modifying the skeleton reflecting lifestyle and behavioral adaptation indicating certain types of strenuous activities.

Hence, repetitive positional strain because of biomechanical and postural factors can produce permanent deleterious changes at the lower end of femur in the form of imprints and facets. It is highly probable that all these morphological markers are acquired and that heredity has no influence needs to be further investigated. This provides an insight for further genetic studies and for studies of gene-environment interaction in various population groups pertaining to the presence of such non-metrical morphological traits at the lower end of femur.

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