Anatomical Variations of the Profunda Femoris Artery and Its Branches—A Cadaveric Study in South Indian Population

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Received: 25 September 2011 / Accepted: 22 June 2012 / Published online: 25 July 2012
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Abstract The variations of the profunda and its branches are numerous, and, to a considerable extent, largely associated with one another. In occlusion of the Superficial femoral artery, the profunda femoris artery forms an effective collateral bed between the ileo-femoral segment and the popliteal artery and its branches. This study based on dissections performed on 40 properly embalmed human cadaver specimens. The position, source and the point of origin of the profunda and its circumflex branches were studied and compared with earlier literature. We found that profunda femoris was originated from the posterolateral surface of the common femoral artery with a mean distance of 3.56 cms from the midinguinal point. An absence of profunda femoris was noted in one (5 %) case. Medial circumflex femoral artery (in 40 % on right side and 60 % on left side) originated from the profunda femoris; whereas in 50 % on right and 35 % on left side, it begins from the femoral artery. On the otherhand, the lateral circumflex femoral in 80 % on right and 70 % on left sides sprungs from profunda femoris with 20 % and 25 % from common femoral arteries of right and left limb specimens respectively. Knowledge of variations in profunda femoris and its branches helps surgeons during preoperative clinical evaluation for surgical and interventional revascularization of the ileo-femoral and femoro-popliteal segments, in open canulation of femoral artery for cardiopulmonary bypass, in radiological interventions for A-V malformations, and in salvage operations for traumatic limb ischemia.

Keywords Artery · Deep femoral artery · Profunda femoris artery · Variations

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Introduction

In the vascular surgical literature, the femoral artery above the origin of the profunda branch (deep femoral artery) is termed the common femoral artery, and the vessel below the branch is the superficial femoral artery [1].

The profunda femoral artery has an important compensatory role for the collateral blood flow in the atherosclerotic occlusive disease through collateral pathways in the lower pelvis, starting from the internal iliac arteries (or the mesenteric arteries if the internal iliac arteries are also affected). This collateral pathway is more important if aortoiliac lesions are associated with femoropopliteal lesions [2]. In this case the profunda femoris artery represents a “bridge” between the lower pelvis circulation and the infrapopliteal circulation, through collateral pathways such as genicular arteries.

In order to identify the more frequent anatomical variations involving the profunda femoris artery and its circumflex branches that may be encountered by the vascular surgeon, we undertook the dissection of the femoral triangle in cadavers.

Material and Methods

Forty properly embalmed lower extremities of 20 adult human cadavers belonging to South Indian origin, with the age range of 30–70 years, were selected for this study. Femoral triangles were dissected with proper care to identify the profunda femoris and circumflex femoral arteries. Their source of origin, position, and distance were noted with the mid-inguinal point (MIP) as a reference point. All measurements were recorded by a single author to minimize the observational errors.

Table 1 Variations of profunda femoris artery and its branches observed in the present study

Parameters	Profunda femoris artery (PFA)		Medial circumflex femoral artery (MCFA)		Lateral circumflex femoral artery (LCFA)	
	Right	Left	Right	Left	Right	Left
Side	PL P L Absent	10 (50 %) PL 8 (40 %) P 1 (5 %) L 1 (5 %) PM	14 (70 %) M 2 (10 %) PM 3 (15 %) P 1 (5 %) FA	15 (75 %) L 3 (15 %) PL 2 (10 %) AL	15 (75 %) L 4 (20 %) PL 1 (5 %) AL	20 (100 %) L
Origin from	FA by common trunk with MCFA	FA by common trunk with MCFA	FA by common trunk with PFA	FA by common trunk with PFA	FA by common trunk with PFA	FA by common trunk with PFA
Mean distance	3.56 cm	3.195 cm	3.96 cm	4.85 cm	5.63 cm	5.37 cm

PL Posterolateral, P Posterior, L Lateral, PM Posteromedial, FA Femoral artery, M Medial, AL Anterolateral

Results

Profunda Femoris Artery

The findings of this study is tabulated in Table 1 and shown in Fig. 1. The profunda femoris artery (PFA) originated from the common femoral artery in 90 % or more of the specimens on the right and left-sided limbs. In two cases (10 %) it was from the common femoral artery by a common trunk with the medial circumflex artery and in another case (5 %) it was completely absent on the right side. The median distance of its origin from the MIP was 3.56 cm for the right and 3.195 cm for the left side of specimens. The most common position of the origin of profunda femoris was posterolateral in 50 % of the right and 70 % of the left limb specimens. The next common position was posterior (40 % on the right side and 10 % on the left side), followed by lateral and posteromedial in one case (5 %) each.

Medial Circumflex Femoral Artery

The medial circumflex femoral artery (MCFA) originated from the common femoral artery in 50 % of the right limb specimens and 35 % on the left limbs with a mean distance of 2.71 and 2.65 cm, respectively. However, the profunda femoris artery contribute the media circumflex in 40 % of the specimens on the right limbs compared to 60 % on the left side, branching at an average distance of 3.96 cm on the right and 4.85 cm on the left side of limb specimens. Rarely, in three (15 %) cases it arose from the common femoral artery as a common trunk with profunda femoris. Most commonly MCFA begin from the medial side of the profunda femoris (60 % on the right and 75 % on the left limbs), with the least common exit from the posterior side in both sides of limb specimens.

Lateral Circumflex Femoral Artery

The origin of the lateral circumflex femoral artery (LCFA) from the profunda femoris was 80 % (mean distance of 5.63 cm from MIP) on the right limb specimens and 70 % (mean distance of 5.37 cm from MIP) of specimens on the left side. It was from the common femoral artery with a mean distance of 5.63 and 5.37 cm from the MIP in the right and left limb specimens, respectively. The position of origin of the LCFA varied greatly on both sides with lateral being the most common in 75 %, posterolateral in 20 %, and antero-lateral in 5 % in right limb specimens whereas the lateral position was seen in all left limb specimens.

Fig. 1 Schematic presentation of profunda and circumflex arteries: **a** point of origin of profunda, **b** source of origin of profunda, **c** point of origin of MCFA, **d** source of origin of MCFA, **e** point of origin of LCFA, and **f** source of origin of LCFA. (Note: All diagrams shown here are related to right femoral artery)

i) Point of origin of Profunda

ii) Source of origin of Profunda

iii) Point of origin of MCFA

Discussion

Bergman et al. describe that various vessels of the profunda complex may more or less dissociate, one or another of them having an independent origin from the femoral artery; this may occur to such an extent that a profunda femoris as a definite vessel may not exist [3]. Differing patterns of the origin of the PFA and its branches have been described on a racial basis as well as variations being noted between the two legs of the same individual [4].

The point of origin of profunda from the femoral artery is usually stated to be about 4 cm distant from the inguinal ligament [3], but the figure must be taken as an average from which there may be wide departure.

Bozaric et al. also point out that variances in the height of PFA origin influence the distribution of their lateral

branches. If PFA is separated in the lower part of the femoral triangle, the circumflex arteries are separated as the lateral branches of the femoral artery and also PFA caliber decreases [5]. This caliber and distribution of PFA lateral branches have a significant impact on the quality of vascularization of the musculocutaneous flap they are nourishing.

The average distance of origin of the profunda femoris from the midpoint of inguinal ligament on the right side was 3.56 and on the left side was 3.195 cm. This indicates that the origin of the right profunda is usually distal to the origin of the left profunda femoris by 0.365 cm, which is similar to the study by Bannister et al., but more than the average distance of origin has been reported by Snell 4 cm, Sidharth et al. 4.4 cm, and Dixit et al. 4.75 cm [1, 4, 6, 7]. High origin of PFA can cause problems in procedures such as femoral arterial and venous puncture and femoral nerve

Fig. 1 (continued)

iv) Source of origin of MCFA **v) Point of origin of LCFA** **vi) Source of origin of LCFA**

blocks because of the close relationship between vessels and nerves in the femoral triangle. Pseudoaneurysms can occur when the puncture site is the PFA or FA distal to the origin of the PFA. The knowledge of the site of origin of the profunda helps to enable us to identify the correct site of making incision for surgical exposure of the common femoral and profunda femoris junction.

In our dissections, most commonly the PFA originated from the posterolateral surface of the common femoral artery, and in two cases (10 %) we found a common trunk for PFA and MCFA. Interestingly an absence of PFA was noted in one case which is very rare, and the available literature search yielded only one such case reported by Lipshutz in 1916 [8]. The direction of the origin of PFA is also important in catheter application, in making flaps with

pedicles, in reconstructive surgery and bypass procedures made to supply the lower extremity.

In this study, MCFA was given off at an higher level than the lateral circumflex. In 42.5 % of cases, it directly arose from the femoral artery which is relatively higher than studies by Bergmann et al. (20.5 %), Tanyeli et al. (21 %), Siddharth et al. (37 %), Dixit et al. (37.5 %), and Gautier et al. (16.7 %) [3, 4, 7, 9, 10]. Since it arises at a higher level than the lateral femoral, it is an important collateral for the PFA when the common femoral artery or origin of profunda femoris is diseased [4].

Many authors reported that the usual origin of MCFA was from profunda femoris in 79 % by Tanyeli et al., 64 % by Siddharth et al., 62.5 % by Dixit et al., and 83.3 % by Gautier et al. [4, 7, 9, 10], but we found only 50 % of

MCFA from PFA and a common stem of origin for both MCFA and PFA in 7.5 %. The artery of ligamentum teres femoris arises from the medial femoral circumflex in about 15 % of cases and supplies the head of the femur [3].

Gautier et al. opine that precise knowledge of the anatomy of MCFA is essential in performing both trochanteric and intertrochanteric osteotomies and is also helpful to avoid iatrogenic vascular necrosis of the head of the femur in reconstructive surgery of the hip and fixation of acetabular fractures through the posterior approach [10].

In more than 70 % of our specimens, we found that the lateral circumflex arose from the lateral side of the PFA and located distal to the level of origin of MCFAs. It therefore can serve as a major source of collateral circulation for the deep system by way of the ascending branch when the common femoral artery is occluded. In 22.5 % of our specimens, LCFA arose from the common femoral artery proximal to the profunda branch. This variation is important as the lateral circumflex caliber is wider when it arose at an higher level as a separate branch from the common femoral artery, which can be mistaken for the profunda during surgical and therapeutic interventions.

Orebaugh evaluated the position of the LCFA in relation to accepted landmarks for the femoral nerve blockade. In 40 dissected cadavers he found the lateral circumflex artery was crossing the femoral nerve within 1 cm of the inguinal crease in 50 % of specimens, which is the recommended level for needle insertion for femoral nerve blockade [11].

Occasionally, both circumflexes arise independently from the femoral artery, the profunda in such cases usually having a low origin, and one of the perforating arteries may arise from the circumflexes [3].

In the light of the rare occurrence of certain variations, we did not see the following variants: (a) Perforating arteries, as the number may varies widely, and (b) the distinct intergender difference in the origin of the PFA and its branches because many authors such as Bergmann et al. and Siddharth et al. opined that the origin of profunda and circumflex femoral groups of arteries showed no differences in their side (right / left) with respect to sex, and we did not get enough female specimens.

Conclusion

The origin of the PFA from the MIP is placed more proximally in other studies. However, the right profunda originates more distally than left in most cases. Points of origin

are helpful to avoid “high” or “low” punctures. High punctures, above the inguinal ligament, may result in a retroperitoneal hematoma, as the artery is difficult to compress without the support of the femoral head. Low punctures may result in pseudo-aneurysms formation. Very rarely, femoral artery punctures result in femoral nerve damage or neural compression by a large hematoma. It is important to bear in mind the proximity of the femoral nerve, which lies just lateral to the artery. A case of absence of profunda femoris was noted with its circumflex branches directly arose from common femoral artery. MCFA has a variable origin and begins at an higher level than LCFA. Common femoral arteries and PFA share an equal contribution to MCFA origin whereas LCFA more frequently from PFA.

Conflict of interest Authors declare that they have no conflict of interest.

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