A Study About the Topometry and Origins of the Deep Femoral Artery

Profunda Femoris'in Topometrisi ve Çıkış Yerleri ile İlgili Bir Çalışma

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ABSTRACT Objective: The present study was aimed: 1. To examine the topometry and branching location of the deep femoral artery (DFA), 2. To propose new approaches for clinicians to use in diagnostic and therapeutic interventions at the region, and 3. To prevent possible injuries by supplying information regarding the branching of the DFA. **Material and Methods:** This study was conducted on 238 lower extremities of 120 cadavers, which were fixed with formalin-glycerin-alcohol mixture, between 1990 and 2006. First, the inguinal region was dissected and the location of the branching point of the DFA on the femoral artery (FA) was investigated. To define the topography of the branching point of the DFA, the midinguinal point (MIP), the anterior superior iliac spine (ASIS) and the pubic tubercle (PT) were used as landmarks. The distance of the DFA to the MIP, ASIS and the PT were measured by using a metal caliper. **Results:** In most (49.1%) of the cases the DFA branched from the posterior aspect of the FA. The other sites of origin were posterolateral (29.4%), lateral (17.8%), posteromedial (1.7%), medial (1.3%) and anterior (0.8%). The average distance of the branching point to the MIP, ASIS and the PT was 4.2 cm, 10.3 cm and 5.1 cm, respectively. There were no significant differences between right and left sides, and males and females ($p > 0.05$). **Conclusion:** In this study, it was found that DFA originated mostly (49.1%) from the posterior aspect of the FA. By comparing the data of the present with the other data in the literature, the concordance of the results of the present study with the results of the other studies were examined and some differences were found. It was found that two DFA's originated from the anterior aspect of the FA. It's expected that these data regarding the origin of the DFA will decrease the risk of failure, and that the topographic data will be helpful to clinicians in cases where it's difficult to find the origin of the DFA.

Key Words: Femoral artery; anatomy; angiography

ÖZET Amaç: Bu kadavra çalışmasında a. profunda femoris'in (DFA) topometrisini ve a. femoralis'ten (FA) çıkış yerlerini araştırmayı; elde edilen verilerle, bölgedeki tanı ve tedavi amaçlı klinik uygulamalarda (cerrahi girişimler, anjiyografi vb.) klinisyenlere yeni yaklaşım noktaların sunulması, bunun yanında dallanma tipleri konusunda bilgi vererek olası hasarlanmaların önüne geçilmesi amaçlandı. **Gereç ve Yöntemler:** Bu çalışma, 1990 ve 2006 yılları arasında, formalin-gliserin-alkol karışımıyla fikse edilmiş 120 kadavranın 238 alt ekstremitesinde yapılmıştır. İnguinal bölge diseksiyonunun ardından DFA'nın FA'dan çıkış noktası ortaya çıkarıldı. DFA'nın dallanma yerinin topometrisini belirlemek için referans noktaları olarak midinguinal nokta (MIP), spina iliaca anterior superior (ASIS) ve tuberculum pubicum (PT) kullanıldı. DFA'nın MIP, ASIS ve PT'ye olan uzaklıkları metal metrik kumpasla ölçüldü. **Bulgular:** DFA'nın, olguların çoğunda (%49.1) FA'nın arka yüzünden çıktığı görüldü. Diğer çıkış yerleri ise posterolateral (%29.4), lateral (%17.8), posteromedial (%1.7), medial (%1.3) ve anterior (%0.8) olarak bulundu. DFA'nın dallanma yerinin, MIP'ye, ASIS'e ve PT'ye olan ortalama uzaklıkları sırasıyla 4.2, 10.3 ve 5.1 cm olarak bulundu. Sağ-sol ve erkek-kadın arasındaki farklar istatistiksel olarak anlamlı olmadığından ($p > 0.05$) tüm olgular beraberce değerlendirildi. **Sonuç:** Bu çalışmada DFA'nın en sık olarak (%49.1) FA'nın arka yüzünden çıktığı ortaya kondu. Elde edilen verileri literatürdekilerle karşılaştırarak sonuçların diğer çalışmalarla uyumluluğu incelendi ve farklılıklar bulundu. Sıklıkla görülen çıkış yerlerinin dışında, daha önce literatürde başka araştırmacılar tarafından bildirilmemiş olan, DFA'nın iki olguda FA'nın ön yüzünden çıktığı belirlendi. Bulunan çıkış yeri verilerinin bölgede çalışan klinisyenlere ön bilgi vererek hata riskini azaltmasını ve ayrıca topometrik verilerin de, DFA'nın çıkış yerinin bulunmasının zor olduğu durumlarda klinisyenlere sabit kemik noktalar yardımıyla kolaylık sağlaması amaçlandı.

Anahtar Kelimeler: Femoral arter; anatomi; anjiyografi

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The deep femoral artery (DFA) is the largest branch which usually emerges between the posterior and lateral aspects of the FA. It arises from the femoral artery (FA), approximately 3-4 cm below the inguinal ligament (IL). It gives rise to lateral (LCFA) and medial circumflex femoral arteries (MCFA), three perforating arteries and continues as the fourth perforating artery. It's the main blood supplier of the thigh region.[1-4] The variations of origin and branching of the DFA are important in revascularization of the ischemic limb.[3,5-7] As it's mentioned in the discussion, the DFA gained importance due to the increasing number of diagnostic and therapeutical interventions (such as percutaneous transluminal coronary angioplasty, myocutaneus flaps, vascular reconstructive procedures) at this region as well as to importance of its branches (MCFA, LCFA); thus, the pathologies and injuries of the DFA became more important. Because of its importance, in this study the aim was to define its topography relative to certain landmarks. For doing this, MIP, ASIS and PT were chosen as landmarks. The distances were measured and the topography of the branching point of the DFA was defined. The topometry and origins of the DFA may be helpful in surgical or angiographic interventions, so these data may be useful for clinicians dealing with this artery.

MATERIAL AND METHODS

In this study, 238 inguinal regions of 120 cadavers (99 male, 21 female) were investigated between 1990 and 2006. In two inguinal regions, the FAs were found destroyed, so these two were excluded from the study. The ages of the individuals were between 21 and 85 years. Cadavers were fixed by using a formalin-ethanol-glycerol solution. After dissection of the inguinal region, the FA and its branches were exposed and the branching point of the DFA was examined. After the examination of the branching point, to define the topography of the branching point of the DFA, the distance of the DFA to the MIP (I), ASIS (II) and PT (III) were measured. Measurements were taken by a caliper. All measurements were performed by using basic metric units (cm). The landmarks used are shown in Figure 1. The mean values and standard deviations of the data were calculated. Student's t-test was used to calculate the bilateral differences of the same cadaver.

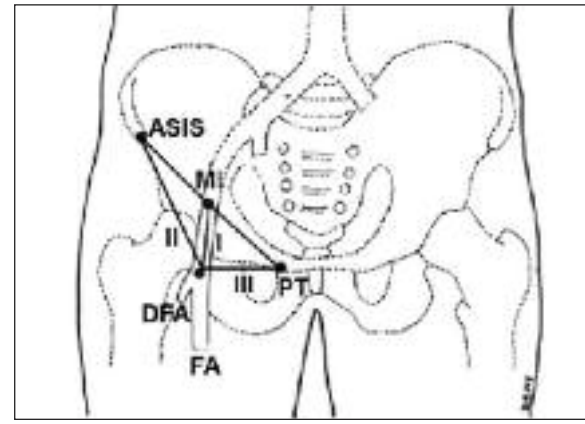

FIGURE 1: The distance of the DFA to the (I) MI, (II) ASIS and (III) PT. ASIS, anterior superior iliac spine; MI, midinguinal point; PT, pubic tubercle; DFA, deep femoral artery; FA, femoral artery.

RESULTS

The first investigation on the cadavers was the site of origin of the DFA. It was found the DFA originated from different aspects of the FA. In 117 halves (49.1%) the DFA originated from the posterior, 70 (29.4%) from the posterolateral, 42 (17.7%) from the lateral, 4 (1.7%) from the posteromedial, 3 (1.3%) from the medial and 2 (0.8%) from the anterior aspect (Table 1).

The second investigation in cadavers was the distances between:

1. The origin of the DFA and the MIP (4.2 ± 1.3 cm (range 0.4-9.1)),

2. The origin of the DFA and the ASIS (10.3 ± 1.1 cm (range 5.7-13.1)), and

3. The origin of the DFA and the PT (5.1 ± 1.0 cm (1.8-8.7)) (Table 2).

The differences between the places of origin and measurements on the right and left sides, as well as the genders, were not statistically significant ($p > 0.05$). So, obtained data were calculated and expressed as a whole.

TABLE 1: The number and frequency of places of origin of the DFA.

Sides (%)	Lateral	Posterolateral	Posterior	Medial	Posteromedial	Anterior
Present study	17.7	29.4	49.1	1.3	1.7	0.8
Adachi	36		55	9		-
Lippert&pabst	48		40	10		-
Massoud	91.4		5.9	2.7		-
Siddharth	12	40	37	2	9	-
Puerta	11.4	70.5	17.1	1	-	-
de Beer	47.8	4.4	43.3	4.4	-	-

DISCUSSION

One of the authors [ET] of this study has been investigating the FA and its branches in cadavers in our department since 1990. The number of the anatomic studies about the DFA's point of origin and its site on the FA is rather few in the literature. Furthermore, few studies could be found in the literature regarding the topometry of the origin of the DFA in cadavers.

TABLE 2: The minimum, maximum, mean values and standard deviations of the distances.

Distance	Mean ± SD	Min - max
I	4.2 ± 1.3	0.4 - 9.1
II	10.3 ± 1.1	5.7 - 13.1
III	5.1 ± 1.0	1.8 - 8.7

Distance I: MIP-origin of the DFA; distance II: ASIS-origin of the DFA; distance III: PT-origin of the DFA.

The FA is commonly used as a puncture site in diagnostic and therapeutical interventions for angiographies or angioplasties (i.e. profundaplasty) of, such as, coronary arteries, and arteries of the thigh and leg.[3,7-11] The increasing number of interventions on the FA also increases the risk of false aneurysms and arteriovenous fistulas (AVF). AVF can occur as a complication after the percutaneous transluminal coronary angioplasty.[8] Pseudoaneurysms can be seen on the DFA after surgical procedures.[12] Although they are rare, true aneurysms can also occur on the DFA.[13,14] The DFA is rather resistant to atherosclerosis. In case of occlusion of the FA due to atherosclerosis, the DFA can act as a collateral pathway to the genicular system and sustain a certain level of blood supply to the knee region.[9,15-17] The DFA is also used in plastic surgery for myocutaneus flaps and is necessary in vascular reconstructive procedures.[15] Besides, the origins of the MCFA and the LCFA are close to the origin of the DFA. Recently, these two arteries gained importance in many reconstructive flaps and coronary artery by-pass grafts.[18-23] The DFA is an important landmark for invasive, diagnostic and therapeutic angiographic procedures. Although they're rare, complications may occur during these procedures unless the anatomy of the femoral triangle is well understood. Since all of the AVFs are seen below the origin of the DFA, invasive cardiologist should try to puncture the FA between the IL and the origin of the DFA (just below the IL) to minimize the risk of the AVF and other complications such as hematoma, thrombosis, dissection, embolus, and pseudoaneurysm.[8] The information about the distance of the DFA to MIP, ASIS and PT may be helpful to clinicians to find where to puncture the FA.

Although there are not too many studies in the literature, there are some studies which examined the site of origin of the DFA (Table 1). In Adachi's study, which included 215 cases, posterior origin was observed in 119 (55%), lateral and posterolateral origin in 78 (36%) and medial and posteromedial origin in 18 (9%) cases.[24] In Siddharth et al.'s study, the most common site of origin of the DFA was posterolateral (40%); it originated from the posterior, lateral, posteromedial and medial aspects in 37%, 12%, 9%, and 2%, respectively.[3] Lippert and Pabst's ratios of origin points were as following: lateral or dorsolateral 48%, dorsal 40%, and medial or dorsomedial 10%.[1] In their angiographic

study Massoud et al. analyzed 188 FA angiograms of 94 patients according to Lippert and Pabst's classification and reported the ratios as following: lateral or dorsolateral 91.4%, dorsal 5.9%, and medial or dorsomedial 2.7%.[25] De Beer found the ratios as following: posterior 43.3%, lateral 47.8%, posterolateral 4.4%, and medial 4.4%.[26] Puerta found the ratios as 17.1%, 11.4%, 70.5% and 1%, respectively.[27] As it can be seen on Table 1, the percentages in different studies are rather inconsistent. The percentages are especially different in Massoud's study than in other studies; this difference can be attributable to its angiographic nature. Angiographic studies are not as reliable as dissection (cadaver or surgical) studies. The reasons for these unreliable results of the angiography are that in angiographic studies vessels can superimpose on each other hence can make it difficult to interpret the actual pattern, and the data from the angiography itself can't be based on a representative group of patients since obviously there was an indication for angiography. So, especially for large arteries as the DFA, cadaver dissection studies are more reliable and valuable.[1]

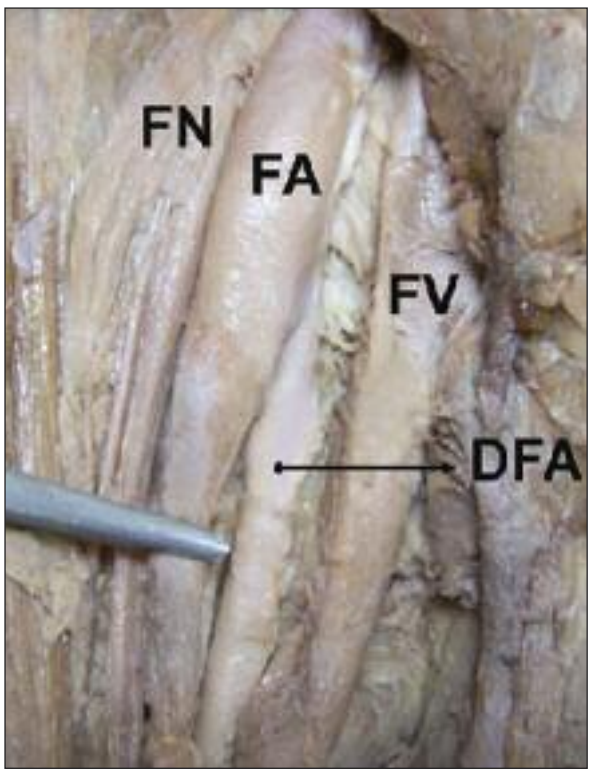

FIGURE 2: A case with medial origin. FN, femoral nerve; FA, femoral artery; FV, femoral vein; DFA, deep femoral artery.

This study reports three (1.2%) DFAs originated from the medial aspect of the FA (Figure 2). Medial origin is quite uncommon in the literature (Table 1). The results of this study are consistent with the results of Siddharth and Puerta. This study reports two (0.8%) DFAs originated from the anterior aspect of the FA, which were not reported by any other researcher. One of these cases was reported in a previous case report (Figure 3).[28] The second case was found during a thesis project of one of the authors [ET] of this study in 1994, but it wasn't reported in anywhere else before (Figure 4). While the most common site of origin of the DFA in most of the studies is either lateral or posterolateral, it was posterior in this study as in Adachi's study (Table 1).[24]

A DFA with an anterior origin should also be remembered by clinicians who are working at the inguinal region. It can be injured during the angiographic or surgical interventions, and more prone to traumas, especially when it is close to the IL. Besides, angiograms in which the FA and the DFA are superimposed in frontal view, an anterior origin of the DFA should also be considered and a lateral view should be added to find out the situation.[8,29]

In the literature, there are few topometric studies about the origin of the DFA. (Standring et al. 3.5 cm, p. 1451) While Adachi found the distance between the MIP and the origin of the DFA around 3-4 cm, Siddharth et al. found it as 4.4 cm (median distance).[3,23] Our result is 4.2 ± 1.3 cm (mean ± SD) which is consistent with the others. Another study examined the topographic relationship of the perforating and nutrient arteries and the shaft of the femur.[30] An angiographic study examined the topography of the position of the inguinal ligament because of the known risks of catheterization.[31] As these studies show, the topographies of the above mentioned structures in the inguinal region are important. Therefore, knowing the distance of the origin of the DFA to different landmarks may be of help to clinician to find the right spot to puncture in situations where the anatomy of the region is

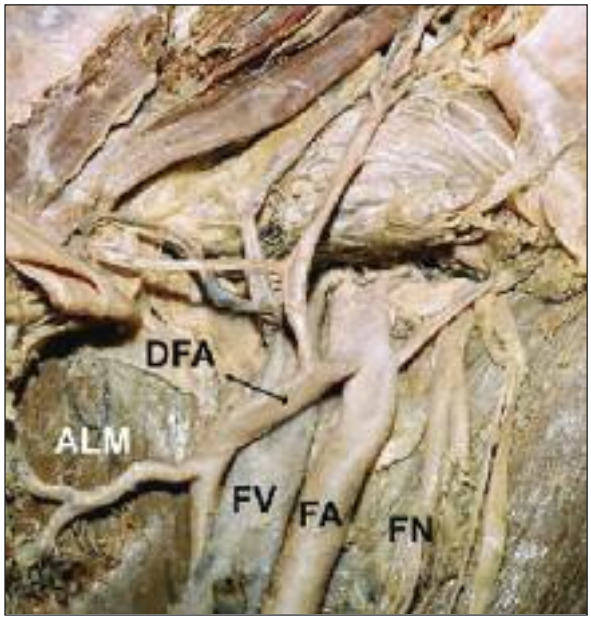

FIGURE 3: One of the cases with the anterior origin. ALM, adductor longus muscle; DFA, deep femoral artery; FV, femoral vein; FA, femoral artery; FN, femoral nerve.

difficult to understand (morbid obesity, heavily scarred tissues, extremity abnormalities etc.).

There are many studies in the literature regarding the anatomy of the DFA. Although it is possible to find similarities between the present study and the others, the present study has some differences. First, this is the largest cadaver study about the DFA in Turkey. Second, this study examined the topography of the point of origin of the DFA, which wasn't studied much. The only study, which examined the topography of the DFA, is Adachi's study, and the MIP was the only landmark in that study. In the present study, one of the aims was to find a topographic relationship between the point of origin of the DFA and certain body landmarks (MIP, ASIS, and PT) in Turkish population and compare them with the literature. Although the number of the cadavers in the present study is not sufficient to define the topography in the Turkish population, it provides some figures and shows that they are similar with Adachi's study. Third, the present study found.

The present study was conducted in a relatively large number of cadavers in Turkey. To define the topography of the branching point of the DFA, certain bony landmarks, in addition to the MIP, were chosen and the distances between those points and the DFA were measured. Also, the site of the branching point of the DFA was examined. Apart from the classical findings, some new, unrecognized patterns were found. The number of the cadaver studies on this subject is not numerous in the literature, so our findings may be helpful to clinicians who are dealing with this region.

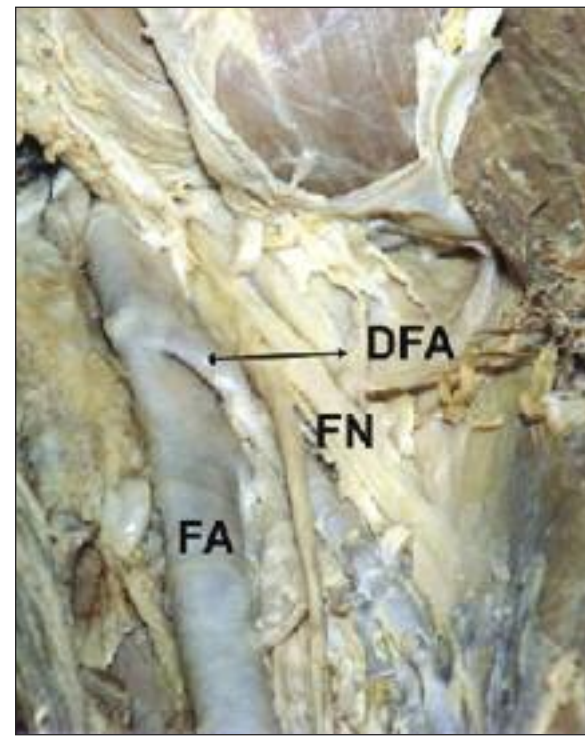

FIGURE 4: The other case with the anterior origin. FA, femoral artery; FN, femoral nerve; DFA, deep femoral artery.

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