

STUDY ON VARIOUS PATTERNS OF PROFUNDA FEMORIS ARTERY AND ITS BRANCHES

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Abstract

Background: Awareness about profunda femoris artery and its branching patterns is imperative for vascular surgeons, orthopaedics, radiologists, anatomists and interventional cardiologists. Aim of the study is to examine the sites of origin, width, distances from mid inguinal point of profunda femoris artery (PFA) & variations in branching patterns, thereby to revisit the classification system. **Materials and Methods:** The study was conducted on 70 lower limbs, profunda femoris artery was examined for its sites of origin, distance of origin from mid inguinal point and width/calibre. Femoral artery was also noted for its calibre. Medial and lateral circumflex femoral arteries (MCFA & LCFA) were traced for their origin and branching patterns. All values were presented in percentages and for comparing the data SPSS version 17 was used. Chi square test is utilised to show correlations. **Result:** Most common site of origin of PFA was posterolateral 57% & posteromedial in 20% with no significant difference on right and left sides. Mean width of FA & PFA were 0.4±0.05cm & 0.25±0.15 respectively. Mean distance of PFA origin from mid inguinal point was 3.6±0.13cm. MCFA & LCFA distances from origin of PFA ranged between 2-4 cm & 2-8 cm respectively. Branching patterns of MCFA & LCFA were noted which were: type 1A- 28.5%, 1B- 46%, 1C-11.4%, 2A-0%, 2B-2.8% & 3-5%. No significant side differences were observed. PFA & MCFA were absent in 5.7% & 2.8% limbs respectively. There was strong correlation between widths of femoral artery and PFA. **Conclusion:** Unilateral occurrence of variations of PFA & its branches MCFA & LCFA are common. It essential to note the variations in origin side and branching patterns to prevent iatrogenic trauma while performing catheterisation or surgeries like arterial by pass & anterolateral thigh flap plastic surgery.

INTRODUCTION

The profunda femoris artery (PFA) is a large branch that arises laterally from the femoral artery about 3.5-4 cm below the inguinal ligament. Behind the femoral vessels PFA gives off medial and lateral circumflex femoral vessels. At first lateral to the femoral artery, it spirals posterior to it and the femoral vein to reach the medial side of femur.^[1] The circumflex arteries encircle the upper most shaft of femur and anastomose with each other and other arteries supplying the thigh muscles and superior end of femur. The medial circumflex femoral artery is extremely important because it supplies most of the blood to the head and neck of the femur via its branches, posterior retinacular arteries. The lateral circumflex artery supplies mainly muscles on the lateral side of thigh and femoral head to the lesser extent.^[2] The profunda femoris artery is an important

collateral pathway through its anastomosis with the geniculate branches of popliteal arteries and the recurrent tibial arteries. In the operation of profundoplasty the origin of the artery from the common femoral artery is made wider.^[3] The deeply located profunda femoris artery is in close proximity to the femoral shaft. It may also be injured due to blunt injury to the thigh without fracture of femur. The artery is also liable to injury in surgical procedures like fixing of metallic screws in the femur.^[4] Authors of present article appended to the existing knowledge of variations of PFA & its branching pattern in the following areas; 1: Measurements:- Width of FA & PFA, distance of PFA from mid inguinal point and distances of MCFA & LCFA from PFA origin point. 2: Pattern of origin of PFA, medial circumflex and lateral circumflex arteries. 3: Classification of patterns of branches of PFA.

MATERIALS AND METHODS

The specimens are obtained from embalmed cadavers of department of anatomy from Hassan institute of medical sciences, Hassan. 70 lower limbs were dissected and studied for the origin and branching pattern of profunda femoris artery. After identifying the anterior part of thigh sartorius muscle is exposed. Fascia Lata is removed from the femoral triangle. Femoral artery and vein are exposed. The position of profunda femoris artery is noted in relation to femoral artery. Distance of point of origin of profunda femoris from mid inguinal point, length of medial and lateral circumflex from their origin from profunda femoris was measured with the help of scale. Width of femoral arteries and profunda femoris i.e external calibre, were measured with the help of divider and the scale. Femoral artery bifurcates into superficial femoral artery which continues further in femoral triangle and deep femoral artery also called as profunda femoris artery which usually gives medial and lateral circumflex femoral artery 1st the continues further deeply. To observe branches and for better clarity venous tributaries had to be removed after thorough inspection and after clarifying profunda femoris artery branching pattern. Medial circumflex artery runs postero medially between pectineus and psoas major and terminates by dividing into anterior and posterior branches. Lateral circumflex femoral artery runs laterally deep to sartorius and rectus femoris divide subsequently into ascending, descending and transverse branches.

All measurements and variations of the arteries were expressed as proportions or percentage and mean \pm SD. Statistical analysis was performed with IBM SPSS statistics version 17.0. To examine the patterns various statistical tests were applied like, chi square test for categorical variables, student's t test is used for two groups with continuous variables, to find association between variables, Pearson's correlation was done. P value < 0.05 is considered significant.

RESULTS

PFA originated from femoral artery in 88.5% of limbs. Especially posterolateral side of femoral artery in 57%. In 20% limbs, PFA was taking origin from posteromedial aspect. Posterior origin of PFA was noted in 13% cases. It was absent in 5.7% of cases bilaterally. Shown in [Table 1].

Range of distance of PFA from its origin to midpoint of inguinal ligament is 3.5-3.8cm with mean 3.6 ± 0.13 , shown in [Table 2]. Right side 3.58 ± 0.12 and left side 3.57 ± 0.13 . No significant difference was seen on sides of the limbs.

Range of width or external diameter of FA was observed was 0.4-0.8 cm with the mean external diameter 0.4 ± 0.05 cm. Right side 0.36 ± 0.05 and left side 0.4 ± 0.04 respectively. Width of profunda femoris artery ranged from 0.2-0.6cm & mean width observed is 0.25 ± 0.1 cm with right side 0.25 ± 0.08 and

left side 0.26 ± 0.12 . Shown in [Table 3]. Femoral artery showed significant difference on right and left side. Statistical high significant correlation was observed in these measurements in relation to width of FA & PFA (p value-0.003), shown in [Table 4]. Diameter of PFA was negatively correlated with distance of origin PFA from mid inguinal point as shown in table no-4 with no significance.

Distance of origin of medial circumflex and lateral circumflex femoral artery from the origin of profunda femoris artery: MCFA & LCFA distances of their origin from origin of PFA, ranged between 2-4 cm & 2-8 cm respectively table no-5. Mean distances were 3.48 ± 1.67 & 2.3 ± 2.1 In about 2.8% of specimens in the present study the medial circumflex femoral artery is absent

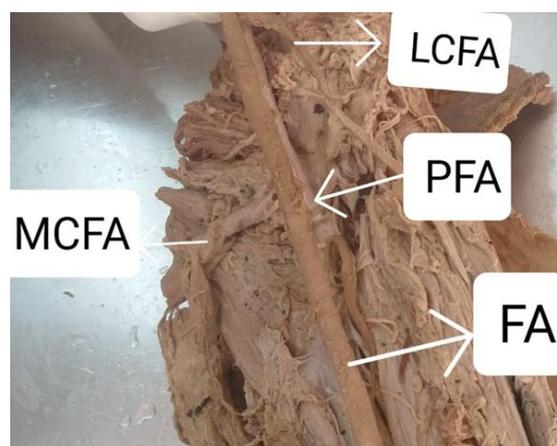


Figure 1: Origin of PFA from Femoral artery (FA) & LCFA & MCFA from PFA (Type 1)

PFA-Profunda femoris artery, FA-femoral artery, MCFA & LCFA- Medial & lateral circumflex artery

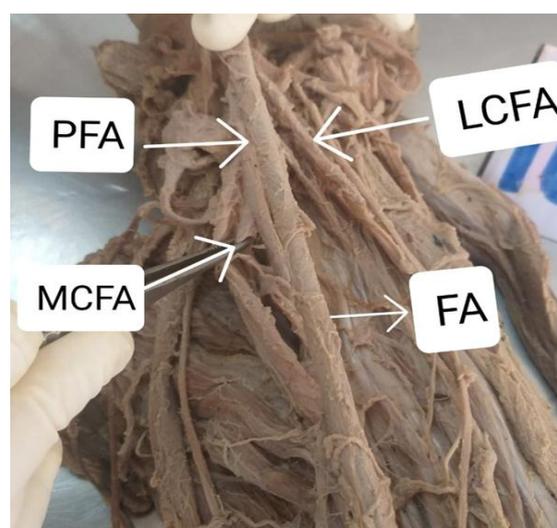


Figure 2: MCFA from PFA & LCFA from FA (Type 2)

PFA-Profunda femoris artery, FA-femoral artery, MCFA & LCFA- Medial & lateral circumflex artery.

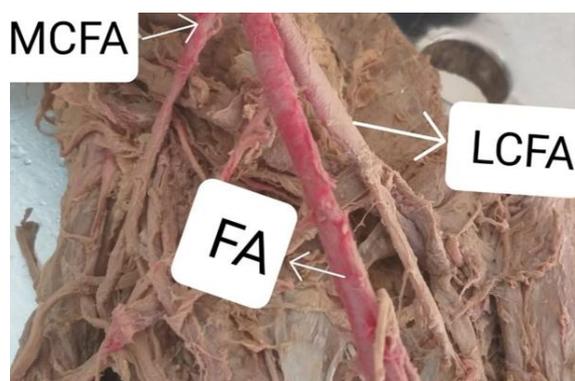


Figure 3: Profunda femoris artery- absent

FA-femoral artery, MCFA & LCFA- Medial & lateral circumflex artery.

Prevalence of Types

MCFA & LCFA both were commencing from PFA (Type 1) Fig no-1. In type 1 further subgroups were noted in our study. MCFA arose from PFA proximal to the origin of LCFA in 28.5% of limbs (type1A). LCFA arose from PFA proximal to MCFA in 45.7% of limbs(type1B). Both MCFA & LCFA arose as a common trunk from PFA in 11.4% of limbs(type1C). When one of the branches of PFA are arising from FA it is labelled as type 2 shown in fig no 2: further it is sub grouped into, type2a-MCFA arises from FA. Incidence of this pattern was not observed in our study. Type2b-LCFA arose from FA in 2.8% of limbs. In 5.7% of limbs both MCFA & LCFA were directly from FA (type 3).

Study on various patterns of Profunda Femoris Artery and its branches.

Table 1: Various Positions of PFA.

Position Distribution	Side		Total
	RIGHT	LEFT	
0	2 (50%)	2(50%)	4(5.7%)
P	7(58.3%)	5(41.6%)	12(17%)
PL	22(55%)	18(45%)	40(57%)
PM	4(28.6%)	10(71.4%)	14(20%)
Total	35 (50%)	35 (50%)	70(100.0%)

$\chi^2 = 0.214$, p value = 0.975 (NS)

* p value <0.05 is significant. Pearson Chi-square test done

Table 2: Distance of PFA from mid inguinal point.

PFA distance	Right	Left	Total	t value	P value
N	35	35	70	0.167	0.684
Mean	3.58	3.57	3.6		
Std. Deviation	0.12	0.13	0.13		

Table 3: Width of Femoral and profunda femoris artery

Width of Femoral Artery	Right	Left	Total	t value	P value
N	35	35	70	0.719	0.400
Mean	0.36	0.4	0.30		
Std. Deviation	0.05	0.04	0.046		
Width of PFA				0.627	0.432
N	35	35	70		
Mean	0.25	0.26	0.2517		
Std. Deviation	0.08	0.12	0.10167		

* p value <0.05 is significant.

Table 4: Correlations test of significance between width and distance of PFA

		Width of Femoral Artery	Width of Profunda Femoral Artery	PFA Distance
Width of Femoral Artery	Pearson Correlation	1	0.619	0.156
	Sig. (2-tailed)		0.003*	0.235
Width of Profunda Femoral Artery	Pearson Correlation	0.119	1	-0.019
	Sig. (2-tailed)	0.365		0.886
PFA Distance	Pearson Correlation	0.156	0.186	1
	Sig. (2-tailed)	0.235	0.155	

Table 5: Distances of origin of MCFA & LCFA

Range of distance	MCFA		LCFA	
	Right	Left	Right	Left
0-2	-	-	10(58.8%)	7(41.2%)
2-4	26(56.5%)	20(43.5%)	21(56.8%)	16(43.2%)
4-6	8(66.7%)	4(33.3%)	3(75%)	1(25%)
6-8	-	-	1(50%)	1(50%)
Absent	1(50%)	1(50%)	-	-

$\chi^2 = 0.554$, p value = 0.907 (NS)

* p value <0.05 is significant. Pearson Chi-square test done

Table 6: Classification system of origin of branches of PFA

Classification	Side		Total
	Right	Left	
1A	11(55%)	9(45%)	20(28.5%)
1B	12(37.5%)	20(62.5%)	32(45.7%)
1C	5(62.5%)	3(37.5%)	8(11.4%)
2A	0(0%)	0(0%)	0(0%)
2B	1(50.0%)	1(50.0%)	2(2.8%)
3	4(100.0%)	0%	4(5.7%)
Absent PFA	2(50.0%)	2(50.0%)	4(5.7%)
Total	35(50.0%)	35(50%)	70(100.0%)

$\chi^2 = 4.238$, p value = 0.516 (NS) * p value <0.05 is significant. Pearson Chi-square test done

Table 7: Various studies on classification of PFA based on origin of MCFA & LCFA.

Author's name	Size of sample	Type I	Type II	Type III
Lalani (2022), ^[16] MCFA LCFA	155	60% 68%	22.9% 12.9%	7.1% 9.7%
Pretty Rathnakar et al 2016, ^[17]	73	61.6%	34.2%	4.11%
Vasquez (2007), ^[18]	439	78.8%	20.5%	0.5%
Dixit et al (2001), ^[13]	228	64.4%	30%	14.2%
Vasanti (2019), ^[19]	50	76%	20%	4%
Waseem (2015), ^[20]	342	57%	39.3%	9%
Ashraf (2013), ^[11] MCFA LCFA	90	M-60%, F-57.5% M-74%, F-65%	M-18%,F-15% M-14%, F-15%	M-14%,F-17.5% M-8%, F-12.5%
Present study	60	IA-27% IB-45.7% IC-11.5%	IIA-0% IIB-3.3%	5%

DISCUSSION

Profunda femoris artery other than supplying compartments of thigh, it provides chief source of blood supply to head of Femur through retinacular fibers of femoral neck, via medial circumflex artery.^[5] Since branches of PFA involved in extensive anastomosis around hip joint, which play important role in providing alternative pathways there by help surgeons to pick it for replacement surgeries for arteries like coronary artery, branches of aorta and popliteal artery. Lateral circumflex artery is of great importance in antero lateral flap construction surgeries. There are numerous studies available on variations of profunda femoris artery with little emphasis on lucid classification system based on its branching pattern. A good knowledge of vertical topography and significant patterns might aid in avoiding arterial damages during robotic and laparoscopic surgery.^[6] This is equally important for interventional radiologists during catheterizations,^[6] as well as for vascular surgeons, oncologists, and anatomists.

Site of Origin of Profunda Femoris Artery

PFA originated from posterolateral side of femoral artery in 57%. Same data was reported by other researcher Prakash et al,^[7] Manjappa et al,^[8] and Rajani et al,^[9] 50%, 50% & 53% respectively. In the contrary Shruti,^[10] reported in 80% of 70 cadavers showed origin from lateral side of FA and only 20% had from postero lateral side of FA. In our study 20% limbs, PFA was taking origin from posteromedial aspect. According to other researchers Ashraf et al,^[11] Manjappa et al,^[8] and Rajani et al,^[9] incidence

of this variation is lesser than our findings, 12%, 8% and 3% respectively. Posterior origin of PFA was noted in 12% cases in our study while as researchers like Prakash et al,^[7] & Ashraf et al,^[11] noted 25% & 46% cases respectively. This variations could be due to disappearance and persistence of complex network of arteries, as per the need during angiogenesis in axial artery of thigh region which develops into PFA.^[12]

Distance of Origin of Profunda Femoris Artery

Distance of PFA from midpoint of inguinal ligament is 3.5-3.8cm with no gender difference. Other literatures agree with our results and have shown distance as 3.5cm,^[1] 3.2cm,^[10] 3.75.^[13] Different ranges are shown by other researchers, 4.2,^[7] 5,^[14] 5.1.^[11] One has to be vigil for site of origin of PFA from FA to prevent inadvertent events like haemorrhage and A-V fistula formation.^[15]

Classification Based on Origin of MCFA & LCFA

Our results indicate that most common incidence in origin of LCFA is from PFA proximal to the origin of MCFA (which is classified as IB), with prevalence of 46%. A review literature on LCFA shows 76% of pooled prevalence for this pattern of origin and true for side, gender and geographic regions.^[21] Vasquez observed this pattern in 23.4% cases.^[18] Ashraf et al reported 60% in males and 57.5% in females type A pattern.^[11] Our results contradict to other studies where in sample size is larger.

The most common origin of MCFA in our research is from PFA proximal to origin to LCFA, 27% incidence (which is classified as IA). There is no significant difference was found with respect to side

of the limbs. Other studies report that origin of MCFA from PFA with the following incidences: 60%,^[16] 61%,^[17] 64%,^[13] as shown in [Table 7]. Ashraf et al,^[11] reported that 58.9% of limb with male and left side higher incidence, but statistically not significant. Mentioned studies have not described its proximity of origin from PFA in relation to LCFA. Vasquez reported higher incidence than our values (53.2%).^[18] Waseem mentioned that incidence of origin of MCFA is inconstant either from PFA or from CFA.^[20]

MCFA & LCFA arose as common trunk from PFA in 11.4% limbs (which is classified as IC) with right 62.5% & left 37.5%. Statistical significant difference was not noted for this type of variation in arterial patterns. However origin of such pattern is rarely described in literatures where it was found in 23%,^[18] 6.8% & 7%.^[20,22]

When one of the arteries MCFA/LCFA originate from FA then such pattern is labeled as type II. Type IIA pattern (MCFA from FA) was not observed in our research though we found trunk of LCFA arising from FA proximal to PFA in 3.3% limbs. Other study showed 30%, 34%, 39.3%. Vasquez et al,^[18] and Lalani,^[16] described incidence of type II A and B separately as 22.9%, 12.9% and 77.8%, 22.2% respectively with no significance. Ashraf,^[11] reported in elaborate manner this pattern type IIA, in Male-18%, F-females-15%, type II B in Males-14%, Females-15% with no statistical significance. Such variation in our results and other authors could be due to number of limbs studied and geographic factors. Both MCFA & LCFA arose from FA as a single trunk or in common with PFA (type III) in 5% of limbs right side limbs, there were no such branching pattern found on left side with no statistical significance. Other authors reported similarly 7%,^[16] 4%,^[17,19] 9%.^[20] While as Vasquez,^[18] showed 0.5%, Ashraf,^[11] and Dixit,^[13] reported slightly higher incidence in this pattern 14.4% and 14% respectively. Ashraf,^[11] reported higher incidence of this arterial pattern in right sided limbs significantly, who also reports in his study that this differences in different population is related to number & species of cadavers used for research.^[11]

MCFA/LCFA arise from superficial femoral artery is called as type IV pattern. We did not get this pattern of arteries. Authors like Lalavani et al,^[21] reported in LCFA-5.2%, MCFA-0.6% and Ashraf,^[11] reported 8% in males & 10% in females this pattern. Waseem,^[20] same pattern reported in MCFA in 2.5% limbs. Absence of MCFA is demonstrated in our article 2.8% limbs. This finding is also reported by authors like Vasquez et al,^[18] Waseem,^[20] & Lalvoic et al,^[23] 0.3%, 0.6% & 4.8% respectively. Unusual origin of this arteries are due to embryological complete or in complete development of primitive arterial plexus and axial artery regression.^[24]

Width of PFA & its correalation with FA

Width of FA & PFA reported was 0.4 ± 0.05 cm & 0.25 ± 0.1 cm, which is less than the values reported

by M.Ma et al,^[6] 0.9 cm % 0.75 cm. This disparity could be due to less number of samples and different population of study with different anthropometric measurements. Very less studies are available on correlation of width/external diameter of FA & PFA, authors have co related between this 2 arteries diameter externally. There is significant correlation was observed (R value-0.61 & p value- 0.003). Similar to the study done by Ashwini^[25] where author reported positive correlation between PFA & FA external calibre.

CONCLUSION

Posterolateral origin is commonest site of PFA origin. Variations in PFA branching pattern can be classified into various types however there is no consistency in prevalence of variations. It is imperative to note the variations in origin side and branching patterns to prevent iatrogenic trauma while performing catheterisation or surgeries like arterial by pass & anterolateral thigh flap plastic surgery. Arterial anatomy should be studied before head & neck reconstruction surgeries using anterolateral thigh flap to have successful procedure.

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