International Journal of Anatomy and Research,
Int J Anat Res 2019, Vol 7(1.2):6171-77. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2018.433

Original Research Article

VARIATION IN BRANCHING PATTERN OF FEMORAL ARTERY

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ABSTRACT

Background: During clinical procedure to prevent damage, anatomical knowledge of the common femoral artery, profunda femoris artery (PFA) and the circumflex arteries is essential.

Material and Methods: Present study was done on 40 lower limbs (20 left and 20 right) in Government Medical College and Hospital, Chandigarh. Dissection was done as per the guidelines in Chunighums.

Aim: Present study was done to discuss variations in branching pattern of FA, PFA and also their embryological and clinical significances.

Results: In the present study, we observed that length of FA (Femoral artery) commonly placed "between" 310-350 mm in 55% (22 cases in which 14 right & 8 cases on left side) whereas outer circumferential diameter is commonly placed "between" 16 -20 mm in 52.5% (21 cases) 10 right & 11 left lower limbs and detailed finding are discussed with literature.

Conclusions: This study will be very helpful to the surgeons, radiologist and plastic surgeons to understand possible variations and also will be very useful in reducing the chances of intra-operative secondary haemorrhage and post-operative complications.

KEY WORDS: Common femoral artery, Profunda femoris artery (PFA), Circumflex arteries.

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Access this Article online	Journal Information
Quick Response code	International Journal of Anatomy and Research
	ICV for 2016 90.30
	ISSN (E) 2321-4287 | ISSN (P) 2321-8967
	https://www.ijmhr.org/ijar.htm
	DOI-Prefix: https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2018.433	Article Information
	Received: 28 Nov 2018 Accepted: 03 Jan 2019
	Peer Review: 29 Nov 2018 Published (O): 05 Feb 2019
	Revised: None Published (P): 05 Feb 2019

INTRODUCTION

Prior and preliminary knowledge of the course and branching pattern of the vessels of the body is important for anatomists and surgeons. The Common femoral artery, the main artery of thigh, is continuation of the external iliac artery. It begins behind the inguinal ligament at mid inguinal point i.e. midway between the anterior superior iliac spine and the pubic symphysis, descends along the anteromedial part of the thigh in the femoral triangle. After this it enters and passes through the adductor canal. After passing through adductor hiatus; an opening in adductor magnus near the junction of the middle and distal thirds of the thigh, it becomes the popliteal artery. In the femoral triangle the artery lies on the psoas major tendon, which separates the artery from capsule of the hip joint.

At this point, pulsation of the artery can be felt and which can guide surgeon for arterial catheterization, cannulation.

The several branches given off by femoral artery in the proximal thigh are the superficial epigastric, superficial circumflex iliac, superficial external pudendal, deep external pudendal and profunda femoris arteries. Profunda femoris artery itself gives away medial circumflex femoral (MCFA), lateral circumflex femoral (LCFA), muscular and perforating arteries. Another branch from Profunda femoris is the descending genicular artery which runs in the adductor canal. In clinical subjects, the part of the femoral artery proximal to the origin of profunda femoris is often termed the common femoral artery, while that distal to the origin of the profunda is termed the superficial femoral artery [1], but for present study name Femoral artery is used for whole length i.e. from its beginning to continuation as popliteal artery. Common femoral artery name is used for the segment of artery up to origin of Profunda femoris.

The branching pattern of femoral artery (FA) and their variations are important during arterial catheterization for embolectomy, diagnostic and therapeutic radiology and proximal thigh surgery. Knowing these variations may also explain variations in occurrence of atheroma and thereon their influence on interpretation of the effects of lower limb vasoocclusive disease. The femoral artery is second to the popliteal artery, most common peripheral site of general aneurysm formation, with a frequency of 1/10 of the aorta. These aneurysms are often bilateral, and there is a relation between aneurysms in the femoral artery and aneurysms in other sites of the arterial system.

Recently, an increasing diameter was observed vessels with age, i.e. in healthy volunteers. Further, the diameter also was shown to be affected by body size and sex [1-3]. Data regarding the diameter of the CFA and factor concerned influencing it in clinical studies, is sparse. This knowledge, however, is of fundamental importance in the study of aneurysmal disease [4-6]. In embolectomy of lower limb arterial thrombo embolism Common femoral artery is directly opened at the origin of the Profunda femoris artery in the femoral triangle. In all these cases the anatomical knowledge of the common femoral artery, profunda femoris artery (PFA) and the other branches like circumflex arteries is very important to prevent inadvertent damage to these during clinical procedures. The Profunda femoris artery is frequently incorporated in vascular reconstructive procedures also in the proximal leg. The knowledge of variations in origin of profunda femoris artery and its other branches distribution is of utmost significance for preventing flap necrosis, particularly tensor fascia lata, when used in plastic and reconstructive surgeries [2]. In this study, we focused on the gross features, morphometry and variation in the branching pattern of the FA and PFA and discussed its morphological and clinical significance.

Aim: The aim of the present study is to discuss the variation in morphometry and branching pattern of FA, PFA and to compare it with available literature. Their embryological and clinical significances will also be discussed.

MATERIALS AND METHODS

This study was conducted on 40 lower limbs (20 left and 20 right) of adult cadavers in Government Medical College and Hospital, Chandigarh. Limbs with previous surgery were not included. Dissection was done as per the guidelines in Cunningham's manual. Structures were identified, cleaned, and photographed. After dissection of CFAs, following observations are noted. Vernier calipers were used for various measurements.

1. Length of FA and measurements were noted of origin of FA at midinguinal point from pubic tubercle and anterior superior iliac spine.

2. Outer circumferential diameter at point of origin of FA.

3. Length of PFA till it gives out first perforator.

4. Outer diameter at point of origin of PFA.

5. Site of origin of PFA and distance of origin of PFA from midinguinal point.

6. Length and Site of origin of trunk of MCFA.

7. Distance of origin of MCFA from origin of PFA.

8. Outer diameter at point of origin of MCFA.

9. Site of origin and length of trunk of LCFA.

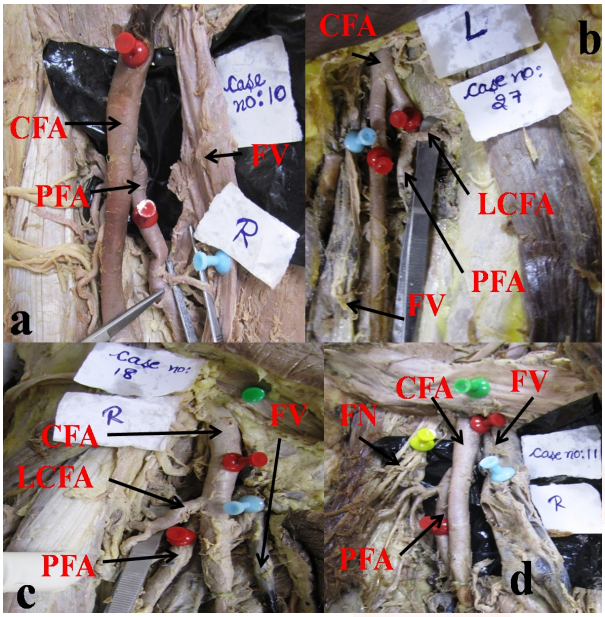
10. Distance of origin of LCFA from origin of PFA.

11. Outer diameter at point of origin of LCFA.

The diameter of Common Femoral, profunda femoris, Lateral circumflex femoral and medial circumflex femoral artery near its origin from the femoral artery was measured in millimeters with the help of vernier calipers and recorded.

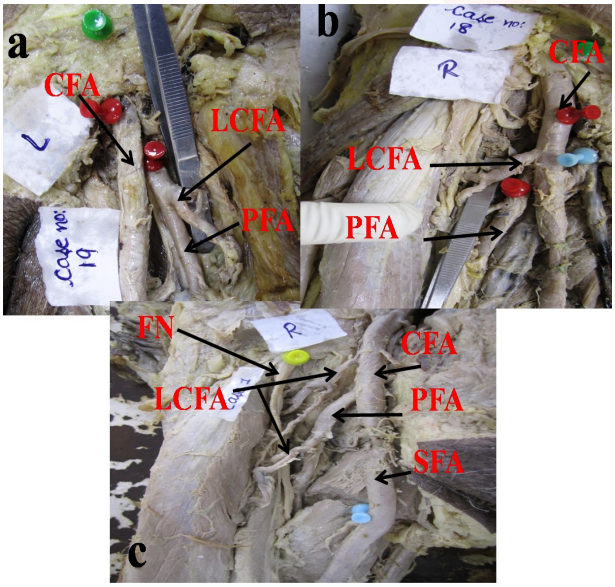
RESULTS AND OBSERVATIONS

Fig. 1: Showing different site of origin of PFA from CFA.



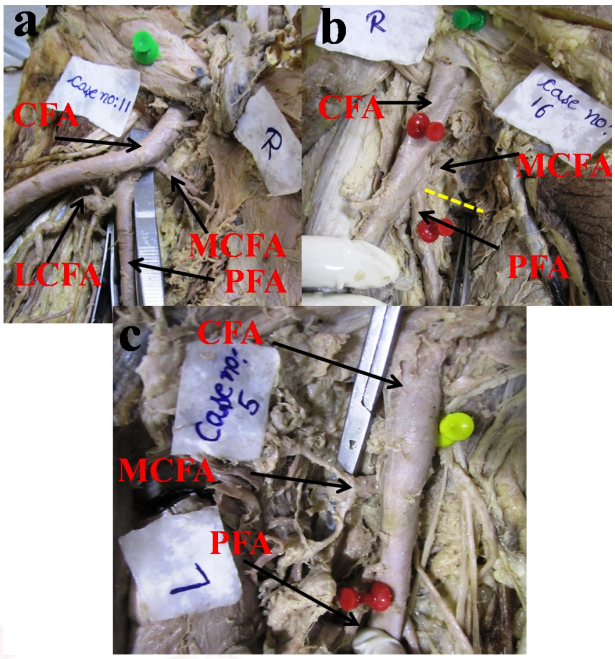
(a) from posteromedial aspect of CFA (b) from lateral aspect of CFA (c) from posterior aspect of CFA (d) from posterolateral aspect of CFA. CFA- Common Femoral Artery, PFA- Profunda Femoris Artery , FN- Femoral Nerve, FV- Femoral Vein, LCFA- Lateral circumflex femoral artery

Fig. 2: Showing origin of LCFA.



(a) LCFA arising from PFA. (b) LCFA arising from CFA. (c) LCFA arising from both CFA and PFA(two arteries from two different sources).

Fig. 3: Showing origin of MCFA.



(a) & (d) from medial aspect of CFA. (b) Showing MCFA from CFA at the level of origin of PFA. MCFA- Medial circumflex femoral artery, CFA- Common femoral artery, LCFA- Lateral circumflex femoral artery.

The length of FA (Femoral artery) commonly placed "between" 310-350mm in 22 cases (14 right & 8 cases on left side) (Table no: 1.a) whereas outer diameter is commonly placed "between" 16 -20 mm (10 Rt & 11 Lt) lower limbs. (Table no: 1.b)

Table 1a: Length of femoral artery from midinguinal point to adductor hiatus along with no: of cases.

S. no:	Length (mm)	No : of cases on right side	No : of cases on left side
1	210- 250	-	2
2	260-300	4	9
3	310-350	14	8
4	360-400	2	1

Table 1b: Comparison of diameter of CFA at midinguinal point on Right and left side.

S. no:	Outer diameter (mm)	No : of cases (right side)	No : of cases (left side)
1	10- 15	10	9
2	16-20	10	11

The PFA originated from either posterior in 19 cases (47.5%), lateral and posterolateral in 8 cases each (20%), 5 cases (12.5%) posteromedial aspect of CFA. (Figure no:1, Table no: 2.c). The distance of origin of PFA from midinguinal point commonly placed between 21-30mm (right side 5 cases & left side 6 cases table no: 2.c). The length of PFA commonly placed "between"

1-10cm in 18 cases on right & 17 cases on left side (Table no: 2.a) whereas outer circumferential diameter is between 0.1 - 0.6mm in 15 right & 18 left lower limbs. (Table no: 2.b)

Table 2a: Comparison of Length of PFA along with no: of cases on Right and left side.

S. no:	Length (mm)	No : of cases (right side)	No : of cases (left side)
1	10- 100	18	17
2	110-200	2	3

Table 2b: Diameter of PFA at origin along with no: of case on Right and left sides.

S. no:	Outer diameter (mm)	No : of cases on right side	No: of cases on left side
1	0.1- 0.6	15	18
2	0.7-0.9	5	2

Table 2c: Cases with position at origin of profunda femoris artery (PFA) versus distance of origin of PFA from CFA at midinguinal point. L- Left, R- Right, CFA- Common femoral artery, PFA- Profunda femoris artery. (Fig.no: 1)

S. no:	Range (mm)	Posterior		Lateral		Posterolateral		Posteromedial	
		No: of cases	Rt/ Lt limb	No: of cases	Rt/ Lt limb	No: of cases	Rt/ Lt limb	No: of cases	Rt/ Lt limb
1	10-20	2	Lt	1	Lt	1	Rt	2	Rt
2	21-30	3	2Lt, 1Rt	6	2Lt, 4Rt	-	-	2	Lt
3	31-40	5	4Lt, 1Rt	-	-	4	2Lt, 2Rt	-	
4	41-50	1	Rt	1	Lt	2	Rt	-	
5	51-60	6	2Rt, 4Lt	-	-	1	Rt	-	
6	61-70	2	Rt	-	-	-	-	1	Rt

Table 3a: Variation in origin of lateral circumflex femoral artery (LCX) and its variation on right and left side.

S. no:	Distance	Origin	No : of cases (right side)	No: of cases (left side)
1	Above (origin of PFA)	CFA	9 (22.5%)	4(10%)
2	Below (origin of PFA)	PFA	10(25%)	12(30%)
3	At the level of origin of PFA	CFA	1(2.5%)	4(10%)

Table 3b: Showing distance of origin of Lateral Circumflex Femoral Artery (LCFA) from origin of Profunda Femoris artery its variation on right and left side .

S. no:	distance (mm)	Total no: of cases	No : of cases on right side	No: of cases on left side
1	0- 10	5	2	3
2	11-20	21	10	11
3	21-30	9	4	5
4	31-40	5	4	1

The lateral circumflex femoral artery originated from lateral aspect of common femoral artery in 18 cases (45%) (10 right and 8 left upper limb). Out of these 18 cases, LCFA originated from CFA above the origin of PFA in 13 cases (9 right and 4 left side) which is commonly between 11-20mm in distance range and in 1 case (right side) LCFA taken origin from on right side was from CFA at the level of origin of PFA. In remaining 22 cases (55%) LCFA originated from profunda femoris artery (14 on right and 18 on left side). In one case, LCFA arisen from both CFA and PFA from their lateral aspects as 2 LCFA. (Figure no: 2).

Table 3c: Comparison of length of LCFA along with no: of cases and variation on right and left sides.

S. no:	Length (mm)	No : of cases (right side)	No: of cases (left side)
1	0.1-0.9	6	7
2	10-20	8	8
3	21-30	6	5

Table 3d: showing circumferential diameter of LCX at origin along with no: of cases its variation on right and left side.

S. no:	Outer diameter (mm)	No : of cases (right side)	No: of cases (left side)
1	0.2-0.5	9	12
2	0.6-0.8	11	8

Medial circumflex femoral artery originated from CFA in 8 cases (3 right & 5 left side). Of these in 7 cases MCX arose from medial aspect of CFA above the origin of PFA whereas in 1 case (left side) MCFA taken origin from posteromedial aspect of CFA at the level of origin of PFA. The distance of origin of MCFA (as a branch of CFA) from origin of PFA is commonly placed between 0.1 – 15 mm. In remaining 32 cases (17 right & 15 left upper limbs) MCX originated from PFA. The distance of origin of MCFA from PFA (at its point of origin) is commonly placed between 16-30 mm.

Table 4a: Showing no: of cases with origin of medial circumflex femoral artery (MCFA) versus distance of origin of MCFA above, below and at the level of origin of PFA and its variation on right and left side.

S. no:	Distance	Origin	No : of cases (right side)	No: of cases (left side)
1	Above (origin of PFA)	CFA	3	4
2	Below (origin of PFA)	PFA	14	15
3	At the level of origin of PFA	CFA	-	1
4	At the level of origin of PFA	PFA	3	-

Table 4b: showing distance of origin of Medial Circumflex Femoral Artery (MCFA) from origin of Profunda Femoris artery (PFA) along with number of cases and its variation on right and left side.

S. no:	Distance (mm)	Total no: of cases	No : of cases on right side	No: of cases on left side
1	0- 10	28	15	13
2	11-20	9	4	5
3	21-30	0	-	-
4	31-40	3	1	2

Table 4c: Showing length of MCFA along with no: of case and its variation on right and left side.

S. no:	Length (mm)	No : of cases (right side)	No: of cases (left side)
1	0.1-0.9	4	2
2	10-20	11	18
3	21-30	5	-

Table 4d: showing circumferential diameter of MCFA at origin along with no: of cases and comparison of right and left side.

S. no:	Outer diameter (mm)	No : of cases (right side)	No: of cases (left side)
1	0.3-0.6	18	17
2	0.7-0.9	2	3

DISCUSSION

The anatomical knowledge of variations of femoral artery and its branches is important as these arteries are frequently accessed by surgeons and radiologists for number of procedures. Accurate knowledge of anatomical variations is also important for clinicians in the present modern era of interventional radiology [2].

The knowledge can be utilized by Orthopedecians while performing various clinical procedures in the femoral region and hip joint surgeries. Knowledge of these parameters is also valuable for avoiding iatrogenic arterio-venous fistula or severe secondary hemorrhage while performing femoral artery puncture [3]. other use of this information is in making anterolateral thigh flap and in Coronary artery bypass grafting (CABG) [4]. Femoral artery is commonly utilized for angiographies, insertion of central lines, ultrasound & Doppler imaging, digital subtraction angiography, magnetic resonance imaging and other various investigative and diagnostic procedures.

Development basis of variations: In the lower animals, the profunda femoris artery is a branch of the internal iliac artery. During course of evolution, the origin shifted distally from the femoral artery. The development of artery follows the principle "Ontogeny repeats phylogeny". Hence, developmental arrest at different stages may lead to anatomical variations related to the division of the femoral artery [2]. The development of the vasculature in the lower limb precedes the morphological and molecular changes that occur in the limb mesenchyme, so vascular variations are more of a rule than an exception [5]. Thus femoral artery and its various branches are crucial as they are likely to get damaged in various invasive procedures of this region. So studying normal anatomy of femoral artery and its branches is important to avoid such mishaps.

The limitation of our study was that comparative study involving radiology department utilizing angiography should also be merged, so that larger study population can be involved. In the present study, we observed that length of FA (Femoral artery) commonly placed "between" 31-35cm in 22 cases in which 14 right & 8 cases on left side (Table no: 1.a) whereas outer circumferential diameter is commonly placed "between" 16 -20 mm in 10 right & 11 left lower limbs. (Table no: 1.b)

Vaas F reported that in the occlusion of the femoral artery the profunda femoris artery acts as a collateral vessel and for this important function, it has to have a large caliber, which can be explained based on the aforementioned comparative anatomy [6]. This view was supported by Parasa S [1].

The various variations in the origin of profunda femoris and its branches are described in the literature. Anatomical variations reported at the level of the division of the femoral artery can be explained by studies done by different authoes. Dixit et al. observed distance 31-40 mm on right side and between 41-50 mm on the left side [3]. Prakash et al. noted this distance to be 4.2 cm [2]. Siddharth P et al observed as 4.4 cm [7]. Vedat Sabancýogullarý et al. recorded the distance of the originating point to the midpoint of the inguinal ligament was found to be 5.6 cm in the right and 2.2 cm in the left [8]. This distance is very important from the point that while performing cannulation of femoral artery you will not encounter the PFA. Anjankar V et al. noted distance of origin of profunda femoris as measured from midpoint of inguinal ligament mostly between 31 and 40 mm on both sides [9]. Generally PFA arise from femoral artery about 35 mm distal to the inguinal ligament [10]. Samarawickrama et.al reported about origin of PFA from CFA on posterior 14/48 cases (29%), posterolateral 03/48 cases (6.2%), medial 1/48 case(2%) and lateral 30/48 cases(62.5%) aspect [11] whereas origin of PFA from posterior 12/26

cases (46%), posterolateral 8/26 cases(30.7%) and 6/26 cases(23%) lateral aspect from CFA observed by Wallia et.al. [12]. The site of origin of PFA from femoral artery as described in Grays Anatomy is from lateral aspect [10]. In the present study, PFA originated from postero-lateral aspect in 48.33% on right side and 46.67% on left side. Its origin from lateral aspect on right side was in just 18.33% and on left side in 15% of cases. (Figure no:2, Table no: 1)

In previous studies, Origin of LCFA a from PFA 77.3% and from femoral artery in 22.7% of cases was noted by Uzel M et al on Turkish population [13]. Fakuda et.al reported that LCFA arise from PFA in 78.6% and from femoral artery in 21.4% cases [14]. Hollinshed observed that LCFA takes origin from CFA proximal to origin of PFA in 15% cases [15]. Anjankar et al. noted that LCFA originated from CFA proximal to the origin of PFA in 8.33% [9] whereas in the present study, LCFA arisen from CFA in 45% cases (10 on right side & 8 on left side). Out of these, in 12.5 % cases LCFA takes origin from CFA at the level of origin of PFA and in remaining 32.5% cases from CFA above the origin of PFA. In other 55% cases, LCFA arisen from PFA. In 1 case (2.5%) LCFA arisen two time as two LCFA, one from trunk of CFA and another from PFA (figure no: 2, table no: 3).

The origin of MCFA from medial aspect of PFA in 65% Cases (right side) & 60% (left side) and from CFA 15% (on left side) & 16.7 (left side) reported by Anjaker et al. [9] Dixit DP et al stated that medial circumflex artery on an average was arising in 62.5% of cases from the profunda and in 20.63% of cases from the femoral artery [16]. These findings are comparable to 59% and 36% found by Lipshutz [17] and 53% and 40% reported by Clarke and Colborn [18]. Where as in our study we found that Medial CFA originated from CFA in 20% cases (3 right & 5 left side). Of these in 17.5% cases MCX arose from medial aspect of CFA above the origin of PFA whereas in 1 case (left side) MCFA taken origin from posteromedial aspect of CFA at the level of origin of PFA. In remaining 80% cases, MCFA arisen from PFA.(figure no: 3, Table no: 4) .

CONCLUSION

The sound anatomical knowledge of femoral artery and its branches placement, variation and their average diameter is important while performing clinical procedures in the femoral region and hip joint replacement. This would also avoid iatrogenic arterio-venous fistula or severe secondary hemorrhage while performing femoral artery puncture. This study will be very helpful to the surgeons, radiologist and plastic surgeons to understand possible variations and also will be very useful in reducing the chances of intra-operative secondary hemorrhage and post-operative complications

Conflicts of Interests: None

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How to cite this article:

Amandeep kaur, Anshu Sharma, Mahesh kumar Sharma. VARIATION IN BRANCHING PATTERN OF FEMORAL ARTERY. Int J Anat Res 2019;7(1.2):6171-6177. **DOI:** 10.16965/ijar.2018.433