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Original Research Article

A STUDY OF VASCULAR FORAMINA OF THE UPPER END OF THE DRY ADULT HUMAN FEMUR BONES

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ABSTRACT

Background: Femur is the long bone of thigh. Femur is richly vascularized bone deriving its arterial input from umpteen vessels. The upper end of the femur in general showed rich vascularization.

Objectives: To observe the location or distribution of vascular foramina, to quantify the number of vascular foramina, to measure the size of the vascular foramina, to observe the direction of the vascular foramina in different segments of upper end of femur bones.

Materials and Methods: The present study was undertaken on 100 dry adult normal human femur bones of both sides, irrespective of sex. The bones were obtained from the Department of Anatomy, S.S.I.M.S. & RC Davangere, Karnataka, India.

Results: In the present study, maximum average number of vascular foramina was observed in the neck posterior region and minimum average number of vascular foramina was observed in head. Size of vascular foramina varies from ≥ 1.27mm to < 0.71 mm. Maximum average number of vascular foramina were directed horizontally.

Interpretation and Conclusion: Knowledge of vascular anatomy is helpful in early identification of vascular interruptions leading to osteonecrosis.

Key words: Vascular Foramina, Ischaemic Necrosis, Perforating arteries, Lesser Trochanter, Greater Trochanter.

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INTRODUCTION

The bone is a highly vascular structure with unique features in its blood supply [1]. A typical long bone is fed by four groups of arterial systems, which are a nutrient artery, epiphyseal, diaphyseal and periosteal arteries [2]. The femur is the long bone of the thigh. It receives nutrition via the above said arteries. The arteries supplying this long bone pervade into it via numerous foramina located over its different segments, being named as vascular foramina. The vascular anatomy of femur is of utmost importance because it is relevant to fracture treatment [3].

Three groups of vessels supply the upper end of femur, namely nutrient artery of the shaft, the retinacular or capsular arteries and the foveolar artery or artery of ligamentum teres. Avascular necrosis of the femoral head is most often seen after fracture of the neck of the femur [4]. Precise knowledge of femoral head vascular anatomy is mandatory for the safe

execution of intracapsular surgical procedures aimed at preserving the hip joint [5]. Aseptic necrosis of the femoral head after simple dislocation is attracting special attention because in the majority of cases when the lesion is recognized irreparable damage has already occurred and the function of the hip has been permanently compromised [6].

The greater trochanter is supplied from branches of the medial circumflex femoral artery, lateral circumflex femoral artery which sends perforating branches to anterior, lateral and posterior surfaces. The medial circumflex femoral artery also supplies branches which enter the trochanter medially in the trochanteric fossa[7]. Iatrogenic damage to the medial circumflex femoral artery has occurred in intertrochanteric osteotomy especially with osteotomy of the greater trochanter. The posterior surface of the neck is free from retinacular vessels and an osteomyograft placed in this area does not lead to vascular disturbance of the head [8]. Churchill suggested that greater trochanter has a separate blood supply even after bony fusion with the shaft and these are few anastomoses with adjacent diaphyseal vessels [9]. Trochanteric osteotomy will run close to avascular plane and probably severs branches arising from circumflex femoral vessels. The osteotomised trochanter will solely depend on supply from gluteal vessels [7]. The above mentioned information may prove very useful in surgical detachment of greater trochanter in hip surgery and its healing process. Moreover no quantitative topographic data exist concerning the exact location and distribution of entrance of vessels through vascular foramina. The knowledge regarding the vascular foramina helps to protect them carefully during conservative operative procedures of the bone [5].

MATERIALS AND METHODS

During the course of 3 years study from 2011 to 2013 in the department of Anatomy at Shamanur Shivashankarappa Institute of Medical Sciences and Research Centre, Davangere, a study of vascular foramina of upper end of femur was conducted on 100 dry adult normal human femur bones. Dry adult human femur bones of both sides, irrespective of sex were included. Deformed, damaged bones, bones with callous formation and unossified bones were excluded from the study. In this present study, the upper end of the femur bone was divided into following segments and the segments are as follows.

Upper end: Includes Head, Fovea, Neck – anterior and posterior, Greater trochanter, Lesser trochanter, Trochanteric fossa, Inter - trochanteric line, Inter - trochanteric crest.

Based on the hypodermic gauge needle number which was admitted by the foramina, the foramina were categorized as follows, large sized foramina: which admitted 18 gauge needle were considered to be of size 1.27 mm (or) more, medium sized foramina: which admitted 20 gauge needle were considered to be between 0.90 mm and 1.27 mm, Small sized foramina: which admitted 22 gauge needle were considered to be between 0.71 mm and 0.90mm,very small sized foramina: which admitted 24 gauge needle were considered to be between 0.55 mm and 0.71 mm. The direction of the needle was noted as upper, lower and horizontal.

RESULTS

In the present study, maximum average number of vascular foramina (mean) was observed in the neck posterior region (18.2) and minimum average number of vascular foramina was observed in head (0).

Size of vascular foramina: Large sized vascular foramina: Maximum average number was observed in neck posterior region (1.38), minimum average number was observed in lesser trochanter, trochanteric fossa, head (0).

Medium sized vascular foramina: Maximum average number was observed in greater trochanter (1.36), minimum average number was observed in lesser trochanter, trochanteric fossa, head (0).

Small sized vascular foramina: Maximum average number of of size $\geq$ 0.71 to < 0.90mm was observed in neck posterior region (1.78), minimum average number was observed in lesser trochanter [0].

Very small sized vascular foramina: Maximum average number was observed in neck posterior region (12.8), minimum average number was observed in inter-trochanteric line (2.0).

Direction of vascular foramina: In the present study, the average number of vascular foramina directed horizontally was about 5.79, those directed in lower direction was about 1.23 and those directed in upper direction was about 0.71.

Fig. 1: Showing specimens 1 to 50.

Fig. 2: Showing specimens from 51 to 100.

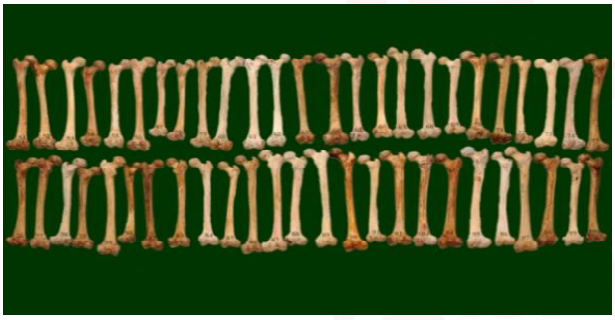

Fig. 3: Vascular foramina on posterior surface of neck. b) vascular foramina on greater trochanter.

Table 1: Location and number of vascular foramina in various segments of upper end of femur bones.

Segments of upper end	Minimum	Maximum	Mean	Standard deviation
Head	0	0	0	0
Fovea	0	16	3.9	2.5
Neck Anterior	6	28	14.4	5.1
Neck Posterior	7	118	18.2	10.9
Greater Trochanter	9	19	13.2	2.4
Lesser Trochanter	0	4	2.4	0.8
Trochanteric Fossa	0	4	2.4	0.8
Inter-Trochanteric Line	2	5	2.5	0.7
Inter-Trochanteric Crest	4	9	6	1.2
Total	41	167	63	13.5

Table 2: Average number of vascular foramina of various sizes in different segments of upper end of femur bones.

Segments of upper end	>= 1.27 mm	>= 0.90 to <1.27 mm	>= 0.71 to <0.90 mm	>= 0.55 to <0.71 mm
Head	0	0	0	0
Fovea	0.02	0.02	0.5	3.4
Neck Anterior	0.94	1.23	1.6	10.6
Neck Posterior	1.38	1.35	1.7	12.8
Greater Trochanter	0.84	1.36	1.8	9.2
Lesser Trochanter	0	0	0	2.4
Trochanteric Fossa	0	0	0.1	2.3
Inter-Trochanteric Line	0.01	0.07	0.5	2
Inter-Trochanteric Crest	0.47	0.83	1.4	3.3
Minimum	0	0	0	2
Maximum	1.38	1.36	1.78	12.81
Mean	0.46	0.61	0.94	5.76
Standard deviation	0.54	0.65	0.75	4.38

Table 3: Direction of vascular foramina in different segments of upper end of femur bone.

Values	Upper	Lower	Horizontal
Minimum	0	0	0.06
Maximum	1.86	2.75	14.13
Mean	0.71	1.23	5.79
Standard deviation	0.76	0.91	5.23

DISCUSSION

The femur is the long bone of the thigh. Blood supply to femur is essential during the growing period, during the early phases of ossification, and in surgical procedures such as bone grafts, tumour resections and traumas, congenital pseudoarthrosis, and in transplant techniques in orthopaedics. Knowledge of vascular anatomy is helpful in early identification of vascular interruptions leading to osteonecrosis.

In the present study, the neck region at the upper end of the femur bone showed maximum number of vascular foramina which speaks for enormity of vascularity in quantitative terms. Our results are in agreement with the study conducted by Lavinge M, their study showed that most vascular foramina are located close to the antero- and posterosuperior regions of the femoral head and neck junction. This larger segment should be carefully protected during any conservative intracapsular procedure of the hip and may be desirable in femoral head resurfacing arthroplasty [5].

In the present study, maximum number of vascular foramina was found in neck followed by greater trochanter. The blood supply to the greater trochanter was investigated in adult rabbits by Naito using a hydrogen washout

technique. Their results indicate that the greater trochanter receives >2/3 of its blood supply from the extraosseous vascular system in a rabbit model [10]. Observations made on the head in the present study did not show presence of vascular foramina on its articular surface. Fovea showed considerable number of vascular foramina which transmit the branches from obturator artery. However in the present study, their number was sufficiently less compared to neck. There is a diverse opinion regarding the role of ligamentum teres in promoting the vascularity to head. Romanes GJ says that a small artery is always found within substance of ligament of the femur. This vessel takes little part in the blood supply of the femoral head in children, though in adults it may supplement the supply derived from the vessels within the retinacula [11]. Astley cooper's observations give credence to the motion that total nourishment provided by the arteries along ligamentum teres to the head needs a second thought [12]. Walmsley T examined 100 round ligaments but never found a vessel of any size. He concluded that arteries of round ligament could convey no more than a trifling amount of blood [13].

The lesser trochanter is least vascularized area which coincidentally is placed at the level of neck shaft angle. Whether this factor of low vascularity plays a vital role in the healing process of bone in subtrochanteric fractures is worth considering.

In the present study, maximum average number of vascular foramina was observed in the neck posterior region (18.2) and minimum average number was observed in head (0). Size of vascular foramina varies from $\geq$ 1.27mm to < 0.71 mm. Maximum average number of vascular foramina were directed horizontally (5.79).

CONCLUSION

Femur is the most richly vascularized long bone which derives its nourishment from various arteries of the lower limb. In the present study, the neck region at the upper end of the femur bone showed maximum number of vascular foramina. This segment should be carefully protected during any conservative intracapsular procedure of the hip[5]. Disruption of blood vessels occurs by fractures at the neck of the femur, hence the high association of the avascular necrosis of the femoral head seen in fractures occurring in this area, especially if displacement has occurred [8]. Knowledge of vascular anatomy is helpful in early identification of vascular interruptions leading to osteonecrosis.

Conflicts of Interests: None

REFERENCES

[1]. Laroche M. Intraosseous circulation from physiology to disease. Joint Bone Spine. 2002;69:262-69.
[2]. Datta AK. Principles of general Anatomy.6th ed. Kolkata, India : Current books international; 2010.p.75-77.
[3]. Al-Motabagani, M A H. The Arterial Architecture Of the Human Femoral Diaphysis. J Anat. Soc. India. 2002;51(1):27-31.
[4]. Tucker FR. Arterial supply at the femoral head and its clinical importance. J Bone Joint Surg Br. 1949 Feb;31B(1):82-93. 8.
[5]. Lavigne M, Kalhor M, Beck M, Ganz R, Leunig M. Distribution of vascular foramina around the femoral head and neck junction: relevance for conservative intracapsular procedures of the hip. Orthop Clin North Am. 2005 Apr;36(2):171-6.
[6]. Kleinberg S. Aseptic necrosis of the femoral head following traumatic dislocation: report of two cases. Arch Surg. 1939 Oct;39(4):637-646.
[7]. Howe WW, Lacey T, Schwartz RP. A study of the gross anatomy of the arteries supplying the proximal portion of the femur and the acetabulum. J Bone Joint Surg Am. 1950 Oct;32(4):856-66.
[8]. Garden RS. Malreduction and avascular necrosis in subcapital fractures of the femur. J Bone Joint Surg Br. 1971 May;53(2):183-97.
[9]. Churchill MA, Brookes M, Spencer JD. The blood supply of the greater trochanter. J Bone Joint Surg Br. 1992 Mar;74(2):272-4.
[10]. Naito, Masatoshi, Ogata, Kosuke, Emoto. The Blood Supply to the Greater Trochanter. Clinical Orthopaedics & Related Research: Feb 1996;323:294-297.
[11]. Romanes GJ. Cunninghams manual of practical anatomy vol 1. 15th ed. London: Oxford Medical Publications; 2013.p.126-28
[12]. Cooper A. A treatise on dislocation and fractures of joints, London; Longman and Hurst;1842.
[13]. Walmsley T. The Epiphysis of the Head of the Femur. J Anat Physiol. 1915 July;49(4):434–440.
[14]. Moore KL, Dalley AF, Agur AMR. Clinically oriented anatomy. 7th ed. Philadelphia: Lippincott Williams and Wilkins; 2013.p.632.

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