ORIGINAL ARTICLE

Variations of the Femoral Artery Position in Relation to Femoral Vein and Mid-inguinal Point: A Cadaveric Study

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ABSTRACT

Introduction: Femoral artery is one of the major arteries in human body. It is more preference for catheterization in some medical procedures. This study was designed to identify anatomical variations of the femoral artery position, in relation to femoral vein and mid-inguinal point of human cadavers. **Methods:** Dissection was performed on 22 cadavers. The associations were analyzed using Fisher's Exact test and correlation test. **Results:** There was superolateral positioning detected. Distal traversing was only observed on the left thigh. Bivariate analysis showed that there was a significant association of distance from anterior superior iliac spine (ASIS) to femoral artery between the right and left thigh. However, there was no significant association of distance from mid-inguinal point (MIP) to femoral artery between the right and left thigh, position of femoral artery to MIP between the right and left thigh and distance of traversing point between the right and left thigh. **Conclusion:** This study showed that distance from ASIS to mid-point of femoral artery was significantly associated with the left-right sided of cadavers, while distance from MIP to femoral artery, position of femoral artery to MIP and distance of traversing point were not significantly associated with the left-right sided of cadavers. These informations may help in diagnostic cardiac catheterization procedures and coronary interventions.
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Keywords: Anterior superior iliac spine; Femoral artery; Femoral vein; Mid-inguinal point; Mid-point of femoral artery; Traversing point

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INTRODUCTION

Femoral artery is the chief artery to the lower limb (1). It is a continuation of external iliac artery, which bifurcates from the common iliac artery (1, 2). It begins its course as the external iliac artery passes below the inguinal ligament at the mid-inguinal point and descends into the femoral triangle (2). Femoral artery acts as one of the contents of the femoral triangle together with femoral vein, femoral nerve and femoral canal. It then passes vertically downward through the femoral triangle at anterior aspect of the thigh. As it reaches the apex of the triangle, femoral artery then descends into the adductor canal. It proceeds behind and later passes through the adductor hiatus at the lower end of adductor magnus. Femoral artery finally ends its course at the aperture of the adductor magnus and terminates as popliteal artery to further supply the leg and foot (2).

The anatomical knowledge of variations of femoral artery and its branches is important as it is frequently accessed by vascular surgeons and radiologists during cardiac catheterization or coronary angiogram (3, 4). The importance of femoral artery access in some of the medical procedures indicates the need of having a proper knowledge on the basic anatomy of femoral artery. However, over the years, there have been reported cases on accidental findings of the femoral artery variations, commonly during surgical incision of the thigh region (5). This proves that having only basic understanding of the anatomical position of femoral artery is not sufficient enough to prevent intraoperative complications. Hence, this study targets to identify anatomical variations of the femoral artery position, in relation to femoral vein and femoral triangle, in preserved cadavers at the Anatomical Dissection Hall, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

MATERIALS AND METHODS

Subjects

Cadavers provided at Anatomical Dissection Hall,

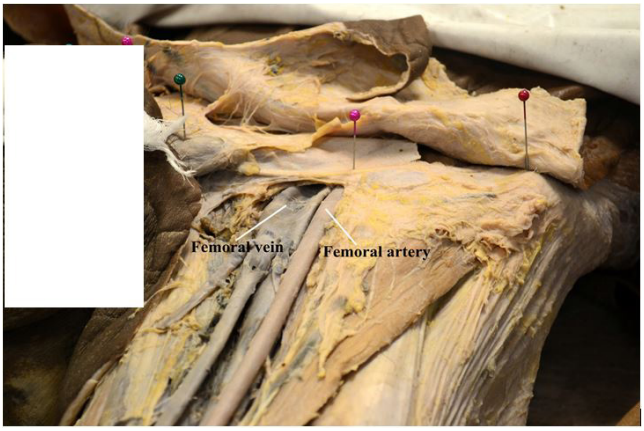
Faculty of Medicine and Health Sciences, Universiti Putra Malaysia were observed and measured on the interest femoral artery after received ethical clearance from University Research Ethics Committee Universiti Putra Malaysia (JKEUPM Ref No: FPSK9EXP15-medicU033).

Sample size

The sample size was calculated by using formula and estimated prevalence of lateral circumflex artery from femoral artery was adapted from Savithri (4).The sample size calculated was 44 lower limbs. Cadavers that were still having both right and left lower limbs attached with good condition of both thigh regions were eligible as this study's respondents.

Dissection

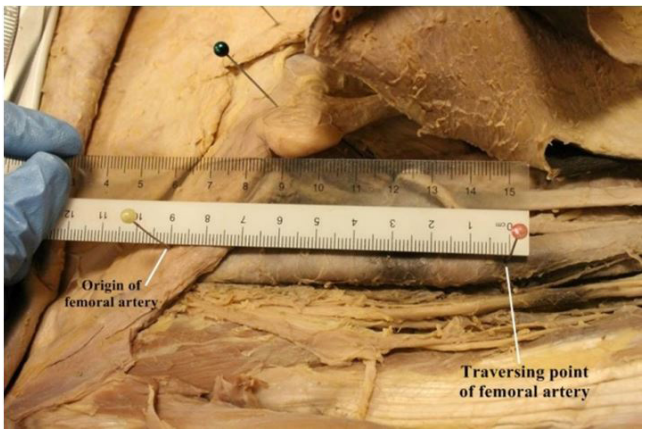
Formalin-fixed specimens were dissected on the femoral region with reference to a cadaveric study done by Dixit et al. (6). The skin was incised first and reflected, followed by cutting the superficial fascia. After reflecting the superficial fascia, superficial inguinal lymph nodes were visible enough to be identified along with the superficial vessels. Next, fascia lata (deep fascia) was cut open, thus exposing the femoral triangle. At this point, inguinal canal was identified, where the adductor longus and sartorius muscles, which formed the medial and lateral borders of femoral triangle respectively. The femoral sheath was cut open and the femoral vessels within were exposed. From here, the position of femoral artery in relation to femoral vein was observed (Figures 1). The location of femoral artery in its relation to femoral triangle was also assessed.



Figures 1 : View of lateral positioning of femoral artery in normal case. White rectangle added to close the sensitive/private area.

The second part of data collection was assessing the variation of the femoral artery in relation to the femoral triangle. The distance between the center of the anterior superior iliac spine (ASIS) and the pubic symphysis, as well as the distance between the center of the ASIS and the femoral artery, were measured using a string and a ruler (please refer to Figures 2 and 3). Besides that, we tabulated the traversing point for each femoral artery by measuring the distance between inguinal ligament and the point where femoral artery started to run above or superior to femoral vein. All measurements were recorded by single person to minimize the errors, where three readings were taken and averaged.

Figures 2 : Measuring the distance from center of ASIS to mid-point of femoral artery. Mid-point of femoral artery is center of origin of femoral artery. ASIS: Anterior superior iliac spine.



Figures 3 : Measuring the distance of traversing point of femoral artery from inguinal ligament.

Statistical analysis

Statistical calculations was performed using the standard statistical software package, SPSS 22.0 for Windows (LEADTOOLS ©, LEAD technologies, Inc, US). For the first part, the distributions of position of femoral artery in relation to femoral vein for both sides of limb were determined by frequency and percentages. As for the second part, Fisher's Exact test was used to analyse the categorical data, whereas correlation test was used for continuous data. Normal distributed continuous data was analysed using Pearson's correlation and not normal distributed continuous data used Spearman's correlation. In all statistical analyses, a p value of <0.05 (95% confidence interval) was onsidered to be statistically significant.

RESULTS

Table I showed the distribution of variation of the position of femoral artery in relation to the femoral vein, which was observed at the point directly below the inguinal ligament. In normal condition, femoral artery was located lateral to the femoral vein (Fig. 1). In the present study, there were 20 lateral positioning (90.91%) and 2 superolateral positioning (9.09%) on the right thigh, while there were 21 lateral positioning (95.45%) and 1 superolateral positioning (4.55%) in the left thigh (refer Fig. 4). No other variations such as superior, superomedial and medial variations were detected on any of the cadavers (Table I).

Table I : Distribution of position of femoral artery in relation to femoral vein for both sides of limb (n=44).

Position	Right Lower Limb		Left Lower Limb	
	n	%	n	%
Lateral	20	90.91	21	95.45
Superolateral	2	9.09	1	4.55
Superior	-	-	-	-
Superomedial	-	-	-	-
Medial	-	-	-	-

- : were not detected

Table II showed the distribution of location of traversing point of femoral artery for both sides of limb, either within the femoral triangle or within the adductor canal. In right thigh, there were 22 femoral arteries (100%) traverse femoral vein in the femoral triangle but in left thigh, 20 femoral arteries (90.91%) traverse in the femoral triangle and 2 (9.09%) femoral arteries traverse inside the adductor canal.

Table II : Distribution of location of traversing point for both sides of limb (n=44).

Location of Traversing Point	Right Lower Limb		Left Lower Limb	
	n	%	n	%
Femoral triangle	22	100	20	90.91
Adductor canal	0	0	2	9.09

Table III showed the result from correlation test where association of distance from center of anterior superior iliac spine (ASIS) to femoral artery between right and left thigh was statistically significant with p value of 0.028 ($p<0.05$) and fair degree relationship with R value of 0.468. In addition, there was no significant association of distance from mid-inguinal point (MIP) to femoral artery between right and left thigh with p value of 0.073 and fair degree relationship with R value of 0.390, from correlation test result. Spearman's correlation test result showed the association of distance of traversing point between right and left thigh was statistically not significantwith p value of 0.552 ($p>0.05$) and weakly correlated with R value of 0.134.

Table III : Correlation between variables and side of thigh of cadavers (n=44).

Independent variables	Pearson correlation r_s (p-value)
Distance from ASIS to femoral artery	0.468 (0.028)*
Distance from MIP to femoral artery	0.390 (0.073)
Independent variables	**Spearman rank correlation r_s (p-value)**
Distance of traversing point	0.134 (0.552)

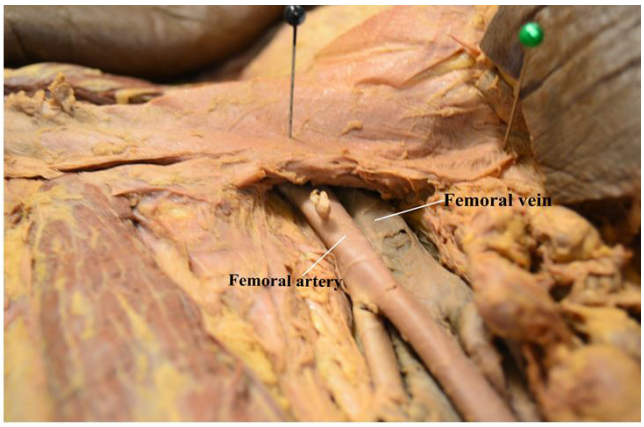
* Correlation is significant at the 0.05 level (2-tailed). ASIS: Anterior superior iliac spine; MIP: Mid-inguinal point.

Table IV showed test result from Fisher's test. The result showed no significant association of position of femoral artery to mid-inguinal point between right and left thigh as the p value is 0.292 ($p>0.05$). There were 87.5% of normal position of femoral artery to mid-inguinal point (MIP) in both sides of thigh, while there were 12.5% normal position of femoral artery to mid-inguinal point (MIP) in right thigh with lateral position of femoral artery to mid-inguinal point (MIP) in left thigh.

Table IV : Association of position of femoral artery to mid-inguinal point between right and left thigh (n=44).

Position of Femoral Artery to Mid-Inguinal Point		Left Thigh				df	χ^2	p value
		Normal		Lateral				
		n	%	n	%			
Right Thigh	Normal	14	87.5	2	12.5	1	1.273[a]	0.292
	Lateral	4	66.7	2	33.3			

df : degree of freedom; χ^2 ; chi-square value.

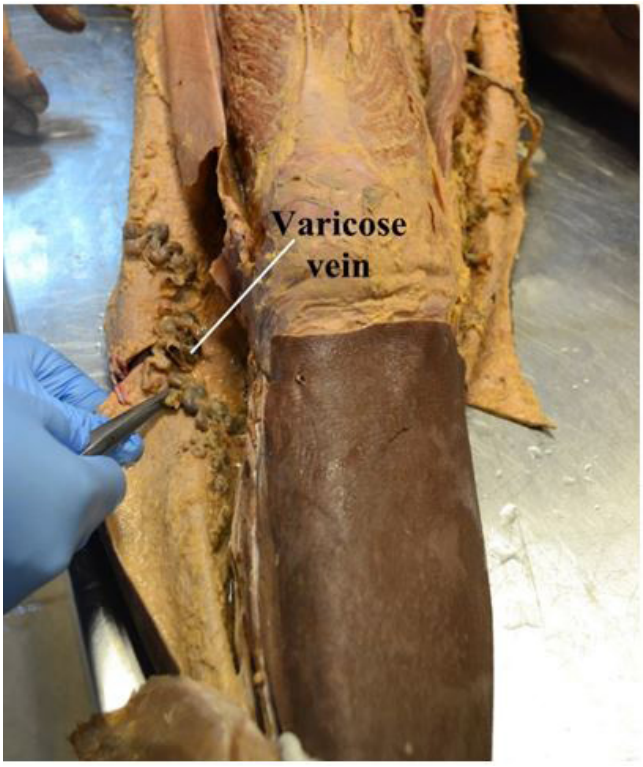


Figures 4 : View of superolateral positioning of femoral artery on the femoral vein in left limb of cadaver.

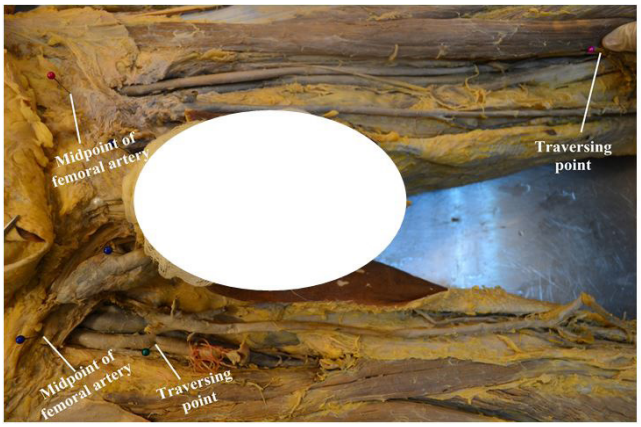
DISCUSSION

Data collection from this study showed that most femoral arteries observed were positioned laterally to the femoral veins; 90.91% (20) on right side of the lower limb and 95.45% (21) on left side. There were only three cases of superolateral variation detected (Fig. 4), whereas other variations were not detected. These findings were in line with a study done by Hughes et al. (7) where they reported that lateral positioning of femoral artery on the femoral vein was found in 72% of patients on the right side and 59% on the left side. However, different from our study, Hughes et al. (7) also detected one case of superior variation on the left side. Therefore, we can say that there are variations in the position of femoral artery and the artery should not assumed to always place lateral to the femoral vein at the level of inguinal ligament. This variation has to be noted for surgeons when plan to perform procedure involving femoral artery for example during femoral endarterectomy (remove plaque) or cardiac catheterization (8). Besides these variations, we also able to detect some abnormalities in the appearance of the involved limbs, which was believed to be related to the variations. One of the cadavers with superolateral variation was presented with varicose veins (refer Fig. 5). It was believed that the greater pressure in the artery may impinged the flow of the adjacent femoral vein and caused backflow of the venous blood and eventually resulted in varicosities of veins (like appear in Fig. 5).

There were two cases of delayed traversing whereby the femoral arteries traverse the femoral veins inside the adductor canal. A study done by Hughes et al. (7) stated that the average distance from the inguinal ligament to where the vein starts to pass behind the artery (traversing point) is 6.6 cm (range 0.0 – 11.0 cm). After comparing our data with the range provided by Hughes et al. (7), only two cases of delayed traversing have distances of traversing point of more than



Figures 5 : Varicose veins on the right limb of cadaver.



Figures 6 : View of two different of the traversing points for both sides of lower limb. Traversing point is the point where femoral artery started to run above or superior to femoral vein. White circle added to close the sensitive/private region.

11.0 cm and Figure 6 showed two different of the traversing points in the same cadaver.

Comparison between Side of Thigh of Cadavers with Distance from Anterior Superior Iliac Spine (ASIS) to Mid-point of Femoral Artery (is center of origin of femoral artery)

In the study, distance from center of ASIS to femoral artery showed significant association in between right and left thigh. It is understandable that there is association between right and left thigh as the size of two hip bones would be the same. It is unlikely that one hip bone would be smaller or larger than the

other hip bones. Standard anatomy teaching is that the femoral artery is identified midway between the ASIS and pubic symphysis which is the mid-inguinal point (1).

With the variability of femoral artery position from the usual mid-inguinal point, it can affect the definition of position of deep inguinal ring as we always know that the deep inguinal ring is lateral to femoral artery. According to the study by Sanjay et al. (9) they found that deep inguinal ring is located medial (22/30) to femoral artery, above (8/30) and never lateral which is contrary from standard teaching and this explain the difficulty in distinguishing the direct and indirect inguinal hernias preoperatively. Therefore, we believed this variation is correlated to the position of femoral artery itself.

Comparison between Side of Thigh of Cadavers with Distance from Mid-Inguinal Point (MIP) to Femoral Artery

In the study, there were no significant association between side of thigh of cadavers and distance from mid-inguinal point to femoral artery. We believed that the distance of femoral artery to mid-inguinal point in the right thigh had no relation to the distance of femoral artery to mid-inguinal point in left thigh because, the inguinal distance itself varies from one thigh to another. Mid-inguinal point is not just a point but an area. Therefore, it is not reliable to select an exact value of half of inguinal distance.

On the basis of these findings we conclude that the relationship between the mid-inguinal points, found using bony landmarks, was an appropriate guide to the common femoral artery (CFA) as it can be expected to lay within 1.5 cm either side of the mid-inguinal point (10). So, in this study, we set a range value of +/- 1.5 cm to mid-inguinal point as a normal position of femoral artery. However, with our best effort, we do not found any reference and article regarding this particular topic. Thus, our result cannot be compared with previous study to show whether it was same pattern or vice versa instead.

Comparison between Side of Thigh of Cadavers with Position of Femoral Artery to Mid-Inguinal Point (MIP)

From the result of distance from mid-inguinal point to femoral artery, we categorized them into normal, lateral and medial with reference value of +/- 1.5 cm of mid-inguinal point. In this study, there was no significant association between side of thigh of cadavers and position of femoral artery to MIP. This relation would definitely correlate with the result in previous section. We found high percentage of normal position of femoral artery which was 87.5% on both side of thigh, while the lateral position was only 33.3% also on both side of thigh. This was supported by the study from Sanjay et al. (9) that the femoral artery was consistently identified midway between the ASIS and center of pubic symphysis; mid-inguinal point. However, the position does not correlate in between right and left thigh as the measurement of inguinal distance itself was differ from one another.

Comparison between Sides of Thigh of Cadavers with Distance of Traversing Point

In this part, we manage to see a very distinctive different of distance of traversing point in between right and left thigh where in the left thigh, the traversing point is distal and deep down to the adductor canal which is a variation to its normal course, while in right thigh, the traversing point just proximal to its origin which is still in the femoral triangle. Due to this variation, the statistical analysis showed no significant association between distance of traversing point in right and left thigh.

This variation was supported by a study did by Bandyopadhyay et al. (11) who stated that the femoral artery crossed the vein just deep to the inguinal ligament so that the femoral vein was lying deep to the artery at the base of the femoral triangle. However, there was no study had been done about the relation of this variation in between right and left thigh, therefore our results cannot be compared with previous study to show whether it was same pattern or vice versa instead.

CONCLUSION

Only three cases of superolateral variation seen and other variations were not detected and only two cases of delayed traversing were detected. Fisher's Exact test and correlation tests showed that there was significant association between side of cadavers with distance from anterior superior iliac spine (ASIS) to mid-point of femoral artery. However, there was no significant association of distance from mid-inguinal point to femoral artery between right and left thigh, no significant association of position of femoral artery to mid-inguinal point between right and left thigh and no significant association of distance of traversing point between right and left thigh.

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