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Original Research Article

STUDY OF VARIATIONS IN PROFUNDA FEMORIS ARTERY AND ITS CIRCUMFLEX FEMORAL BRANCHES IN THIEL EMBALMED CADAVERS

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ABSTRACT

Introduction: Studying the possible variations of the profunda femoris artery and its circumflex femoral branches will guide surgeons and other health professionals during surgical and radiological procedures.

Methods: The study investigated variations in the vascular patterns of origin of the profunda femoris artery, the medial circumflex femoral and the lateral circumflex femoral artery in 20 (7 males and 13 females) Thiel embalmed cadavers of the Centre for Anatomy and Human Identification (CAHID), University of Dundee, Dundee United Kingdom. Distances were measured between the origin of the PFA and midpoint of the inguinal ligament, between the origins of the MCFA and PFA and from the origin of LCFA to the origin of PFA. The data were analysed with IBM SPSS.

Results: The PFA originated mostly from posterolateral aspect of the FA and the PFA was found to also originate from anteromedial side of the FA. The medial and lateral circumflex femoral arteries originated from the PFA with incidences of 47.5% and 87.5% respectively, both originated separately as a common origin with PFA and from the femoral artery.

Conclusion: Variation research can potentially reduce complications that may arise from ignorance of the ramifications in the vascular patterns. An awareness of PFA variations will help to carry out radiological interventions, to define vascular patterns, helps during orthopaedic procedures in the femoral region such as hip replacement and is also a basic requirement during femoral artery puncture to minimise cases of severe secondary bleeding.

KEY WORDS: Profunda femoris artery. Circumflex femoral branches, Thiel.

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INTRODUCTION

Study of the arterial variations of the lower limb has been an area of interest in recent years [1]. Knowledge of the anatomical variations of the femoral artery and its branches especially profunda femoris artery, the medial circumflex femoral and the lateral circumflex femoral arteries is important to reduce complications during surgical procedures[2-3].

Precise knowledge of variations in the site and pattern of the origin of the profunda femoris artery and its circumflex femoral branches is sought by clinicians to carry out radiological interventions [4].

Previous studies have widely reported profunda femoris artery to arise commonly from the posterolateral aspect of the femoral artery [2,4,5;6].

The femoral artery is the primary artery of the lower limb which enters the femoral triangle deep to the midpoint of the inguinal ligament [7]. The external iliac artery takes its course below the inguinal ligament to enter the femoral triangle on the

anterior aspect of the upper thigh and forms the femoral artery [8]. The femoral artery which lies lateral to the femoral vein forms the superficial circumflex iliac, superficial epigastric, superficial external pudendal, deep external pudendal, profunda femoris and the descending genicular as its branches [9]. The principal artery to the thigh and the largest branch of the femoral artery is the profunda femoris [7].

During its course, three perforating arteries are given off and the circumflex femoral arteries emerge from its origin [9]. The medial circumflex femoral artery (MCFA) takes a posteromedial course between pectineus and iliopsoas, enters the gluteal region where it supplies the head and neck of femur and ends where it divides into the transverse and ascending branches [7].

Anatomical variation in origin of the lateral circumflex femoral artery has been widely reported in the literature; knowledge of this variation is significant in avoiding injury to the femoral nerve branches which can result into intraoperative haemorrhage and creating sensory and motor deficits [3].The lateral circumflex femoral artery (LCFA) takes its origin from the lateral side of the profunda femoris artery and forms the ascending, transverse and descending branches [9].

OBJECTIVES OF THE STUDY

1. To identify the site of the origin of the profunda femoris and to measure the distance of the origin of the profunda femoris from the midpoint of the inguinal ligament.

2. To determine the site of the origin of the medial circumflex femoral artery and to measure the distance of the origin of the medial circumflex femoral artery from the origin of the profunda femoris or from its other variant sites of origin.

3. To identify the site of the origin of the lateral circumflex femoral artery and to measure the distance of the origin of the lateral circumflex femoral artery from the origin of the profunda femoris or from its other variant sites of origin.

4. To investigate variations in the pattern of the profunda femoris, medial circumflex femoral artery and lateral circumflex femoral artery based on the sites of their origins.

MATERIALS AND METHODS

For the study, 40 femoral triangles (20 on right and 20 on left limbs) of Thiel embalmed human cadavers were used. These were part of the cadavers used for teaching and had been previously dissected by undergraduate and postgraduate students in the Centre for Human Anatomy and Identification (CAHID), University of Dundee, Dundee. The cadavers studied were from the local Scottish population and consisted of 7 males and 13 females. The age range of the subjects used for the study was 60-100 years. Each femoral triangle was cleaned and the skin was reflected to identify the anterior superior iliac spine and pubic tubercle landmarks which were marked with coloured pins.The following distances were measured:

(i) The distance between the anterior superior iliac spine (ASIS) and pubic tubercle was measured with a ruler in centimetres (cm) and the midpoint of the distance between both landmarks was taken as a reference point (Fig.3.1).

(ii) The sites of origin of the profunda femoris artery (PFA), MCFA and LCFA branches were identified and the distance between the midpoint of inguinal ligament and the origin of the profunda femoris from femoral artery was measured (Fig. 3.2).

(iii) The distances from the origins of the MCFA and LCFA were measured from the origin of profunda femoris artery in millimetres (mm) with digital caliper.

(iv) The distances from the origins of the MCFA and LCFA were measured from the midpoint of inguinal ligament in millimetres (mm) for those which branched directly from the femoral artery with digital caliper. All measurements were carried out with accuracy of 0.02mm and recorded.

The branching patterns of the profunda femoris artery and its circumflex femoral branches were

studied based on the sites of their origins and documented. Photographs of the observed variations in the branching pattern and sites of origin of PFA, MCFA and LCFA were taken with a Nikon Coolpix digital camera (equipment from CAHID).

Intra observer reliability test was carried out by measuring distances from the origin of PFA to midpoint of inguinal ligament and from the origins of MCFA and LCFA to PFA origin three times and an average was taken for each measurement. Inter observer reliability was performed by using two other observers who repeatedly measured the distances three times.

The data were tabulated in excel software sheets and analysed by using IBM SPSS version 22 for windows. Descriptive statistics and distribution such as mean, standard error, standard deviation, range were generated by using SPSS and percentages of the incidences in the branching patterns of PFA, MCFA and LCFA from their origins were calculated by using the excel software. P value < 0.05 was considered as statistically significant for the data analysis.

RESULTS

Profunda Femoris Artery (PFA) VARIANTS:

The study involved the use of 20 cadavers where measurements were taken at the sites of origin in relation with other sites of origin and the photographs of the observed variant sites of origin were taken. Therefore, the following variations were found at the sites of origin of the profunda femoris artery (PFA), the medial circumflex femoral artery (MCFA) and the lateral circumflex femoral artery (LCFA) in relation to their respective origins.

Fig.1:The profunda femoris artery (PFA) originating from the anteromedial aspect of the femoral artery (FA).

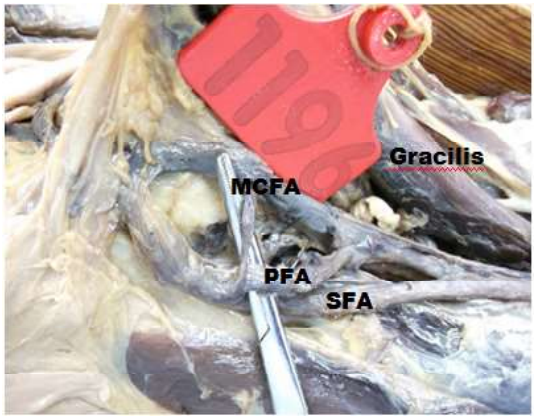

Fig.2: Medial circumflex femoral artery (MCFA) originating as a common trunk with the profunda femoris artery (PFA).

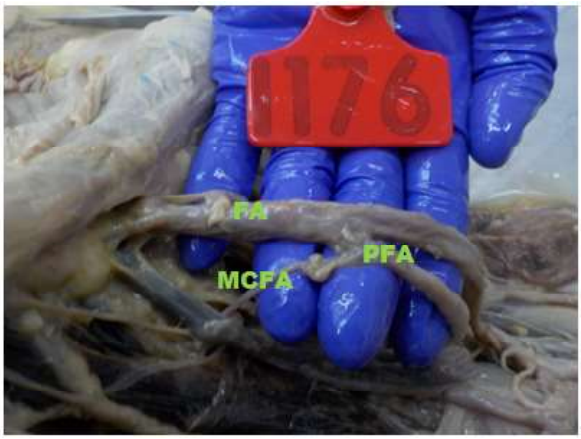

Fig. 3: Lateral circumflex femoral artery (LCFA) originating from the profunda femoris artery (PFA).

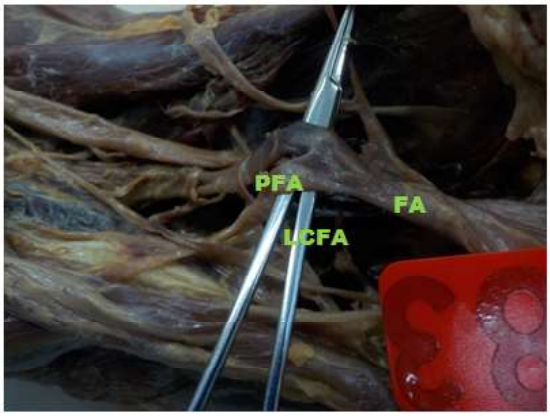

Table 1: Sites of origin of the profunda femoris artery (PFA) from the mid inguinal point (MIP).

Author	Sample Size (No of Cadavers)	Posterolateral (%)	Posteromedial (%)	Anteromedial (%)
Samarawickrama MB, et al 2009 [4]	13	30		
Priyadarisini SE, Chithra S. 2017 [10]	50	64		
Vishal K, 2014 [11]	46	65.22	10.86	-
Siriporn T, 2012 [12]	112	30.8		
Nasr AY, 2014 [2]	45	42.2		
Current study	**20**	**64.3 (M)** **57.7 (F)**	**23.1 (F)** **0 (M)**	**7.2 (M)** **0(F)**

Table 2: Sites of origin of the medial circumflex femoral artery (MCFA) from the profunda femoris artery (PFA) origin.

Author (year)	Profunda femoris artery (%)	Femoral artery (%)	Common trunk with profunda femoris artery (%)	Common origin with profunda femoris artery (%)
Siddharth P, 1985 et al. [13]	63	37		
Dixit DP, et al. 2001 [15]	62.5	37.5		
Samarawickrama MB, et al 2009 [4]	62	31	4	
Dixit D, et al. 2011 [5]	66.7	19.3	14	
Prakash, et al. 2010[1]	67.2	32.8		
Nasr AY, 2014 [2]	58.9	24.5	8.9	
Current Study	**47.5**	**25**	**5**	**12.5**

Table 3: Sites of origin of the lateral circumflex femoral artery (LCFA) from the profunda femoris artery (PFA) origin.

Author (year)	Profunda femoris artery (%)	Femoral artery (%)	Common trunk with profunda femoris artery (%)
Massoud TF, Fletcher EWL. 1997 [16]	81	2.8	
Priyadarisini SE, Chithra S. 2017 [10]	78.8	21.2	
Samarawickrama MB, et al 2009 [4]	92	-	8
Prakash, et al. 2010[1]	81.25	18.75	
Dixit D, et al. 2011 [5]		8.3	8.3
Nasr AY, 2014 [2]			14.4
Current Study	**87.5**	**2.5**	**2.5**

DISCUSSION

The study of variations in the originating sites and patterns of the profunda femoris artery and its circumflex femoral branches have been widely carried out with formalin fixed cadavers and reported in the literature. However, no known study in this area has adopted Thiel embalmed cadavers to find data comparable to the existing data in the published literature. Therefore, the current study sought to investigate the variations of the profunda femoris artery and its circumflex femoral branches based on their sites of origin and compare its findings with the results generated from the previous studies where formalin fixed cadavers were used.

Findings from the previous studies have revealed that PFA arises mostly from the posterolateral aspect of the femoral artery though it assumes other variant patterns of origin from the femoral artery (FA). The results of the present study confirm a posterolateral origin as its most common site of origin. The average distance of origin of the PFA from the midpoint of inguinal ligament on the right side was reported as 3.56 cm and 3.195cm on the left side [17].

Therefore, the PFA arises always more distally in the right limb than in the left [17]. This was concluded based on their argument that the origin of the right PFA is usually distal to the origin of the left PFA artery by 0.365cm. The current study also found an anteromedial pattern of PFA origin from the femoral artery which is rare in the literature (table 1). Surgeons must also be aware of this unexpected vascular pattern to avoid femoral artery puncture and to reduce complications that may arise from invasive vascular procedure.

Accurate data regarding the medial circumflex femoral artery (MCFA) may assist in minimising the incidence of avascular necrosis of the femoral head while embolization and the hip surgery are performed [18]. The medial circumflex femoral artery mostly originates from the PFA and less commonly from the FA [2]. The current study is consistent with this (table 3). However, higher incidences of MCFA origin from the PFA and FA origin can be seen from the previous studies if compared with the present study. This may be due to the sample size used. Also, origin of MCFA with the PFA as common trunk occurs in 5% of individuals (table 3) which is similar to the results of [4]. This incidence is very rare in the literature [2]. More importantly, it was found in

the present study that the MCFA arose as a common origin with the PFA in 12.5%cases. This is equally rare in the data available in the literature. Precise knowledge of these incidences or dispositions of the circumflex femoral arteries in relation to the PFA is helpful in femoral triangle and hip surgeryand to understand the cause of diseases affecting the proximal portion of femur [19].

The lateral circumflex femoral artery likewise originates mostly from the PFA, in the present study and in previous studies, though there is a higher incidence of its PFA origin when comparing the current study with the previous studies. Notably, this study found that the incidence of LCFA origin from the FA is very low. Comparatively, its 2.5% incidence is similar to the results of [16], who recorded an incidence of 2.8%. The genetic and environmental influence in the population where the study took place may be reasons for this disparity between the Scottish population and other populations among which the Indian population was dominant. Summarily, the incidence of MCFA that originated from the PFA far exceeds that of LCFA. The distal shift of the level of separation of PFA from the FA might be accountable for this [1]. This finding is comparable with the results of [2].Manjappa and Prasanna concluded that LCFA which arose from the common femoral artery proximal to the profunda branch could be mistaken for the profunda femoris artery during surgical and therapeutic interventions due to its wide caliber when it arose at a higher level as a separate branch from the common femoral artery.

CONCLUSION

Several studies have been carried out in the femoral region with different techniques such as imaging, cadaveric study involving dissections and others, but the study of profunda femoris artery and its circumflex femoral branches gains an increasing attention in anatomical research because of its wide applications during surgical procedures and radiological investigations. Variation research can potentially reduce complications that may arise from ignorance of the ramifications in the vascular patterns. Therefore, this study was conducted to investigate variations in the branching patterns of the profunda femoris artery and its circumflex femoral branches from their sites of origin and to measure distance from their origin in relation to their variant origins in Scottish population. The anteromedial pattern of PFA origin in this study was rare in the literature, the medial circumflex femoral artery took common origin with the profunda femoris artery with 12.5% incidence and like previous studies the circumflex arteries originated mostly from the PFA with a high incidence. The lateral circumflex femoral artery arose from the femoral artery by a low incidence from the femoral artery.

ABBREVIATIONS

FA - Femoral Artery
PFA - Profunda Femoris Artery
MCFA -Medial Circumflex Femoral Artery
LCFA - Lateral Circumflex Femoral Artery
SFA - Superficial Femoral Artery
CFA - Common Femoral Artery

Conflicts of Interests: None

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