RESEARCH ARTICLE

Morphometric features of Linea aspera on dry femur bones

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Abstract

Introduction: To observe and describe the features of linea aspera in dry femurs.

Methods: The prospective observational study was conducted from October to December 2017 at Darul Sehat Hospital, Karachi, and comprised dry femurs. Data was collected by trained medical students. Observations of landmarks of linea aspera were taken using classical measuring techniques. Data was analysed using SPSS 21.

Results: There were 48 dry femurs with mean maximum length of linea aspera 133.4±22.4 mm, and mean minimum length 188±79 mm. The mean diameter of antero posterior thickness was 2.7±1.1 mm. Linea aspera was widest at its lower one third 30(62.5%) and narrowest at its middle one-third 5 (10.4%). The most common pattern on linea aspera was three ridges 26 (54.2%). Majority of bones had at least one uninterrupted ridge 32(66.7%). The most prominent ridge on linea aspera was lateral in 20 (41.7%) bones. The largest nutrient foramen in 19 (42.2%) bones was located at the level of proximal one-third of linea aspera.

Conclusion: linea aspera was widest at its lower one-third. In majority of bones the lateral ridge was the most prominent, and the largest nutrient foramen of femur was most commonly located at the level of proximal one-third of linea aspera.

Keywords: Linea aspera, Femur, Nutrient foramen, Dry bone. (JPMA 69: .474; 2019)

Introduction

Femur is the long bone of the thigh. The middle part of the shaft of the femur is triangular in cross-section. In the middle part, the shaft of the femur has smooth medial, lateral and anterior surfaces, and medial, lateral and posterior borders. The medial and lateral borders are rounded, whereas the posterior border forms a rough crest which is known as linea aspera.[1] Most of the shaft of femur is smooth and rounded and provides origin to extensors of knee except posteriorly where linea aspera provides aponeurotic attachment for the adductors of the thigh. Linea aspera is prominent in the middle one-third of the femoral shaft where it has medial and lateral lips. Superiorly, lateral lip blends with broad and rough gluteal tuberosity, and the medial lip continues as narrow spiral line. The spiral line later continues as inter trochanteric line near the lesser trochanter. Inferiorly, linea aspera divides into medial and lateral supracondylar lines.[2]

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Linea aspera is an important anatomical and surgical landmark on the shaft of femur.[3] To our knowledge, limited data is available in global literature on the morphometric features of linea aspera. The current study was planned to analyse the morphometric features of linea aspera in detail.

Materials and Methods

The prospective observational study was conducted from October to December 2017 at Darul Sehat Hospital, Karachi, and comprised dry femurs. Sample size was calculated[3] by using sample size calculator, and the sampling was done using non-probability convenience technique. Dry femurs were collected from the study setting and from students of different medical colleges. Data was primarily collected from dry femurs by trained medical students. Classic measuring techniques[4] were used for observation of features of linea aspera, including the use of Vernier caliper. Variables used in the study were maximum and minimum width of linea aspera, levels of maximum and minimum width, maximum anterio-posterior diameter (called pilaster), number of ridges,

Table-1: Characteristics of study subjects as per diabetes status (n=211).

Variable	Maximum value (mm)	Minimum value (mm)	Mean/median (mm)	SD/inter quartile range
Length of linea aspera	188	79	133.4	±22.4
Maximum width of linea aspera	25.5	6.5	10	±2.0
Minimum width of linea aspera	24	3.5	6.5	±2.5
Maximum anterio-possterior diameter of linea aspera	12	1.0	2.7	±1.1

(mm)=millimeters, SD=tandard deviation

most prominent ridge, and the level of the largest nutrient foramen in relation to linea aspera.

Dry femur cadaveric bones were included while excluding those with missing parts, and fractured or deformed bones.

Data was analysed using SPSS 21. Data was presented as frequencies and percentages for categorical variables and means±standard decviation (SD) and median(interquartile range [IQR]) for continuous variables. Approval was obtained from the institutional review board.

Results

There were 48 dry femurs with mean maximum length of linea aspera 133.4±22.4mm, and mean minimum length 188±79mm. The mean diameter of anterio-posterior thickness was 2.7±1.1mm (Table-1).

Linea aspera was widest at its lower one-third 30(62.5%) and narrowest at its middle one-third 5 (10.4%) (Table-2).

The most common pattern on linea aspera was three ridges 26(54.2%). Majority of bones had at least one uninterrupted ridge 32 (66.7%), 22(45.8%) had two ridges, and there was no linea aspera with a single ridge. Besides, 6 (12.5%) bones had no uninterrupted ridges, 32 (66.7%) had one uninterrupted ridge, 9 (18.8) had two uninterrupted ridges and in only 1(2%) bone, all three ridges were uninterrupted. The most prominent ridge on linea aspera was the lateral ridge in 20 (41.7%) bones, medial ridge in 18(36.7%) bones and the middle ridge in 10(20.4%).

The largest nutrient foramen in 19(42.2%) bones was located at the level of proximal one-third of linea aspera; in 17 (37.8%) bones at the level of middle one-third; and in 9 (20%) bones at the level of lower one-third of linea aspera (Figure).

Table-2: Width of linea aspera in relation to its levels.

	Level of maximum width Frequency (%)	Level of minimum width Frequency (%)
Upper one third of linea aspera	13 (27.1)	11 (22.9)
Middle one third of linea aspera	5 (10.4)	30 (62.5)
lower one third of linea aspera	30 (62.5)	7 (14.5)

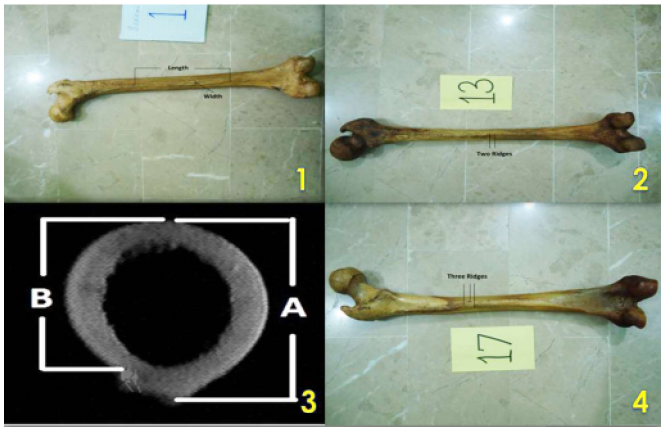

Figure: The width and length of linea aspera;[1] the two ridges on linea aspera;[2] the measurement of anterio-posterior diameter of linea aspera (A-B);[3] and three ridges on linea aspera.[4]

Discussion

Linea aspera is an important anatomical landmark on femur. The current study aimed at describing a few quantitative and qualitative anatomical landmarks of linea aspera. To our knowledge, to date no study has ever been published with such detailed description of linea aspera. As such, the study cannot be compared directly with any other study. One study[5] stated that the main functions of the linea aspera are stabilisation and support for the femur, especially while walking and running. Linea aspera is divided into medial lip and a lateral lip. It gives attachments to various muscles. The medial lip gives origin to vastus medialis and lateral lip gives origin to vastus lateralis. Adductor brevis is attached to the proximal part of linea aspera. Adductor magnus is attached to the linea aspera along supra condylar line up to the adductor tubercle. Short head of bicep femoris also arises from linea aspera throughout its whole length. Adductor longus is inserted in the middle third of linea aspera.[6] In a study on iliotibial tract, the tract was attached to the femur along the linea aspera from the greater tronchanter to, and including, the lateral epicondyle of the femur by coarse fibrous bands.[7] Linea aspera has important prominence which protects

Table-3: Comparing the current study with literature (Similarities and differences in our study in relation to international studies).

Our Study	International Studies
In our study we measured the maximum anterio-posterior diameter of linea aspera which is also known as pilaster	Micheal J pitt in his study described pilaster as cross sectional elevation of ridge on radiographs but did not describe its characteristics.[8]
We have observed that linea aspera can have upto three ridges	M Polguj in his study described that linea aspera has two ridges[9]
The maximum, minimum and mean lengths in our study were 188 mm, 79 mm and 133.4 mm respectively	M.Polguj also described maximum, minimum and mean length of linea aspera. The maximum, minimum and mean length in his study was 270 mm, 150 mm and 195.6 mm respectively.[9]
In our study the most common location of the largest nutrient foramen was at the level of upper one third of linea aspera	According to Imre Nucrane, the most common location of nutrient foramen was at the level of middle one third of linea aspera.[10]
We described the relation of nutrient foramen to linea aspera in our study	Gumusburun described the total number of nutrient foramina on the long bones but did not specify the location in relation to linea apera.[11]

the femur against bending when bearing the stresses and loads. It is less developed in younger children so they are more prone to the bending of the femur.[8]

The current study discussed the maximum anterio-posterior diameter of linea aspera which is also known as pilaster. A study[9] described pilaster as cross-sectional elevation of ridge on radiographs but did not describe its characteristics, while the current study measured and analysed the diameter of pilaster.

Another study[10] described that linea aspera has two ridges, but the current study showed that linea aspera can have up to three ridges.

Also, the current study shorter lengths compared to literature which is perhaps a reflection of shorter heights in the local population.

The current study also describes and analyses the width of linea aspera which has never been described before, and it has also determined the levels of maximum width of linea aspera.

Various authors have described the location of the nutrient foramina in relation to linea aspera often citing the most common location as the level of middle one-third of linea aspera. In another study,[11] the most common location of the largest nutrient foramen was at the level of the upper one-third of linea aspera. Another study[12] described the total number of nutrient foramina on the long bones but did not specify the location in relation to linea apera. In another study,[13] 65% femurs had only one nutrient foramen. Since the current study was not aimed at determinng the number of nutrient foramina, therefore it determined the relation of the largest nutrient foramen with linea aspera (Table-3).

According to an Indian study,[14] the location of nutrient foramina is surgically very important because knowledge of location of the nutrient foramina can be useful in many surgical procedures like in bone grafting, in microsurgical vascularised bone transplantation and in many fractures. It helps the surgeon to prevent intra-operative injuries in orthopaedic surgery, as well as in plastic and reconstructive surgery. In addition, in forensics the pattern of ridges on linea aspera on a pre-mortem radiograph can be compared with the post-mortem radiograph of the remains of femur containing linea aspera for identification.

There were limitations to the current study as it did not divide the bones according to gender.

In future, the comparison of radiological and morphological features of linea asperas of the same study sample can be done, so it may become useful for diagnostics. Also, the differences of features of linea aspera in relation to gender can be determined, which may be particularly helpful to forensic experts.

Conclusion

The morphometric analysis of linea aspera found the most common location of maximum width to be at the level of lower one-third of linea aspera. The most common pattern had three ridges, in which the lateral ridge was the most prominent in majority of the bones. The most common location of the largest nutrient foramen was at the level of proximal one-third of linea aspera.

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