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Original Article

A Study Of Variations In The Origin Of Profunda Femoris Artery And Its Circumflex Branches.

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ABSTRACT

The knowledge of the variations in site of origin and course of the profunda femoris artery and its circumflex branches has great clinical importance during diagnostic imaging procedures as well as during surgeries that are performed in the femoral triangle. We dissected 228 femoral triangles in 114 human cadavers which revealed interesting variations apart from the usual description about these arteries that is available in standard anatomy textbooks. The most common site of origin of profunda femoris artery was from the posterolateral aspect of the femoral artery. A rare variation of the profunda femoris artery arising from either posterior or medial aspect of the femoral artery and then coursing superficial to femoral vein was found. The lateral circumflex femoral artery on the right side was absent in 1 Down's syndrome female cadaver, but all its 3 branches were present and were arising from the profunda femoris artery. We also observed a very rare variation of lateral circumflex femoral artery arising from the external iliac artery. The medial circumflex femoral artery originated at a higher level from the profunda femoris artery as compared to the lateral circumflex femoral artery. The incidence of medial circumflex femoral artery arising from the femoral artery was higher than that of lateral circumflex femoral artery. Variations in the arterial patterns may be due to the divergence in the mode and proximo-distal level of branching or aberrant vessels that connect with the principal vessels, arcades or plexuses during the development of the blood vessels. Thus the knowledge of these variations can be of great help to the surgeons in reducing the chances of intra-operative secondary haemorrhage and post-operative complications.

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1. Introduction

Years after the advent of highly advanced imaging techniques, arteriography still remains the main line of investigation in peripheral occlusive arterial diseases. Peripheral angiograms are used to evaluate peripheral occlusive arterial diseases, suspected congenital vascular anomalies, arterial status in trauma, imaging of

vascular malignancies, demonstration of the vascularity of malignancies and for identifying diseases inherent to the arterial system.

The femoral artery is easily accessible to catheterisation. The profunda femoris artery is used for arteriography, ultrasound and doppler imaging, digital subtraction angiography and magnetic resonance imaging. In the recent era, profunda femoris is being used for haemodialysis other than femoral artery and also the branches of profunda femoris are used in anterolateral perforator thigh flap as long vascular pedicle during breast reconstruction after mastectomy in cases of carcinoma of breast [1].

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The profunda femoris artery emerges from the posterolateral aspect of the femoral artery in the femoral triangle approximately 4-5 cms below the inguinal ligament [2]. This is the main artery which supplies the adductor, extensor and flexor muscles of the thigh. The branches of profunda femoris artery are medial and lateral circumflex femoral arteries and four perforating arteries [3].

The expanding scope of interventional radiology has prompted this study on the variations in the origin of profunda femoris artery and its circumflex branches.

2. Materials and Methods

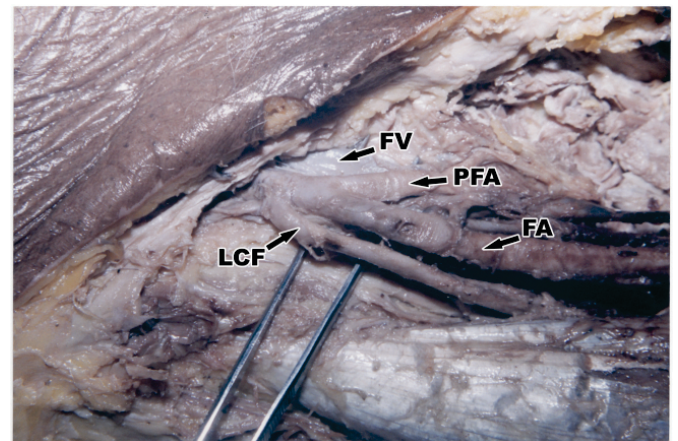
The materials used for this study were 40, 54 and 20 cadavers from the Departments of Anatomy of J. N. Medical College, Belgaum, M. P. Shah Medical College, Jamnagar and Government Medical College, Bhavnagar, respectively. This study was done simultaneously at all the 3 Medical Colleges using the same methods of study and data collection. In all the 3 Medical Colleges total of 114 cadavers and 228 femoral triangles were dissected as follows: the skin from the front of thigh was incised and reflected followed by the superficial fascia. The great saphenous vein and superficial inguinal lymph nodes were identified and the fascia lata was incised thus exposing the femoral triangle. The inguinal canal along with the inguinal ligament were identified, so were the adductor longus and sartorius muscles. The femoral sheath was identified and its compartments were dissected thus clearing the femoral artery and its major branches. The profunda femoris artery with its medial and lateral circumflex femoral branches were dissected and identified. Their origin and courses were studied. The relation of profunda femoris artery at its origin to the femoral artery was studied. The distance of the site of origin of profunda femoris artery from the midpoint of the inguinal ligament was measured in mm with a scale and vernier callipers and recorded. The site of origin of medial and lateral circumflex femoral arteries were studied and the distance of their site of origin from the origin of profunda femoris artery was measured and recorded. The diameter of profunda femoris artery near its origin from the femoral artery was measured in mm with the help of vernier callipers and recorded.

3. Results

A total of 228 femoral triangles were dissected and the observations of various parameters are as follows: -

3.1 Site of origin of profunda femoris artery: in the total of 228 lower limbs the profunda femoris originated from the posterolateral aspect of femoral artery in 96 cases i.e. 42.1%, from the posterior aspect in 68 cases i.e. 28.5%, from lateral side in 43 cases i.e. 18.8% and from the medial side in 29 cases i.e. 10.5%. The profunda femoris artery which originates from the medial or posterior aspect of the femoral artery may course superficial to the femoral vein. This type of variation was found in 5 cases (Fig. 1).

Figure 1: Profunda femoris artery arising from the medial aspect of femoral artery and coursing superficial to the femoral vein. Also lateral circumflex femoral artery is arising from the femoral artery superior to the origin of profunda femoris artery. (FV – femoral vein, PFA – profunda femoris artery, FA – femoral artery, LCF – lateral circumflex femoral artery.)



3.1 Distance of origin of profunda femoris artery from the midpoint of the inguinal ligament: the distance of origin of profunda femoris artery from the midpoint of the inguinal ligament on the right side was most commonly between 31-40 mm whereas on the left side it was between 41-50 mm (Table 1).

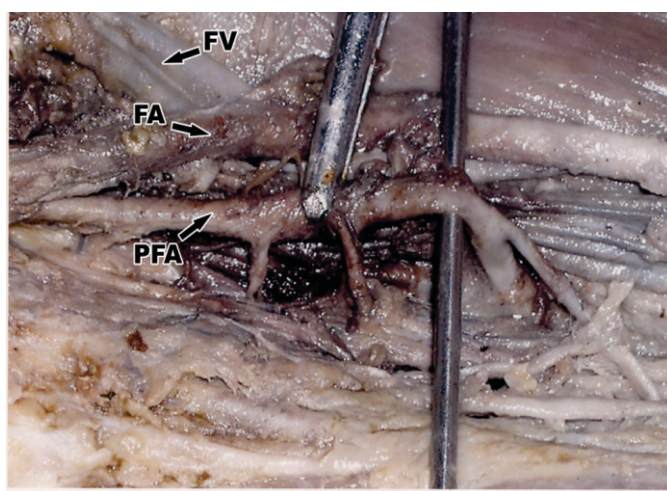
Table 1: Distance origin of profunda femoris artery from the midpoint of the inguinal ligament.

Distance (mms)	No. of cases on Right side		No. of cases on Left side	
10-20	1	1	2	4.08
20-30	3	2	5	10.2
30-40	2	6	8	16.32
40-50	4	6	10	20.4
50-60	9	7	16	32.65
60-70	1	3	4	8.16
70-80	2	1	3	6.12
>80	-	1	1	2.04

3.2 Site of origin of lateral circumflex femoral artery: the origin of lateral circumflex femoral artery on the right side was from profunda femoris artery in 72.8% (83 cases), from femoral artery as a common stem with profunda femoris artery in 17.5% (20 cases), from femoral artery superior to profunda femoris artery in 5.2% (6 cases), from femoral artery inferior to profunda femoris artery in 2.6% (3 cases) and from external iliac artery 0.8% (1 case) which is

a very rare variation. In 1 Down's syndrome female cadaver, the lateral circumflex femoral artery was absent and its branches were directly coming from the profunda femoris artery (Fig. 2). There was no double lateral circumflex femoral artery found.

Figure 2: Lateral circumflex femoral artery is absent and its 3 branches; ascending, descending and transverse are arising from the profunda femoris artery. (FV – femoral vein, PFA – profunda femoris artery, FA – femoral artery.)



3.3 On the left side the lateral circumflex femoral artery was taking origin from profunda femoris artery in 77.2% (88 cases), from femoral artery as a common stem with profunda femoris artery in 14.9% (17 cases) (Fig. 3), from femoral artery superior to profunda femoris artery in 5.2% (6 cases) and from femoral artery inferior to profunda femoris artery in 2.6% (3 cases) (Table 2).

Figure 3: Lateral circumflex femoral artery arising from femoral artery as a common stem with profunda femoris artery. (FV – femoral vein, PFA – profunda femoris artery, FA – femoral artery, LCF – lateral circumflex femoral artery.)

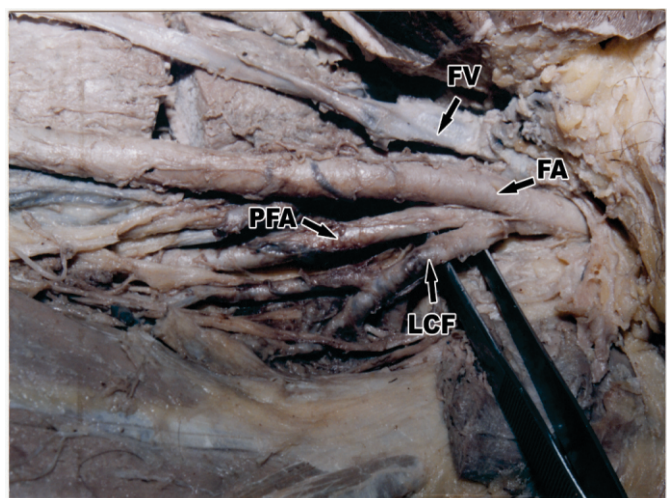


Table 2: Site of origin of lateral circumflex femoral artery

Site of origin	No. of cases on Right side	Percentage	No. of cases on Left side	Percentage
From profunda femoris artery lateral aspect	83	72.8	88	77.2
From femoral artery as a common stem with profunda femoris artery	20	17.5	17	14.9
From femoral artery superior to profunda femoris artery	6	5.2	6	5.2
From femoral artery inferior to profunda femoris artery	3	2.6	3	2.6
From external iliac artery	1	0.8	-	-
Absent lateral circumflex femoral artery	1	0.8	-	-

3.4 Distance of origin of lateral circumflex femoral artery from the origin of profunda femoris artery on both the sides was recorded in mm and was most commonly between 21-30 mm (Table 3).

Table 3: Distance of origin of lateral circumflex femoral artery from the origin of profunda femoris artery.

Distance (mms)	No. of cases on Right side	No. of cases on Left side
0-10	11	10
11-20	32	25
21-30	45	42
31-40	14	21
41-50	7	12
51-60	4	4

3.5 Site of origin medial circumflex femoral artery: on the right side the medial circumflex femoral artery originated from the medial aspect of profunda femoris artery in 56.1% (64 cases), from the femoral artery as a common stem with profunda femoris artery in 16.6% (19 cases), from femoral artery superior to profunda femoris artery in 18.4% (21 cases) and from femoral artery inferior to profunda femoris artery in 8.7% (10 cases).

On the left side the origin of medial circumflex femoral artery was from the medial aspect of profunda femoris artery in 66.7% (76 cases), from the femoral artery as a common stem with profunda femoris artery in 14% (16 cases) (Fig. 4), from femoral artery superior to profunda femoris artery in 14.9% (17 cases) and from femoral artery inferior to profunda femoris artery in 4.4% (5 cases) (Table 4). Out of the total 228 cases, in 14 cases the medial circumflex femoral artery originated from either profunda femoris artery or femoral artery and coursed superficial to the femoral vein (Fig. 5).

Figure 4: Medial circumflex femoral artery arising from femoral artery as a common stem with profunda femoris artery and lateral circumflex femoral artery. (FV – femoral vein, MCF – medial circumflex femoral artery, PFA – profunda femoris artery, FA – femoral artery, LCF – lateral circumflex femoral artery.)

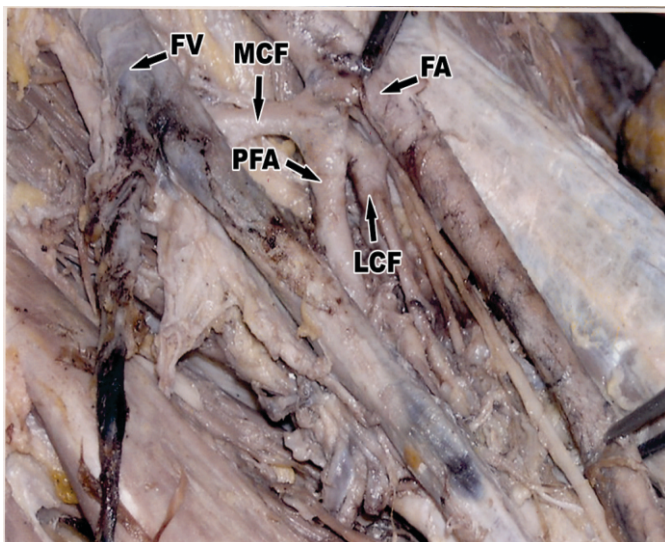
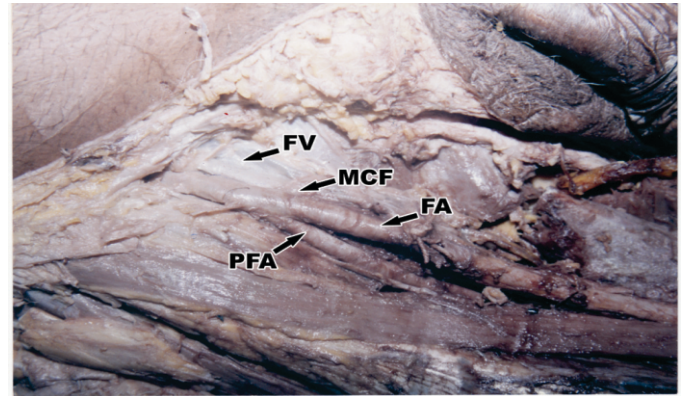


Table 4: Site of origin of medial circumflex femoral artery.

Site of origin	No. of cases on Right side	Percentage	No. of cases on Left side	Percentage
From profunda femoris artery lateral aspect	64	56.1	76	66.7
From femoral artery as a common stem with profunda femoris artery	19	16.6	16	14.0
From femoral artery superior to profunda femoris artery	21	18.4	17	14.9
From femoral artery inferior to profunda femoris artery	10	8.7	5	4.4

Figure 5: Medial circumflex femoral artery is arising from femoral artery and coursing superficial to femoral vein. (FV – femoral vein, PFA – profunda femoris artery, FA – femoral artery, MCF – medial circumflex femoral artery.)

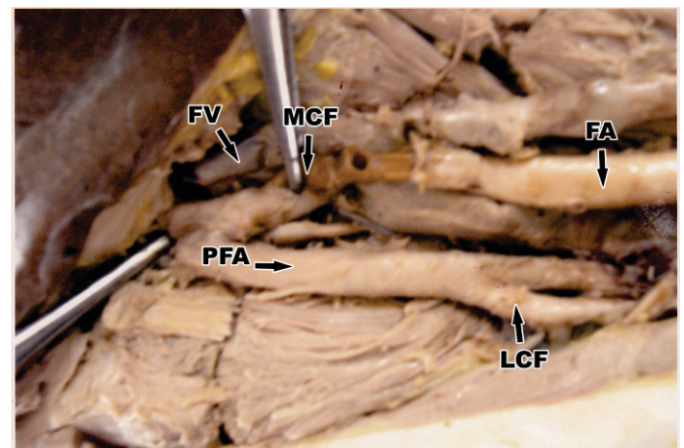


3.6 Distance of origin of medial circumflex femoral artery from the origin of profunda femoris artery was between 0-10 mm on both the sides (Table 5).

Table 5: Distance of origin of medial circumflex femoral artery from the origin of profunda femoris artery.

Distance (mms)	No. of cases on Right side	No. of cases on Left side
0-10	45	44
11-20	30	30
21-30	22	21
31-40	11	14
41-50	4	5
51-60	2	-

Figure 6: Profunda femoris artery arising from the lateral aspect of femoral artery at a higher level. (FV – femoral vein, MCF – medial circumflex femoral artery, PFA – profunda femoris artery, FA – femoral artery, LCF – lateral circumflex femoral artery.)



3.7 Diameter of profunda femoris artery: in our study the normal range of the diameter of profunda femoris artery was 4-8 mm. In 5 cases the profunda femoris artery was unduly large, the size being 10 mm and in 23 cases the size was very small and between 2-3 mm.

4. Discussion

The knowledge of the site of origin of profunda femoris artery is important while performing clinical procedures in the femoral region and hip joint replacement and also for avoiding iatrogenic arteriovenous fistula or severe secondary haemorrhage while performing femoral artery puncture. The most common site of origin of profunda femoris artery is posterolateral aspect of femoral artery [2, 4]. In our study also the profunda femoris artery originated from posterolateral aspect of femoral artery in 96 lower limbs i.e. in 42.1 % of cases. This is similar to 48% which was recorded by Lippert H and Pabst R [5]. In 28.5% of cases (65 limbs) the profunda femoris artery originated from the posterior aspect of femoral artery.

In our study we had 89 cases (39%) wherein the profunda femoris artery was arising either from medial or posterior aspect of femoral artery. Out of these, 5 cases were such that the profunda femoris artery was coursing superficial to the femoral vein, thus forming an arterial circle around the sapheno-femoral junction. Such type of variation carries a risk of damage to the large and unexpected arterial channel while collecting blood in infants from femoral vein and during exposure of saphenous vein for ligation at its junction with the femoral vein.

The normal distance of origin of profunda femoris artery from the midpoint of inguinal ligament is 35-40 mm [3]. In our study this distance was between 31-40 mm on right side and between 41-50 mm on the left side. We had 2 cases, one on either side, in two different cadavers, where the profunda femoris artery originated at a higher level between 0-10 mm (Fig. 6). The advantage of such a high origin of profunda femoris artery is that it can be used for catheterisation and further investigation of any arterial system of the body.

The commonest site of origin of lateral circumflex femoral artery bilaterally was from the lateral aspect of profunda femoris artery i.e. in 72.8% cases on the right side and in 77.2% cases on the left side. Baptist M et al have also reported the origin of lateral circumflex femoral artery from the femoral artery [6]. Tanyeli E et al reported the origin of lateral circumflex femoral artery from the femoral artery inferior to the profunda femoris artery [7]. Uzel M et al studied 110 inguinal regions and found lateral circumflex femoral artery arising from profunda femoris artery in 85 cases (77.3%) and from femoral artery including common stem in 25 cases (22.7%) [8]. Fukuda H et al in 2005 reported 78.6% cases wherein lateral circumflex femoral artery originated from the profunda femoris artery and 21.4% cases wherein it originated from femoral artery including common stem [9]. These findings are similar and comparable to our findings. In our study we found 1 case on the right side, wherein the lateral circumflex femoral artery was arising from external iliac artery.

In most of our cases the distance of origin of lateral circumflex femoral artery from the origin of profunda femoris artery was between 21-30 mm. In 1 of our cases the lateral circumflex femoral artery was absent on the right side in a 35 year old female cadaver having Down's syndrome. The 3 branches of lateral circumflex femoral artery i.e. ascending, descending and transverse were present and arose directly from profunda femoris artery. On the left side of this cadaver the lateral circumflex femoral artery was present and originated from the profunda femoris artery. The medial circumflex femoral artery mostly originated from the medial aspect of profunda femoris artery on both the sides i.e. in 56.1% cases on right side and in 66.7% cases on the left side. This is comparable to 59% found by Lipshutz BB in 1916, 63% found by Siddharth P et al in 1985, 53% reported by Clarke SM and Colborn GL in 1993 and 67.2% reported by Prakash et al in 2010 [10, 11, 12, 13]. The distance of origin of medial circumflex femoral artery from the origin of profunda femoris artery was mostly between 0-10 mm on both the sides. Thus the medial circumflex femoral artery originated at a higher level from the profunda femoris artery as compared to lateral circumflex femoral artery.

Evans CA et al found both medial and lateral circumflex femoral arteries arising by a common trunk from the femoral artery [14]. Bergman RA et al in 1996 observed 200 limbs out of which in 123 cases both the lateral and medial circumflex femoral arteries originated from profunda femoris artery. Out of the remaining cases the medial circumflex femoral artery was arising from femoral artery in 41 cases and lateral circumflex femoral artery was arising from femoral artery in 29 cases [15]. In our study also out of the total 228 limbs, the medial circumflex femoral artery in 53 cases was arising from femoral artery while the lateral circumflex femoral artery was arising from femoral artery in only 18 cases. Thus it means that the incidence of medial circumflex femoral artery arising from femoral artery is higher than that of lateral circumflex femoral artery. The origins of medial and lateral circumflex femoral arteries directly from the femoral artery is associated with distal shift of the level of separation of the profunda femoris artery from the femoral artery [13].

5. Conclusion

According to our study the most common site of origin of profunda femoris artery was from the posterolateral aspect of the femoral artery. A rare variation was observed in 5 cases wherein the profunda femoris artery arose from either posterior or medial aspect of the femoral artery and then coursed superficial to femoral vein. This is of great surgical importance as such a large and unexpected arterial channel can be damaged while collecting blood in infants from femoral vein or during exposure of saphenous vein for ligation at its junction with the femoral vein.

The lateral circumflex femoral artery was absent in 1 Down's syndrome female cadaver on the right side but all its 3 branches were present and were arising from the profunda femoris artery. We also observed a very rare variation of lateral circumflex femoral artery arising from the external iliac artery in 1 lower limb. Sachin B et al in 2003 attributed such a variation to the different ramification patterns during the development of the vasculature of the lower limb [16].

In our study the medial circumflex femoral artery originated at a higher level from the profunda femoris artery as compared to the lateral circumflex femoral artery. We also found that the incidence of medial circumflex femoral artery arising from the femoral artery was higher than that of lateral circumflex femoral artery.

The development of the vasculature in the lower limb precedes the morphological and molecular changes that occur in the limb mesenchyme, hence vascular variations are more of a rule than an exception [17]. Anomalous patterns of vascular system may be due to: divergence in the mode and proximo-distal level of branching; presence of unusual compound arterial segments; aberrant vessels that connect with the principal vessels, arcades or plexuses; and vessels occupying exceptional tissue planes and having unsuspected neural, mycological or osteo-ligamentous relationships [3, 18]. A thorough knowledge of the normal anatomy and variations of the site of origin and course of the profunda femoris artery and its circumflex branches is not only of paramount surgical importance during vascular diagnostic interventional procedures and surgeries but also helps in reducing the chances of intra-operative secondary haemorrhage and post-operative complications. Needless to say, that the aforementioned anatomical facts should be considered before planning different diagnostic and therapeutic procedures on the femoral artery and its branches.

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