Dissertation on

STUDY OF BRANCHING PATTERN AND SURGICAL ANATOMY OF FEMORAL ARTERY

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CERTIFICATE

This is to certify that the dissertation work on **STUDY OF BRANCHING PATTERN AND SURGICAL ANATOMY OF FEMORAL ARTERY** is the bonafide work done by **Dr.K. RAJESWARI** in the Institute of Anatomy, Madras Medical College, Chennai–600 003 during the year 2006–2009 under my supervision and guidance in partial fulfillment of the regulation laid down by The Tamil Nadu Dr.M.G.R Medical University, for the M.S., Anatomy branch V examination to be held in March 2009.

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CONTENTS

THE STUDY OF THE BRANCHING PATTERN AND SURGICAL ANATOMY OF THE FEMORAL ARTERY

INTRODUCTION

"Variability is the law of life" -

Sir William Osler.

The human features and countenance although composed of some ten parts or little more, are so fashioned that among so many thousands of men, there are no two in existence who cannot be distinguished from one another.

Variations could be external. Even if it is the same externally, variations in the internal organs could be the possibility. Here comes the knowledge of anatomy- both normal and abnormal which help the clinical scientists to avoid unexpected complications and failures.

Arteries are used by the surgeons and radiologists for many procedures of their specialities. Responsibility for teaching anatomical variations lies with the anatomist. Action in the mode of severance is the problem of the surgeon. Anatomy and surgery are forever intertwined.

Femoral artery being the artery of the lower limb, the important organ in human locomotion is one such which the above scientists come across daily in their professional life.

Apart from the above scientists, the plastic surgeons, oncologists, vascular surgeons, anaesthetists, nephrologists also encounter the femoral artery in different procedures. Hence `femoral artery being one of the most important main artery in the human body, the knowledge of variations in it will definitely enhance the ability of the above scientists. This inculcated the interest to study the different aspects of femoral artery.

The femoral artery is the continuation of external iliac artery. It begins behind the inguinal ligament midway between anterior superior iliac spine and pubic symphysis, descends along the anteromedial part of the thigh in the femoral triangle, enter and passes through the adductor canal, and becomes the popliteal artery as it passes through an opening in adductor magnus near the junction of the middle and distal thirds of the thigh. Its first three or four centimeters are enclosed with its vein, in the femoral sheath. The part of the artery proximal to the origin of profunda femoris artery is often clinically termed the common femoral, while that distal to the profunda origin is termed the superficial femoral artery. The profunda femoris artery is termed as deep femoral artery.

In the femoral triangle, anterior to the artery are the skin, superficial fascia, superficial inguinal lymph nodes, fascia lata, femoral sheath, superficial circumflex iliac vein and the femoral branch of the genitofemoral nerve. Near the apex of the triangle, the medial femoral cutaneous nerve crosses the artery from the lateral to the medial side. Posteriorly lie the femoral sheath and the tendons of psoas, pectineus and adductor longus. The femoral vein is medial to the artery in the proximal part of the triangle and becomes posterior distally at the apex.

In the adductor canal, anterior to the artery are the skin, superficial and deep fascia, sartorius and the fibrous roof of the canal. The saphenous nerve is first lateral then anterior and finally medial to the artery. Posterior are adductor longus and adductor magnus; The femoral vein is also posterior proximally, but becomes lateral distally. Antero lateral are vastus medialis and its nerve.

The superficial epigastric artery arises anteriorly from the femoral artery about 1 cm distal to the inguinal ligament. It traverses the

cribriform fascia to ascend anterior to the ligament and run in the abdominal superficial fascia almost upto the umbilicus.

The superficial circumflex iliac artery is the smallest superficial branch of femoral artery and arises near or with the superficial epigastric artery. It usually emerges through the fascia lata, lateral to the saphenous opening, and turns laterally distal to the inguinal ligament towards the anterior superior iliac spine.

The superficial external pudendal artery arises medially from the femoral artery, close to the preceding branches. Emerging from the cribriform fascia, it passes medially usually deep to the long saphenous vein, across the spermatic cord, to supply the lower abdominal, penile, scrotal or labial skin, anastomosing with branches of the internal pudendal artery.

The deep external pudendal artery passes medially across the pectineus and anterior or posterior to adductor longus, covered by fascia lata, which it pierces to supply the skin of the perineum and scrotum or labium majus.

The profunda femoris artery is a large branch that arises laterally from the femoral artery about 3.5 cm distal to the inguinal ligament. At first lateral to the femoral artery , it spirals posterior to this and the femoral vein to reach the medial side of the femur.

The descending genicular artery, the distal branch of femoral artery, arises just proximal to the adductor opening and immediately supplies a saphenous branch. One articular branch crosses above the femoropatellar surface forming an arch with lateral superior genicular artery and supplying the knee joint. The saphenous branch emerges distally through the roof of the adductor canal to accompany the saphenous nerve to the medial side of the knee.

AIM OF THE STUDY

Arterial variations are verifiable facts of human constitution that can be observed from time to time. Because of anatomic variations, surgical injuries in the living body can inadvertently and readily be made by even the most experienced surgeons.

The femoral artery is easily accessible to catheterisation and thereby to investigate any arterial system in the body. Because of the extended scopes of interventional radiology, femoral artery is widely used for arteriography, ultrasound, doppler imaging etc.

Femoral artery is used in interventional cardiology procedures such as catheterisation, invasive coronary angiogram, coronary balloon stenting etc. (Fig.1). Nephrologists also use femoral artery as an access for permanent hemodialysis.

Interventional radiologists and oncologists use femoral artery for delivering regional intra arterial chemotherapy. Regional intra arterial chemotherapy has demonstrated better response rate than systemic chemotherapy, particularly in case of liver metastasis.

In atherosclerotic arterial disease, sometimes the femoral artery may get involved, in which case vascular surgeons correct the damage by doing femoro popliteal bypass graft.

One of the of the branches of femoral artery namely the superficial external pudendal artery may have variable relationship with the arch of great saphenous vein. Misappreciation of the anatomical variation may lead onto the recurrences after surgical treatment of varicose veins of the lower limb.

The femoral artery also serves as an important landmark for femoral nerve block for anaesthetists.

Plastic surgeons uses many musculo cutaneous flaps based on femoral artery branches for various purposes. A recent advance in microvascular surgery has made direct transfer of free groin skin flaps clinically possible, which is mostly based on superficial circumflex iliac artery and superficial epigastric artery. Also defects in lower abdomen can be repaired with groin flap which is based on superficial circumflex iliac artery and can be rotated to cover the lower abdomen.(Fig.2). The flaps supplied by superficial external pudendal artery are used in the procedure of phalloplasty for reconstructions of male genitalia.

Orthopaedicians employ vastus oriented approaches to preserve the descending genicular artery because traditional medial parapatellar arthrotomy disturbs the patellar blood flow and extensor mechanism, which in turn may lead on to the patellar fracture. Knowledge of circumflex femoral arteries is also essential when undertaking clinical procedures within the femoral region and in hip joint replacement.

The profunda femoris artery is frequently incorporated in vascular reconstruction procedures in the proximal leg. The knowledge of site of origin of profunda femoris artery helps in avoiding iatrogenic femoral arteriovenous fistula while performing femoral artery puncture.

Since femoral artery has vast clinical applications in almost all fields of medicine, it is crucial to know the arterial characteristics of lower extremity before proceeding with any interventional or surgical procedure.

Due to the above said reasons, I have made an effort to study the femoral artery, its branching pattern and variations, with its clinical application

under the following parameters:

1. Origin of femoral artery in relation to mid inguinal point.
2. Diameter of femoral artery.
3. Relationship between femoral artery and femoral vein.
4. Origin of the superficial circumflex iliac artery.
5. Origin of the superficial external pudendal artery.
6. Relationship of superficial external pudendal artery and arch of great saphenous vein at the saphenofemoral junction.
7. Origin of the superficial epigastric artery.
8. Origin of the deep external pudendal artery.
9. Origin of the Profuda femoris artery.

i. Level of origin of profunda femoris artery in relation to the inguinal ligament.

ii. Site of origin of profunda femoris artery/ lateral/posterolateral/ medial to femoral artery.

10. Origin of the Descending genicular artery.
11. Presence of abnormal branches arising from femoral artery.

REVIEW OF LITERATURE

1. ORIGIN OF FEMORAL ARTERY IN RELATION TO THE MID INGUINAL POINT

Henry Gray (1858) quoted that the femoral artery is the continuation of external iliac artery, behind the inguinal ligament, mid way between the anterior superior iliac spine and pubic symphysis

George A. Piersol (1907) said that femoral artery is the continuation of the external iliac artery below the inguinal ligament and may be indicated by a line drawn from a point in the inguinal ligament, mid way between pubic symphysis and anterior superior iliac spine of ilium

J.D.Boyd, W.J.Hamilton (1956) et al stated that external iliac artery passes downward and outwards to a point midway between anterior superior iliac spine and pubic symphysis, behind the inguinal ligament, where it becomes the femoral artery.

Sir John Bruce, Robert Wamsley, James A Ross (1964) quoted that femoral artery enters the thigh behind the inguinal ligament at a point midway between symphysis pubis and anterior superior iliac spine (mid inguinal point).

Barry J. Anson, Chester B. McVay (1971) said that femoral artery ,a direct continuation of the external iliac artery, enters the thigh behind the inguinal ligament midway between anterior superior iliac spine and pubic tubercle.

Richard.S.Snell (1973) stated that femoral artery enters the thigh by passing behind the inguinal ligament midway between anterior superior iliac spine and pubic symphysis as a continuation of the external iliac artery.

Keith.L.Moore (1980) quoted that the femoral artery is the chief artery to lower limb is the continuation of the external iliac artery begins at the inguinal ligament, mid way between the anterior superior iliac spine and pubic symphysis.

Jeremy A. Hunt, John P. Harris (1996) had undertaken the study to determine the accuracy of mid inguinal point as a guide to the common femoral artery in patients undergoing femoral angiography and measured the distance between the anterior superior iliac spine and pubic symphysis with calipers and defined as inguinal distance [(mean $\pm$ s.d) 16.03 $\pm$1.06 cm; range 14.00-18.50].The mid point of this line is defined as the mid inguinal point .Similarly the distance was measured from the symphysis pubis to the mid point of the common femoral artery, where it crossed the inguinal line on the arteriogram and was defined as the femoral distance [(mean $\pm$ s.d) 7.99 $\pm$ 0.51cm; range 6.80-9.00]. The location of the common femoral artery coincided with mid inguinal point in only six (10%) of the sixty measurements. The difference between the common femoral artery and mid inguinal point varied from 1.25-1.50 cm either side of mid inguinal point and in six (10%) the difference was 1cm or more and therefore of clinical significance.

On the basis of these findings , they concluded that the relationship between the mid inguinal point and the common femoral artery is not exact in vascular patients undergoing arteriography. The mid inguinal point, found using bony landmarks, is an appropriate guide to the common femoral artery, as it can be expected to lie within 1.5cm either side of mid inguinal point.

Haimovici's (2004) in his book of vascular surgery quoted that femoral artery enters the thigh midway between anterior superior iliac spine and pubic tubercle, as a direct continuation of the external iliac artery.

Dr.P.D. Scott, P.C.T.Willian (2005) studied in 40 cadaveric limbs, the surface marking of both the deep inguinal ring and the femoral artery found

them to lie closer to mid inguinal point than to the midpoint of the inguinal ligament, which lay lateral to both structures considered. Usually the femoral artery was located laterally to the medial margin of the deep inguinal ring but occasionally lay medial.A single surface marking namely mid inguinal point is suggested for both the femoral artery and the deep inguinal ring on grounds of accuracy, simplicity and ease of identification.

2. DIAMETER OF THE FEMORAL ARTERY.

Schnyder et al (2004) demonstrated that the mean diameter of the common femoral artery as assessed by quantitative femoral angiography is lower in women compared to men (6.0 $\pm$ 1.0mm vs 7.5 $\pm$1.2mm; $p < 0.0001$).Also the minimal luminal diameter of common femoral artery was lower in women(5.1$\pm$1.1 mm vs 6.3 $\pm$ 1.2mm; p 0.0001). This may explain their findings, because intra arterial placement of a closure device component (eg- anchor or inadvertently collagen plug) may increase the likelihood of symptomatic luminal obstruction in women with the smaller arterial dimensions.

Marina Baptist, Ferdose Sultana, Tassaduq Hussain (2007) dissected 20 adult male cadavers and the internal diameter of the femoral artery was measured with the radial calipers after injecting it with gelatin and undiluted Indian ink in 40 femoral triangles and found that the internal diameter of the femoral artery ranged between 6-10mm.

3. RELATIONSHIP BETWEEN THE FEMORAL ARTERY AND FEMORAL VEIN

Henry Gray-(1858) quoted that the femoral vein accompanies its artery beginning at the adductor opening as a continuation of the popliteal vein. In the distal adductor canal it is posterolateral to the femoral artery more proximally

in the canal and in the distal femoral triangle (its apex) it is posterior to it, proximally at the base of the triangle, it is medial.

Prof. A.M.Buchannan's (1906) said that immediately distal to the inguinal ligament , the femoral vein lies to the medial side of the artery ,but as the vein inclines obliquely towards the lateral side relative to the artery and below occupies a deeper plane, it lies posterior to the artery in the distal part of the triangle. In the distal part of the sub sartorial canal, femoral vein is posterior and to the lateral side .

Barry J.Anson ;Chester B Mcvay (1971) quoted that the femoral vein lies medial to the femoral artery at the inguinal ligament and from there assumes a posterior position. Occasionally it is found anteriorly or laterally. In the adductor canal the femoral vein is bound closely to the femoral artery by connective tissue which at first lies posterior to and then slightly to the lateral side of the artery.

Keith L.Moore-(1980) stated that the femoral artery enters the femoral triangle deep to the midpoint of the inguinal ligament, lateral to the femoral vein. As the femoral vein ascends through the adductor canal it lies posterolateral and then posterior to the artery.

Phillip. A.Baum, A.H.Matsumoto, G.P.Teitelbaun, R.A.Zuubier and K.H.Barth (1989) assessed variations in the relationship between common femoral artery and adjacent common femoral vein by reviewing the inguinal region of 100 computed tomographic scans of the pelvis (200 vessel pairs).

The results of their study showed that the center of the common femoral artery was anterior to its corresponding vein in 78% of the vessel pairs studied. The centre of the common femoral vein was never anterior to its adjacent artery. In contrast to the classical description there was some overlap of the

common femoral artery and the common femoral vein in the antero posterior plane in 65% of the vessel pairs analysed.

In addition more than 25% of the artery overlapped the vein, in 8% the vessel pairs. High bifurcation of common femoral artery at the level of mid femoral head was observed in 5.5%

The variation in the anatomic relationship between common femoral artery and common femoral vein is clinically significant since femoral vein puncture can be associated with simultaneous passage of the entry needle through the artery and thus formation of arteriovenous fistula

B.Sahin and S.Bilgic, (1998) found 2 rarely reported variation of deep femoral artery from 100 lower extremities studied, one case of a duplicated deep femoral artery was observed in right lower limb of male new born cadaver(1%).

In another case a deep femoral artery passing in front of the femoral vein was found in left lower limb of a new born male cadaver(1%).

D.Hughes, C.Scott and A.Bodenham (2000) . studied 50 consecutive admissions to general or neurosurgical ICU patients who were examined supine by one of the authors using a portable ultrasound machine and 7.5 MHz linear probe. The vessels were easily visualized in all but in one patient.

In most of the patients there was some degree of overlap of the artery over the vein. The frequency and degree of overlap increased as the vessel descended into the thigh.

At the level of inguinal ligament in the majority of the patients there was no vessel overlap observed (in 72% of patients on the right side and 59% on the left side).

In virtually all the patients 4cm below the ligament some degree of overlap was observed (in 100% of patients on the right side and 96% on the left side) and in approximately half of the patients the overlap was complete.(50% and 45% on right and left side respectively).

Faith Kantarci, M.B., Ismail Mihmanli et al (2003) reported an extremely rare arterial variation, duplication of superficial femoral artery in terms of radiological findings, clinical importance and embryologic basis in a 60 year old male patient with bilateral intermittent claudication..

On gray scale examination of right lower extremity, it was seen that below the origin of profunda femoris artery, the superficial femoral artery was dividing into two trunks, which were coursing adjacent to each other until reaching adductor canal, where they reunited to form the distal superficial femoral artery. Colour doppler ultrasonography revealed the flow in 1 limb of duplicated artery throughout its course. However flow was shown just at the proximal 1/3 of the other limb and was absent thereafter.

The superficial femoral vein was identified lying posterior to the duplicated superficial femoral artery and was normal on colour doppler ultrasonography.

MRI angiography showed that one limb of the duplication was normal in diameter and contour, where as other limb was occluded approximately 10cm after its origin. MRI showed that the superficial femoral artery was duplicated below the origin of the profunda femoris artery. One limb of the duplication was normal in diameter and contour whereas the other limb was occluded approximately 10 cm after its origin. However reunion of these vessels could not be made on MR angiography.

A.Vani and S.Saritha (2004) During their routine dissection of lower limb came across a female body with 2 variations One variation is that femoral

vein lies lateral to artery in the upper part of the femoral triangle and at the apex posterior to femoral artery and the other is the bilateral variation of the origin of pofunda femoris artery from the lateral side of the femoral artery opposite to the inguinal ligament.

4. ORIGIN OF THE SUPERFICIAL CIRCUMFLEX ILIAC ARTERY

Henry Gray (1858) quoted in Gray's Anatomy that superficial circumflex iliac artery is the smallest and superficial branch of the femoral artery and arises near or with the superficial epigastric artery.

Morri's (1893) quoted that the superficial circumflex iliac artery arises common in the superficial epigastric or as a separate branch for femoral and is usually smaller than the superficial epigastric artery

Buchannan's (1906) said that the superficial circumflex iliac artery may arise in common with the superficial epigastric artery immediately distal to the inguinal ligament.

George A.Piersol (1907) stated that superficial circumflex iliac artery (a circumflexa ilium superficialis) arises from the anterior surface of the femoral artery, a little below the superficial epigastric artery or from a common trunk from that artery.

Henry Hollinshead (1958) said that the main sub cutaneous arteries in the thigh are superficial epigastric artery, superficial circumflex iliac artery and the superficial external pudendal artery arise from the upper part of the femoral artery. These vessels all arise close together, sometimes by a stem common to two or all three of them from the upper few centimeters of the femoral artery. The superficial circumflex iliac artery arises independently from the femoral artery it tends to come from the lateral aspect of this, at the

level or only slightly distal to the origin of superficial epigastric. The superficial circumflex iliac artery is usually the smallest of the 3 branches.

Taylor & Daniel (1975) studied the anatomy of 400 cases of groin flaps and found that

1. 48% had a common trunk for 2 groups of arteries

2. 35% had a deficient superficial epigastric artery and had only superficial circumflex iliac artery

3. 17% had both the arteries arising from femoral artery while in another 17% it arises from profunda femoris artery

From 20 operated cases the authors found that

1. 3 cases(15%) had 2 group of arteries arising from a common trunk.

2. 9 cases(45%) had 2 group of arteries arising individually from femoral artery.

3. 5 cases (25%) had absence of superficial circumflex iliac artery with only superficial epigastric artery present.

4. 3 cases(15%) had a common trunk for superficial epigastric artery and superficial pudendal arteries.

Ti-Sheng Chang ,Sheng-Hsui Chu, Chung-Cheng Wang (1986) said that the skin of the groin is supplied by 2 separate systems of vessels- superficial inferior epigastric vessels and superficial circumflex iliac vessels. The superficial circumflex iliac artery originates from the lateral side of the femoral artery 0.5 to 3 cm below the inguinal ligament.

Robert J. Allen, Andreas S.Heitland ,(2002) the authors investigated the anatomy of superficial inferior epigastric artery in 100 cadavers. They reported the artery present in 72% of groins. In 55% the artery is present in both the groins. In 79% superficial inferior epigastric artery and superficial circumflex iliac artery arise as a common trunk , 2 cm below the inguinal ligament.

Mangala.M.Pai, Latha,V.Prabu, Prakash, Varsha Nayak (2006) During their routine dissection, an iliofemoral arterial malformation was noticed in 65 year old male cadaver.

They found that a thin twig originated from femoral artery distal to profunda femoris artery from its anteromedial aspect divided into 3 branches superficial epigastric artery, superficial and deep external pudendal arteries. The superficial circumflex iliac artery was conspicously absent.

M.Remya and K.Gopinathan. (2007) in the right lower limb of one of the male cadavers noticed an unusual pattern of femoral artery where just below the mid inguinal point, superficial circumflex iliac artery was seen arising from the lateral side of femoral artery.

5. ORIGIN OF THE SUPERFICIAL EXTERNAL PUDENDAL ARTERY

Henry Gray (1858) quoted superficial external pudendal artery arises medially from the femoral artery, close to superficial inferior epigastric artery and superficial circumflex iliac artery.

George A.Piersol (1907) stated that superficial external pudendal artery arises from the medial surface of the femoral artery and is directed medially and slightly upwards towards the spine of the pubis.

M.Castro, E. Brenda, A.Marques, M.D.Pererria (1998) They dissected 20 cadavers and injected Indian ink into external pudendal artery. In one case, the dye extended beyond the scrotal raphe staining the opposite scrotum. They found that the external pudendal artery was a single vessel in 55% of case , double in 30% and with a common trunk with a superficial inferior epigastric artery in 15%. The diameter length of the pedicle vessels and their constant anatomy suggest that anterior scrotal region may be used as a donar site for a micro vascular flap.

Osvaldir Lanzoni La Falce, Joao Dias Ambrosia ,Romer Rodrigues (2006) they conducted a quantitative investigation of superficial external pudendal artery for skin grafts. They dissected 25 right and left sides of the inguinal region of male cadavers and analysed about superficial external pudendal artery. The results were the following:

i. superficial external pudendal artery was found in 46 of 50 cases.—92%

ii. They originated from femoral artery in 45 cases and from profunda femoris artery in only one case.

iii. The artery was found duplicated in 21 cases-46%

as a common trunk in 11 cases –24%

and as a single artery in 14 cases—30%

They concluded that superficial external pudendal artery generally originates from the femoral artery. It was found as a common trunk, duplicated or as a single trunk. Most of data showed no significant differences between the right and left sides.(Fig.7).

6. RELATIONSHIP OF SUPERFICIAL EXTERNAL PUDENDAL ARTERY AND ARCH OF GREAT SAPHENOUS VEIN AT SAPHENOFEMORAL JUNCTION

Henry Gray(1858) stated that superficial external pudendal artery emerging from the cribriform fascia, passes medially usually deep to the long saphenous vein across the spermatic cord or round ligament to supply the lower abdominal, penile, scrotal and labial skin anastomosing with branches of the internal pudendal artery.

M.Donnelly. S. Tierney; T.M. Feeley (2005) studied the anatomy of sapheno femoral junction, tributaries and the relationship of the external pudendal artery to the saphenous vein in their 2089 groin dissections and recorded that the external pudendal artery was not visualized in 1527 (73.1%) of dissections where identified it lay anterior to the long saphenous vein in 350 dissections (16.8%) and above the sapheno femoral junction in 24 (1.1%).

External pudendal artery crossed behind a ascending tributary and anterior to the long saphenous vein in 96 dissections (4.6%).

Ass Ndaiye, Abd Naidye; J.M.Ndoye, O.Diarra, M.Diop; A.Diarra, M.Diop, **A.Dia, M.Ndaiye and M.L.Sow (2006)** . They dissected 54 inguinofemoral region of fresh black African corpuses. An anterior saphenous vein was found in 23 cases (42%).The external pudendal artery crossed beneath the arch of great saphenous vein in 56% of cases & previously in 44% cases. They also stated that knowing and taking them into account are essential to prevent recurrences after surgical treatment of varices of the pelvic limb.

Preethi 2008 recorded the relationship of the superficial external pudendal artery and the great saphenous vein in 50 specimens and found that in 37 cases (74%) the superficial external pudendal artery was not visualized at the sapheno femoral junction. In 8 cases (16%) the superficial external

pudendal artery was found to be posterior to the great saphenous vein. In 5 cases (10%) the superficial external pudendal artery was anterior to the great saphenous vein.(Fig. 8 and 9).

7. ORIGIN OF THE SUPERFICIAL EPIGASTRIC ARTERY

Henry Gray (1858) said that superficial epigastric artery arises anteriorly from the femoral artery distal to the inguinal ligament.

D.J.Cunningham's (1902) in Cunningham textbook of anatomy said that superficial epigastric artery, one of the branches of the femoral artery arises near the superficial circumflex iliac artery

R.J.Last (1954) in Last's anatomy said that superficial epigastric artery is one of the four cutaneous branches of the femoral artery and was found in the sub cutaneous tissue below the inguinal ligament. It may pierce the fascia lata or emerge through the saphenous opening. It crosses the inguinal ligament and distributed towards the umbilicus to the skin and fat of the lower abdominal wall.

Henry Hollinshed(1958) in anatomy for surgeons said that superficial epigastric artery tends to arise from the anterior surface of femoral artery.

Richard S. Snell (1973) said that the superficial epigastric artery is a small branch that passes through the saphenous opening, crosses the inguinal ligament and runs to the region of umbilicus.

Taylor and Daniel (1975) studied the anatomy of 400 cases of groin flaps and found that

1. 48% had a common trunk for 2 groups of arteries superficial epigastric vessels and the superficial circumflex iliac vessels.

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Robert J. Allen, Andreas S.Heitland ,(2002) the authors investigated the anatomy of superficial inferior epigastric artery in 100 cadavers. They reported the artery present in 72% of groins. In 55% the artery is present in both the groins. In 79% superficial inferior epigastric artery and superficial circumflex iliac artery arise as a common trunk, 2 cm below the inguinal ligament. (Fig.10)

M.Remya and Gopinathan (2007) noticed an unusual branching pattern of the femoral artery in right lowerlimb of one of the adult male cadavers where the superficial epigastric artery and superficial external pudendal artery were seen arising from a common trunk from the medial side of femoral artery

8. ORIGIN OF THE DEEP EXTERNAL PUDENDAL ARTERY

Henry Gray (1858) stated that deep external pudendal artery one of the branches of the femoral artery in the proximal thigh passes medially across the pectineus anterior or posterior to adductor longus covered by fascia lata which it pierces to supply the skin of the perineum and scrotum.

A.M.Buchannan's (1906) said that the deep external pudendal artery one of the cutaneous arteries of the groin is larger arises at a more distal level from the femoral artery and on the deeper plane than the superficial external pudendal artery.

George A. Piersol (1907) quoted that deep external pudendal artery arises from the medial surface of the femoral artery either a little below the superficial external pudendal artery or in common with that vessel.

Russel T.Woodburne(1957) quoted that deep external pudendal artery arises from the medial aspect of femoral artery lies on pectineus and adductor longus muscles.

Sir John Bruce, Robert Wamsley, James A. Ross (1964) stated that deep external pudendal artery arises from the femoral artery near its origin. It runs medially either in front of or behind the femoral vein and in front of pectineus and after piercing deep fascia and passing deep to spermatic cord, supplies the skin of the scrotum or labium majus.

Barry J. Anson,Chester B. Mcvay(1971) stated that deep external pudendal artery is derived from the medial aspect of femoral artery and courses medially over the pectineus and adductor longus

9. ORIGIN OF THE PROFUNDA FEMORIS ARTERY

Quain (1844) In 430 thighs, Quain found that the distance from the inguinal ligament and the origin of the profunda femoris artery was

< 2.5cm in 24.6%

2.5 and 3.8 cm in 42.6%

3.8-5.1 cm in 25.34%

more than 5.1cm in 7.4%

According to him, the profunda femoris artery arises from the lateral side of the femoral artery in most of the cases, but sometimes medially, rarely from the posterior aspect of the femoral artery.

Henry Gray (1858) said that profunda femoris artery is a large branch arises laterally from the femoral artery 3.5cm distal to the inguinal ligament.

Morris (1893) quoted that profunda femoris artery arises 4 cm beyond the inguinal ligament from the back and the lateral part of the femoral artery.

Schrutz (1894) described a case in which profunda passed medially across the fronts of the femoral artery and vein to reach its normal position thus forming an arterial circle about the saphenofemoral junction.

George A. Piersol (1907) quoted that profunda femoris artery arises laterally from the femoral artery about 4 cm below the inguinal ligament.

Johnston (1912) described a case in which the profunda first ran laterally across the fronts of the femoral vessels. In such instances as this, the exposure of saphenous vein for ligation of it at its junction with the femoral vein carries the risk of damage to a large and unexpected arterial channel.

R.J. Last (1954) said that profunda femoris artery arises from the lateral side of the femoral artery about 4 cm (1½ inches) below the inguinal ligament.

Russell T. Woodburne (1957) said that profunda femoris artery arises 5 cm below the inguinal ligament from the lateral side of the femoral artery.

W.Henry Hollinshed (1958) said that profunda femoris artery is the largest branch of the femoral artery and is usually given off at the posterolateral aspect of this artery, fairly high in the femoral triangle, approximately at 4-5 cm below the inguinal ligament.

Lockhardt Hamilton (1959) said that profunda femoris artery arises from the lateral side of the femoral artery an inch and a half beyond the inguinal ligament.

Harold Ellis (1960) said that profunda femoris artery arises from 2 inches (5cm) distal to the inguinal ligament.

Sir John Bruce, Robert Wamsley, James A. Ross (1964) said that profunda femoris artery arises 4 cm distal to the inguinal ligament and descends at first laterally and then posterior to the femoral vessels.

D.J.Cunningham (1964) said that profunda femoris artery is the largest branch of the femoral artery, arises from the lateral side at a somewhat variable level, but usually 4 cm distal to the inguinal ligament.

Barry J. Anson, Chester B Mcvay (1971) said that profunda femoris artery usually branches from common femoral artery about 4 cm below the inguinal ligament and in its descent, it is first lateral and then posterior to the superficial femoral vessels.

Robert B. Rutherford (1976) said that common femoral artery divides into deep and superficial femoral artery approximately 4cm distal to the

inguinal ligament originating from the parent vessel, the deep femoral artery courses posterior to the superficial femoral artery and vein.

Keith L.Moore, Arthur F Dalley (1980) said that profunda femoris artery is the largest branch of the femoral artery and is the chief artery of the thigh, arises in the femoral triangle, from the lateral side of the femoral artery, 1-5 cm inferior to inguinal ligament.

John L. Cameron (1984) current surgical therapy said that common femoral artery divides into superficial and deep femoral artery about 3-5 cm inferior to inguinal ligament.The deep femoral artery arises from the posterolateral aspect of the common femoral artery

Padmanabhan Siddharth, Noel L.Smith, Robert A Manson , Fabio Giron (1985) dissected 100 legs to study the branching variation of the deep femoral artery, which is frequently incorporated in vascular reconstructive procedures. They dissected 100 legs and classified the anatomical patterns. They reported that deep femoral artery originates at a median distance of 4.4cm from the inguinal ligament.

Renan Uflacker (1997) said that arteria profunda femoris artery is the largest branch of the femoral artery has its origin about 3.5cm below the inguinal ligament. It arises laterally and posteriorly from the femoral artery.

T.F.Massoud and E.W.L. Fletcher (1997) assessed normal lower limb angiograms of 94 adult patients and said that profunda femoris artery is situated lateral or posterolateral to the femoral artery.

Dixit Metha L.A.Kothari (2001) dissected 48 femoral triangles in 24 human cadavers. They said that profunda femoris artery originated from the posterolateral aspect of the femoral artery in 17 out of 48 cases (ie) 35.41% and from the posterior aspect in 15 out of 48 cses ie 31.25%

The distance from the mid point of the inguinal ligament on the right side was mostly between 41 and 52mm whereas on the left side it was between 46 and 54mm.

Vani and Saritha (2004) during their routine dissection of the lower limb, they came across a female body with 2 observations. One being the bilateral variation of the origin of the profunda femoris artery from the lateral side of the femoral artery, opposite to the inguinal ligament. The profunda femoris artery then descends lateral to the femoral vessels to the apex of the femoral triangle and it disappeared posterior to the femoral vessels, then behind adductor longus.

Dr.Bharat Trivedi, (2005) During the routine cadaveric dissection of lower limbs in an old male cadaver found the right femoral artery is the continuation of the external iliac artery at the mid inguinal point. Arteria profunda femoris is a large branch arising laterally from about 3 cm distal to the inguinal ligament and left external iliac artery terminates into femoral artery and arteria profunda femoris opposite the inguinal ligament.

Important peculiarity from the surgical point of view is related to the height at which the vessel arises.

Main aim which prompted this study is unusual variation of the profunda femoris artery is due to expanded scope in interventional radiology.

Ercan Tanyeli, Mehmet Yilidirim, Mehmet Uzel, Feridun Vural (2006). during their routine dissection of 72 year old male cadaver found that the deep femoral artery was originating from the anterior aspect of the femoral artery and the inferior epigastric artery and the external pudendal artery were arising from the deep femoral artery.

Mangala M Pai et al (2006) noted that during their routine dissection of 65 year old male cadaver noticed that the femoral artery gave the profunda femoris artery about 1.2cm below the inguinal ligament which was considered proximal to its usual level of origin. The profunda femoris artery originated as the first branch of the femoral artery

Marina Baptist,Ferdose Sultana, Tassduq Hussain (2007) They dissected 20 adult male cadavers and the 40 femoral triangles exposed the femoral artery and profunda femoris artery. In 12-14 cases ,the origin of profunda femoris artery was located between 20 -40 mm from the mid point of the inguinal ligament. In 6-8 cases profunda femoris artery originated lower down in the thigh than the common location.

10. ORIGIN OF THE DESCENDING GENICULAR ARTERY

Henry Gray(1858) quoted that the descending genicular artery the distal branch of the femoral artery arises just proximally to adductor opening, immediately supplies a saphenous branch.

A.M.Buchannan's (1906) said that the descending genicular artery (arteria genu suprema) arises from the femoral artery towards the distal end of subsartorial canal and divides into saphenous and musculo articular branch..

George A. Piersol (1907) said that the highest genicular artery arises from the femoral artery just before it passes through the adductor magnus. The highest genicular artery is occasionally given off from the upper portion of popliteal artery.

Russell T.Wood Burne (1957) quoted that the descending genicular artery arises from femoral artery just before femoral artery passes through the

adductor hiatus. The descending genicular artery immediately divides into saphenous and articular branches.

W.Henry Hollinshed (1958) Just before the femoral artery penetrated the adductor magnus it gives off its last branch, the descending genicular artery, which is usually the only one arising in the adductor canal.

Renan Uflacker (1997). He stated that the descending genicular artery branches off from the superficial femoral artery, before the adductor canal and anastomoses with the medial superior genicular artery.

Umar H Choudry, Karim Bakri et al (2008) quoted that the origin of the descending genicular artery is just prior to the adductor hiatus. It divides into 3 branches, an articular , a muscular and a saphenous branch. The articular branch ends in the periosteum of the femoral condyle. The saphenous branch supplies the overlying skin in the region of the medial knee and this branch may be dissected to preserve a skin paddle with the bone flap. The muscular branch supplies blood to vastus medialis.(Fig.12)

11. PRESENCE OF ABNORMAL BRANCHES FROM FEMORAL ARTERY

Henry Gray (1858) quoted that the lateral circumflex femoral artery is a laterally running branch given off at the root of the profunda. It may arise from the femoral artery .The medial circumflex femoral artery usually originates from the posteromedial aspect of profunda femoris artery but often originates from femoral artery itself.

Poirier (1909) suggested a more practical subdivision of the femoral artery and gave 4 types.

1. The profunda femoris artery gives rise to both circumflex arteries corresponding to Adachi's truncus profundo circumflexus perfectus.

2. The medial circumflex femoral artery arises from the femoral corresponding to Adachi's truncus profundo circumflexus lateralis.

3. The lateral circumflex artery arises from the femoral corresponding to truncus profundo circumflexes medialis.

4. Both medial and lateral circumflex arteries arises from the femoral artery.

Poirier's method of classifying these variations is more in line with the usual anatomical description of the vessels.

Adachi.B. (1928) Adachi gives us table of the percentage distribution of various femoral artery patterns in 7 series of observation, 4 European series, 2 Japanese and 1 American series which included Negroes.

Adachi looks upon circumflex arteries as 2 branches of the femoral and profunda femoris being a subsidiary vessel linked with circumflex arteries. If the two circumflex arteries arise by a common trunk with profunda femoris as a continuation.Adachi named it as truncus profundo circumflexus perfectus.

W.Henry Hollinshed (1958) in the anatomy for surgeons said that the lateral circumflex femoral artery typically arises from the lateral side of the upper end of the profunda or less frequently from the femoral artery above the origin of the profunda femoral artery. The medial circumflex femoral artery typically arises from the medial or the posterolateral aspect of the profunda or the femoral artery.(Fig.13)

J.A.Keen(1961) reported the variation of arterial pattern in both the lower limbs of 140 subjects (280 dissections). As per Poirier classification he found

Type 1- 118 times or 42 %.

Type 2 - 87 times or 31%.

Type 3 - 56 times or 20%.

Type 4- 19 times or 7%

Padmanabhan Siddharth, Noel.L.Smith, Robert.A.Mason, Eabio Giron(1985) To study the branching variation of the deep femoral artery which is frequently used in vascular reconstructive procedures in the proximal leg , they dissected 100 legs and then classified the anatomical patterns.

They reported that the origin of lateral circumflex femoral artery varied greatly when it branched from deep femoral and the origin of lateral circumflex femoral artery was 1.5 cm from the origin of deep femoral.

The medial circumflex femoral artery originated from deep femoral in 63% of the specimens. It arose separately from the circumflex femoral artery or more prominently in 26% of the specimens.

M.T.VAZQUEZ, J.MYRILLO, E.MARANILLO, I.PARKER, J.SANUDU (2006) They studied the lower limbs of 221 embalmed human cadavers and reviewed the previous literature to purpose a unified and simple classification that will be useful to the clinicians.. The medial and lateral circumflex femoral arteries has been classified into 3 different patterns. Based on the levels of their origin,

Pattern 1- Both the arteries arose from deep femoral artery. This pattern is more frequent in females.

1a. Medial circumflex femoral artery was proximal to lateral circumflex femoral artery (53.2%).

1b. lateral circumflex femoral artery was proximal to Medial circumflex femoral artery (23.4%)

1c. both the arteries arose from common trunk (23.4%)

Pattern2-one of the arteries arose from femoral artery and another from deep femoral artery (90 cases 20.5%)

2a. Medial circumflex femoral artery arose from femoral artery(77.8%).

2b. Lateral circumflex femoral artery arose from femoral artery(22.2%).

Pattern 3- Both the arteries arose from femoral artery (2 cases 0.5%)

Knowledge of variations of circumflex femoral artery is important in undertaking clinical procedures in the femoral region and in hip joint replacement.

Ercan Tanyeli, Mehmet Yildirim,Mehmet Uzel,Feridun Vural (2006) During their routine dissection they found a 72 year old male cadaver where lateral circumflex femoral artery was arising from the lateral aspect of femoral artery, distal to origin of the profunda femoral artery.

Christiana.A.Evans, Kent.S.Smith and Kirby.L.Jarolim (2007) They described two variations of the circumflex femoral artery . First they observed an unusually long common trunk for medial circumflex femoral artery and lateral circumflex femoral artery that arises from the femoral artery inferior to subcutaneous branches , but superior to the branch of the deep femoral artery. The 2nd variation observed was a common trunk for medial circumflex femoral artery and inferior epigastric arteries that arose from the femoral artery superior to deep femoral artery.

Marina Baptist, Ferdose Sultana, Tassdug Hussain (2007) dissected in 20 adult male cadavers 40 femoral triangles. Only in one case, the medial circumflex femoral artery was seen emerging from the femoral artery at the

level of origin of profunda femoris artery. In one case lateral circumflex femoral artery originated directly from femoral artery unilaterally.

M.Remya and K.Gopinathan (2007) In the right lower limb of one adult male cadaver-about 3.5cm below the mid inguinal point -2 thick branches from femoral artery were seen .The lateral branch resembling lateral circumflex femoral artery and the medial branch resembled profunda femoris artery.

One from the medial side and the other from the lateral side of the femoral artery. The thick medial branch resembled profunda femoris artery . The other branch from the lateral side of the femoral artery gave a small branch to the lateral side and then continues medially behind the femoral vessels and then between the psoas and the pectineus muscle to the back of the upper thigh like the medial circumflex femoral artery. Its lateral branch divided into three-one ascending, a transverse and a descending resembling the lateral circumflex femoral artery. The descending branch was small and it ended in rectus femoris and the upper part of the vastus lateralis.

EMBRYOLOGY

The early limb bud receives blood via inter segmental arteries that contribute to a primitive capillary plexus. At the tip of the limb bud there is a terminal plexus which is constantly renewed in a distal direction as the limb grows. Later one main vessel the axial artery supplies the limb and the terminal plexus.

The axial artery of the lower limb arises from the dorsal root of the umbilical artery and courses along the dorsal surface of the thigh, knee and leg. Below the knee it lies between the tibia and popliteus, and in the leg it lies between the crural interosseous membrane and tibialis posterior. It gives of a peforating artery that traverses the sinal tarsus to form a dorsal network and ends distally in a plantar network. The femoral artery passes along the ventral surface of the thigh, opening a new channel to the lower limb. It arises from a capillary plexus that is connected proximally with the femoral branches of the external iliac artery and distally with the axis artery splits into primitive posterior tibial and peroneal branches:

These run distally on the dorsal surface of popliteus and tibialis posterior to gain the sole of the foot. At the distal border of popliteus the artery gives off a perforating branch that passes ventrally between the tibia and the fibula and then courses to the dorsum of the foot, forming the anterior tibial artery and dorsalis pedis artery. The primitive peroneal artery communicates with the axis artery at the distal border of popliteus and in its courses in the leg.

The femoral artery gradually increases in size. Coincidentally, most of the axis artery disappears however, proximal to its communication with the femoral artery, the root of the axis artery persists as inferior gluteal artery and the arteria comitans nervi ishiadici.

MATERIALS AND METHODS

STUDY MATERIALS

The study materials consists of

i. 50 adult lower limb specimens from 25 adult cadavers (18 males and 7 females)

ii. 6 foetal lower limb specimens from 3 full term foetuses.

iii. 10 clinical cases for angiographic study.

iv. 10 clinical cases for the study of 64 slice computerized tomographic scan.

METHODS OF STUDY

1. Direct Dissection Method.

a. In adult cadavers.

b. In foetal cadavers.

2. Silicone Gel Injection method for finding the diameter of the femoral artery

3. RADIOLOGICAL STUDY

i. Adult femoral angiogram in 3 cadavers.

ii. Adult femoral angiograms in 10 clinical cases.

iii. Adult 64 slice computerized tomography study in 10 clinical cases.

4. HISTOLOGICAL STUDY

SPECIMEN COLLECTION:-

Adult specimens were obtained from 25 adult cadavers of age group between 50 to 80 years allotted for dissection to the I MBBS students during the year 2006-2007 and 2007-2008, in the Institute of Anatomy, Madras Medical College, Chennai.

3 unclaimed full term foetal cadavers, after getting consent from concerned parents or relatives were obtained from the Institute of Obstetrics and Gynaecology Egmore.

Adult femoral angiograms of 10 patients who underwent the procedure in the Barnard Institute of Radiology, Government General Hospital,Chennai were observed and collected. Adult femoral angiograms were also done in 3 cadavers as in living patient and the angiograms collected.

Adult 64 slice computerized tomography of 10 patients who underwent the procedure in the Barnard Institute of Radiology, Government general Hospital, Chennai were observed, collected and studied.

METHODS OF STUDY

A. CADAVERIC STUDY.

ADULT SPECIMENS

1. DIRECT DISSECTION METHOD.

2. ADULT CADAVERIC ANGIOGRAPHIC METHOD .

DIRECT DISSECTION METHOD

i. IN ADULT CADAVERS

The dissection was carried out as follows:

A horizontal incision was made along the inguinal ligament from the anterior superior iliac spine to the pubic tubercle and the incision was carried down along the external genitalia and carried down vertically along the medial border of the thigh , medial part of the knee, down to the legs upto the level of the tibial tuberosity. Horizontal incision was made from this point laterally. The skin flap was reflected from medial to lateral side.

In the superficial fascia the superficial branches of femoral artery were found to arise from the femoral artery. The superficial circumflex iliac artery is the smallest branch of the femoral artery was found to course in the lateral part of the groin. The superficial external pudendal artery were found to arise medially to supply the external genital organs. The superficial epigastric artery was found to run superiorly to the anterior abdominal wall. The superficial arteries were found to accompany with their corresponding veins.

The deep fascia was then reflected. The great saphenous vein was identified through the anterior wall of the femoral sheath and its entry into the femoral vein was also exposed. The femoral sheath was split laterally and the femoral artery was exposed. The sartorius and the adductor longus were exposed down to the apex of the triangle where they meet. The femoral artery was traced. The deep external pudendal artery arises from the upper part of the femoral artery and runs medially was also found.

The root of the profunda femoris artery arising from the femoral artery about 4cm below the inguinal ligament was also identified. Sometimes the lateral circumflex and the medial circumflex femoral arteries arise from the femoral artery were also traced.

The middle third of sartorius was lifted laterally. This exposed a narrow strip of fascia the roof of the adductor canal between vastus medialis and the adductor muscles. The fascia was divided longitudinally and the femoral vessels were identified.

The descending genicular artery arises a short distance above the opening in the adductor magnus and was identified and traced. The tendinous opening in the adductor magnus was identified and the continuation of femoral artery as popliteal artery was noted.

During the above dissection , the origin of the femoral artery in relation to the inguinal ligament, relationship between femoral artery and femoral vein were noted, and the branches of the femoral artery were noted, painted with colour paints and photographed for documentation.

The origin of the femoral artery in relation to the mid inguinal point was noted by the following method. First the distance between the anterior superior iliac spine and the pubic symphysis was measured with a measuring tape. This is marked as the inguinal distance. The midpoint of this line is defined as the mid inguinal point. Similarly the distance between the anterior superior iliac spine and the mid point of the common femoral artery where it crossed the inguinal ligament was measured with a measuring tape. This is marked as the femoral distance. Then the total number of cases where the location of common femoral artery coincided with the mid inguinal point was noted.

The diameter of the femoral artery was measured at the level of 1cm below the inguinal ligament with the use of vernier calipers and by silicone gel method.

Initially the vernier calipers was checked for zero error with the jaws closed. The jaws of the calipers were placed on the inner side of the vessel wall with a firm pressure on the artery. When both the locking screws of the calipers

were tightened the caliper was removed from the artery and the measurement in the main scale of the calipers was read to the nearest tenth of a centimeter.

The diameter of the femoral artery was measured in 10 lower limbs specimens by preparing moulds of silicone gel by the following method. The femoral artery was tied 3 cm below the inguinal ligament. Another tie was made in the external iliac artery, proximal to the origin of the femoral artery. A small niche was made near the proximal tie, to allow the nozzle of the silicone gel filled syringe to pass through. The nozzle of the silicone gel filled syringe was inserted through the niche made near the proximal end. The silicone gel was injected into the tied segment and was left undisturbed for 24 hours. After a period of 24 hours the femoral artery was cut 1 cm below the inguinal ligament and was marked 'T' and another cut was made at the level of the distal tie. Now the walls of the femoral artery were dissected out and the diameter of the moulds of the femoral artery was measured by measuring the diameter of the mould at the proximal end marked T by using vernier calipers to the nearest tenth of the centimeter.

ii. Direct dissection method in dead foetuses

Three full term fetuses were obtained from the Institute of Obstetrics and Gynaecology, Egmore. Foetal embalming were done for the three fetuses. Foetal embalming was carried out by the following method. About 200-300 ml of 10% formalin solution was used in each foetus and it was injected into the anterior fontanelle , pleural, pericardial and peritoneal cavities followed by subcutaneous injections in some places like the limbs, thoracic wall and the abdominal walls.

Dissection of the femoral artery in foetal specimens were done as same procedure as in adult dissection but with utmost gentleness due to the extremely small branches of the foetus. As much as possible many branches

were dissected and the findings were noted and then the arteries were painted with colour paint and the photographs were taken for documentation.

RADIOLOGICAL STUDY.

i. ADULT CADAVERIC FEMORAL ARTERY ANGIOGRAPHIC STUDY

The thigh was amputated from the 3 adult cadavers . The head of the femur was separated from the acetabulum of the hip bone and another cut was made below the knee joint. A thorough wash was given to the femoral artery and its branches by injecting normal saline into the femoral artery and the saline was allowed to flow out from the lower end that is the popliteal artery. This procedure was done till the saline was clear and free of debris.

In all the three specimens, the amputated thigh specimen were carried to the Barnard Institute of Radiology , Government General Hospital, Chennai. Inj. Omnipaque 10 ml was injected into the femoral artery through the proximal end after ligating the distal end in the specimens. Then the angiogram was done and the picture were taken, collected and studied.

ii. ADULT FEMORAL ANGIOGRAMS IN CLINICAL CASES.

Femoral angiograms done in the Barnard Institute of Radiology Government General Hospital, Chennai were observed in 10 patients who underwent the procedure for various prophylatic and therapeutic purposes were collected and studied. The procedure of performing femoral angiograms is as follows:

ANGIOGRAPHIC PROCEDURE

Retrograde Femoral Artery Catheterisation.

First the patient was put in the supine position. After selecting a skin entry site and applying local anaesthesia a small superficial niche was made

with a No.11 blade directly over the arterial pulse. The course of the artery was palpated while an 18 gauge needle, stylet was rapidly thrust down the artery. The needle was gently advanced when arterial blood was seen exciting from the stylet hub, the hub was removed and a 0.035 inch wire was carefully inserted into the artery. The wire should not be forced. Now the urograffin solution (contrast) was injected to identify the course of the vessel and to find out the clinical problems like thrombosis, embolism, artheromatous plague, stenosis and abnormal dilatations namely aneurysm.

The study was done by visualizing the pictures taken serially from 5 minutes after injecting the contrast. The angiograms were collected and then the femoral artery, its superficial branches, profunda femoris artery, descending genicular artery and presence of collateral channels were noted and then angiographic pictures were mounted on the lobby and photographs were taken for documentation.

iii. ADULT 64 SLICE COMPUTERISED TOMOGRAPHIC STUDY.

CT Scanning is a noninvasive, painless, medical test that helps physicians diagnose and treat medical conditions. CT imaging uses special x-ray equipment to produce multiple images or pictures of the inside of the body and a computer to join them toghether in cross sectional views of the area being studied.

PREPARATION OF THE PATIENT

The patient is asked to wear comfortable loose fitting clothing. Metal objects including jewellery, eyeglasses, dentures, hairpins, and hearing aids are removed prior to the CT examination. The patient is asked not to eat or drink anything for four hours prior to the CT examination, because we are using contrast material. Any history of allergy especially to contrast material, history of heart diseases, asthma, diabetes, kidney disease or thyroid problems should be also enquired.

CT Scanner equipment:

The CT Scanner is typically a large machine with a hole or tunnel in the centre. The patient is asked to lie supine on the table which slides into and out of this tunnel. The x-ray and the electronic x-ray detectors rotate around the patient. They are opposite to each other in a ring called a gantry. The computer work station that processes the imaging information is located in a separate room.

After positioning the patient, non invasive contrast inj. Omnipaque is injected through an intravenous line. Next the table will move slowly through the machine as the actual CT is performed. The patient is asked to hold the breath for 10 -15 seconds as scan is taken. The CT scanning is usually completed within 30 minutes.

Then the images are analysed and the origin, diameter of the femoral artery, relationship of the femoral artery and the femoral vein and the branching patterns of the femoral artery are analysed and photographed for documentation.

3. HISTOLOGICAL STUDY

Two small bits of femoral artery were taken from 3 specimens. The specimens were fixed with 10% formalin, dehydration of tissue was done with ascending grades of alcohol, clearing with xylol, impregnation with wax, embedding of tissue was done with paraffin wax, section cutting was done with microtome, thin sections of tissue were mounted on the slides by using albumin solution (glycerine +egg white). Fixed sections are stained with eosin and haematoxylin stain and mounted the slide with DPX and covering with coverslip.

The tissue was examined under microscope, photo microscope was used for further examination & making photographs with the help of computer.

OBSERVATION

The femoral artery and its branching patterns were studied by

A . Conventional dissection method both in adults and foetal cadavers.

B. Clinical study was done by Angiography.

C. Clinical study was done by 64 slice computerized tomographic scan.

D. Microstructure of the femoral artery.

a. **Conventional dissection method**

50 (14 female limbs and 36 male limbs) lower limbs from adult cadavers and 6 lower limbs from 3 full term foetuses were taken for study. The findings were noted and summarized as follows under the following headings.

1. Origin of femoral artery in relation to mid inguinal point

In all 50 cases the distance between pubic symphysis and anterior superior iliac spine was measured using a measuring tape and defined as inguinal distance. The mid point of this line is defined as mid inguinal point. The distance between pubic symphysis to mid point of common femoral artery where it crosses the inguinal ligament was measured. This is the femoral distance. Then the total number of cases where the location of common femoral artery coincided with the mid inguinal point was noted.

Out of 50 adult specimens, only in 40 specimens the origin of femoral artery coincided with the mid inguinal point (Pic.2). In 6 specimens the origin of femoral artery is lateral to the mid inguinal point, more towards mid point of inguinal ligament.(Pic.3). In the remaining 4 specimens the origin of femoral artery was medial to mid inguinal point. (Pic.4;Table-1and Table-2) .

In all 6 foetal limbs, the origin of femoral artery coincided with the mid inguinal point. (Pic.5).

2. Diameter of the femoral artery

The diameter of the femoral artery is measured 1cm below the inguinal ligament using vernier calipers. In 40 adult specimens, the diameter of femoral artery ranged from 5-8 mm. (Pic.6 and 7)

The mean diameter of common femoral artery in males is 7.25mm and in females is 5.8 mm. The range of the intra luminal diameter in females is 5-7mm, and the range of the intra luminal diameter in males is 7-8mm (Table-3)

The mean diameter of common femoral artery is lower in women when compared to men. The likelihood of symptomatic lumen obstruction by a closure device component may be increased in women because of smaller arterial dimensions .

Diameter of the femoral artery by moulds prepared from silicone gel.

The diameter of the femoral artery was measured by moulds prepared from silicone gel in 10 adult femoral artery specimens and was tabulated . The mean diameter in males is 8cm and that in females is 6 cm. Also the minimal luminal diameter in females is less than that in males. ((Pic.31 and Table-4).

3. Relationship between femoral artery and femoral vein

In all 50 adult specimens, at the base of the femoral triangle the femoral vein is medial to the femoral artery; in the distal femoral triangle and in the proximal part of the adductor canal, the femoral vein is posterior to the femoral artery; in the distal adductor canal the femoral vein is posterolateral to the femoral artery. (Pic.8,9 and10)

In all 6 foetal specimens, at the base of the femoral triangle the femoral vein is medial to the femoral artery; in the distal femoral triangle and in the proximal part of the adductor canal, the femoral vein is posterior to the femoral artery; in the distal adductor canal the femoral vein is posterolateral to the femoral artery. (Pic.11)

4. Origin of the superficial circumflex iliac artery

Out of 50 adult lower limbs specimens, in 45 specimens(90%), the superficial circumflex iliac artery was seen arising as a separate trunk from the lateral side of the femoral artery. (Pic.12) In remaining 5 specimens (10%), the superficial circumflex iliac artery was absent. (Table-5)

In all 6 foetal specimens , the superficial circumflex iliac artery was seen arising as a separate trunk from the femoral artery. (Pic.17)

5. Origin of the superficial external pudendal artery.

Out of 50 adult specimens, in 48 adult specimens superficial external pudendal artery was seen arising from the femoral artery as a single trunk only. In 2 adult specimens superficial external pudendal artery arose as a common trunk with superficial epigastric artery from the femoral artery. (Pic.17).No case of double trunk of origin of superficial external pudendal artery was seen. (Table-6)

In all 6 foetal specimens superficial external pudendal artery was seen arising from the femoral artery as a single trunk only.

6. Relationship of superficial external pudendal artery and the arch of great saphenous vein at the sapheno femoral junction.

Relationship of superficial external pudendal artery to great saphenous vein was recorded in 50 specimens. In 8 cases (16%) the superficial external pudendal artery was not visualised at the sapheno femoral junction.(Pic.13)

In 26 cases (52%) the superficial external pudendal artery was found posterior to great saphenous vein . (Pic.15)

In 16 cases (32%) the superficial external pudendal artery was found anterior to great saphenous vein (Table-7 and Pic.15)

In all 6 foetal specimens the superficial external pudendal artery was found posterior to the great saphenous vein. (Pic.16)

7. Origin of the superficial epigastric artery

Out of 50 adult specimens in 48 specimens, the superficial epigastric artery was seen arising as a single trunk from the anterior aspect of the femoral artery. In 2 adult specimens, the superficial epigastric artery was seen arising as a common trunk with superficial external pudendal artery. (Table-8 and Pic.14)

In all 6 foetal specimens superficial epigastric artery was seen arising as a single trunk from the anterior aspect of the femoral artery. (Pic.17)

8. Origin of the deep external pudendal artery

In all 50 adult specimens the deep external pudendal artery arises from the medial side of the femoral artery and passes medially across the pectineus anterior to adductor longus, posterior to femoral vein covered by fascia lata, which it pierces to supply the skin of the perineum and scrotum. (Pic.18 and 19)

In all 6 foetal specimens deep external pudendal artery arises from the medial side of the femoral artery and passes medially across the pectineus anterior to adductor longus, posterior to femoral vein covered by fascia lata, which it pierces to supply the skin of the perineum and scrotum.

9. Origin of the profunda femoris artery

a. Distance of origin of profunda femoris artery from the inguinal ligament

Out of 50 adult specimens the distance between the origin of profunda femoris artery from the inguinal ligament varied between 1 to 4.2 cms. The average distance being 3.4 cm.(Table-9 and Pic20 and 21)

In all 6 foetal limbs, distance between the origin of profunda femoris artery from the inguinal ligament varied between 1.2 to 1.8 cm.(Table-10 and Pic 17)

b. Origin of the femoral artery in relation to the femoral artery.

Out of 50 adult specimens, in 38 specimens, profunda femoris artery arose laterally from the femoral artery, (Pic21) whereas in 8 remaining specimens profunda femoris artery arose posterolaterally from the femoral artery. (Pic 22) In 4 cases profunda femoris artery arose posteriorly.(Table-11 and Pic23)

In all 6 foetal specimens, the profunda femoris artery arose laterally. (Pic17)

10. Origin of descending genicular artery.

In all 50 adult specimens, the descending genicular artery arises from the femoral artery just proximal to the adductor opening and immediately divides into saphenous and articular branch. (Pic 24 and 25)

In all 6 foetal specimens, the descending genicular artery arises from the femoral artery just proximal to the adductor opening and immediately divides into saphenous and articular branch.

11. Presence of abnormal branches from femoral artery

In the present study the origin of lateral circumflex femoral artery from femoral artery-3 cases (6%), of which in 2 cases(4%), the origin of the lateral circumflex femoral artery is proximal to the origin of the profunda femoris artery. (Pic26 and 28). In 1 case (2%), the origin of lateral circumflex femoral artery is distal to the origin of profunda femoris artery. (Pic27)

In another 1 case(2%), the origin of medial circumflex femoral artery from femoral artery . (Pic 30)

In all 6 foetal specimens lateral circumflex femoral artery and the medial circumflex femoral artery was not found arising from femoral artery.

Adult femoral angiogram in cadavers

Adult femoral angiogram was done in 3 cadavers . In the cadaveric angiogram the superficial external pudendal artery and the superficial epigastric artery are seen and the superficial circumflex iliac artery was not clearly visualized.

The profunda femoris artery was found to arise from the lateral surface of the femoral artery and the lateral circumflex femoral artery and the medial circumflex femoral artery was seen arising from the profunda femoris artery. In all 50 adult specimens, the descending genicular artery arises from the femoral artery just proximal to the adductor opening & immediately divides into saphenous and articular branch. (Pic 32)

Adult femoral angiogram in clinical cases

Adult femoral angiograms were observed , films collected and studied. In all 10 clinical cases, the superficial circumflex iliac artery, the superficial external pudendal artery and the superficial epigastric artery was seen arising

as a separate trunk from the femoral artery , (Pic 33) the profunda femoris artery was seen arising from the femoral artery, (Pic 34) the lateral circumflex femoral artery and the medial circumflex femoral artery arises from the profunda femoris artery.,the origin of the decending genicular artery from the femoral artery was noted. (Pic 35) In one case there was mid superficial femoral artery obstruction with extensive collaterals noted and photographed for documentation. (Pic 36 and 37)

Adult 64 slice computerized tomographic scans of pelvis

Adult 64 slice computerized tomograptic scans of pelvis of 10 clinical cases were observed in the Bernard Institute of Radiology, Government General Hospital,Chennai and studied. In all 20 computerized tomographic scans of pelvis the origin of femoral artery in relation to mid inguinal point, the diameter of femoral artery, the relationship of femoral artery and femoral vein, the origin of superficial branches of femoral artery and deep branches of femoral artery were noted. (Pic 41 and 42)

In all 10 cases, femoral artery entered the thigh at the mid inguinal point, normal branching pattern of the femoral artery was noted. No anatomical variation in the branching patterns of femoral artery was noted. However, in 1 case, obstruction of the superficial femoral artery was noted . (Pic 43)

The diameter of the femoral artery in all the 10 cases was noted and tabulated. The minimal luminal diameter in males varies from 6-10mm. The minimal diameter in females varies from 6-8.4mm.The minimal luminal diameter in females is lower in females when compared to males. (Table-12 and Pic39 and 40)

Relationship between femoral artery and femoral vein by 64 slice computerised tomographic scans.

Out of 20 limbs studied by 64 slice computerized tomographic scans, in 3 limbs (15%) there was overlapping of the femoral vein over the femoral artery(Pic39). In remaining 17 limbs, (85%) the femoral vein was found lying medial to the femoral artery and the femoral artery and the femoral vein pairs in these cases. (Pic 38)

HISTOLOGY

Three bits of femoral artery measuring about 2 to 3 cm were taken from the thigh. They were processed sectioned and stained with haematoxylin and eosin and studied under the light microscope.

In the arterial wall of the femoral artery, an inner dark sinuous line was seen which represents the internal elastic lamina. Inner to the internal elastic lamina endothelial layer was found to be thin- Tunica intima.

Outer to the internal elastic lamina, a broad pale band was seen which consists of smooth muscular tissue, disposed circularly around the artery and few elastic fibres running parallel to the lumen of the vessel- Tunica media.

Outer to this muscular coat, a broad deeply stained band, largely composed of elastic tissue- Tunica adventitia is found. (Pic.44 and 45)

DISCUSSION

The branching patterns and the variations of the femoral artery was studied:

1. Origin of femoral artery in relation to mid inguinal point.

Henry Gray (1858), George.A. Piersol (1907), J.D. Boyd, W.J.Hamilton (1956), Sir John Bruce , Robert Wamsley, ,James A. Ross (1964), Keith L.Moore (1980), Richard S. Snell (1973), have reported that the origin of femoral artery is midway between anterior superior iliac spine and pubic symphysis.

According to **Dr. Scott; P.C.T.Willian (2005)** the surface marking of both deep inguinal ring and the femoral artery is closer to the mid inguinal point than the mid point of the inguinal ligament . In the present study, in 40 adult specimens (ie) 80% the surface marking of the femoral artery coincided with the mid inguinal point. (Chart 1 and Table13)

In the present study the origin of femoral artery was between anterior superior iliac spine and pubic symphysis in 40 adult specimens (80%), which coincides with the statement of the above scientists. But they have not mentioned any statistical data about the incidence.

In all the 6 foetal limbs the origin of the femoral artery coincided with mid point between anterior superior iliac spine and pubic symphysis.

Barry J . Anson Chester B.Mc vay (1971), Haimovici's (2004), have said that femoral artery enters the thigh midway between anterior superior iliac spine and pubic tubercle.

In the present study , in 6 specimens (ie) 12% the femoral artery enters the thigh lateral to the mid inguinal point -more towards the mid point of the inguinal ligament than the mid inguinal point. (Chart 1 and Table13)

Jeremy A.Hient, John P.Haris(1996) said that the difference between common femoral artery and mid inguinal point varied from 1.25-1.50cm either side of mid inguinal point.

In the present study 6 cases (12%) the origin of femoral artery is 3 to 6 mm lateral to the mid inguinal point and in 4 cases(8%) the origin of femoral artery is 2 to 3 mm medial to the mid inguinal point . (Chart 1 and Table13)

Clinical significance :. The relation between mid inguinal point and the femoral artery is not constant. The mid inguinal point found using bony landmarks is an appropriate guide to the femoral artery as the femoral artery is expected to lie 1.5cm on either side of the mid inguinal point. The radiologists or the cardiologists catheterising the femoral artery for various purposes in their respective fields should have this in mind, when they fail to get at the femoral artery in the usual position which is coinciding with the mid inguinal point.

2. Diameter of the femoral artery

Schnyder et al (2004) said that minimal luminal diameter of femoral artery in females is [5.1±1.1mm vs 6.3 ±1.2mm]. The minimal luminal diameter of femoral artery in men [6.0 ±1.0mm vs 7.5 ± 1.2mm].Also the minimal luminal diameter of common femoral artery is lower in women than in men.

In the present study, by direct dissection method the internal diameter in males ranged from 7 to 8 mm , in females ranged from 5-7mm.

Marina Baptist et all (2007) injected gelatin and Indian ink into the femoral artery and stated that internal diameter of femoral artery ranged from 6-10mm

In the present study, by moulds prepared from the silicone gel the internal diameter of the femoral artery was measured. The internal diameter of the femoral artery in males is 7-8mm and the internal diameter of the femoral artery in females is 6-7mm. So the present study coincides with that of Marina Baptists.

In the present study by 64 slice CT scan pelvis the minimal luminal diameter in males varies from 6-10 mm and that in females varies from 6-8.4 mm. Also the minimal diameter is lower in females than that compared in males. This observation coincides with that of Schnyder et al.

The diameter of the femoral artery is important to diagnose diseases such as aneurysms. Further women are at an increased risk of developing severe assess complications secondary to the application of a collagen based vascular closure device (eg) anchor or inadvertently collagen plug, because of smaller arterial dimensions such as diameter which may increase the likelihood of symptomatic luminal obstruction because of smaller arterial dimensions.

3. Relationship between the femoral artery and femoral vein.

Henry Gray(1858) quoted that at the base of the femoral triangle the femoral vein is medial to the femoral artery, in the distal femoral triangle (ie) at the apex and in the upper part of the adductor canal the femoral vein is posterior to the femoral artery and in the distal part of the adductor canal the femoral vein is posterolateral to the femoral artery.

Prof. A.M.Buchannan's (1906) said that immediately distal to the inguinal ligament , the femoral vein lies to the medial side of the artery, it lies

posterior to the artery in the distal part of the triangle. In the distal part of the sub sartorial canal, femoral vein is posterior and to the lateral side .

Barry J.Anson ;Chester B Mcvay (1971) quoted that the femoral vein lies medial to the femoral artery at the inguinal ligament and from there it assumes a posterior position. In the adductor canal the femoral vein is bound closely to the femoral artery by connective tissue which at first lies posterior to and then slightly to the lateral side of the artery.

Keith L.Moore-1980 stated that the femoral artery enters the femoral triangle, lateral to the femoral vein. As the femoral vein ascends through the adductor canal it lies posterolateral and then posterior to the artery.

In the present study, in all 50 adult specimens and 6 foetal specimens at the base of the femoral triangle the femoral vein is medial to the femoral artery, in the distal femoral triangle and in the upper part of the adductor canal the femoral vein is posterior to the femoral artery and in the distal part of the adductor canal the femoral vein is posterolateral to the femoral artery.

This finding coincided with the statement of Henry Gray1858, Buchannan's 1906, Barry J.Anson1971 and Keith L.Moore.

Barry.J.Anson, Chester B McVay (1971) also mentioned that occasionally the femoral vein is found anteriorly or laterally.

A.Vani and S.Saritha (2004) found that in the upper part of the femoral triangle, the femoral vein lies lateral to the femoral artery.

In the present study , in none of the specimens the femoral vein is anterior or lateral to the femoral artery.

P.Hughes; C.Scott (2000) quoted that in most patients there was some degree of overlap of the artery over the vein

Phillip. A.Baun et al (1989) studied 100 CT scan of pelvis and found that in 65% of the vessel pairs the common femoral artery overlapped the common femoral vein in the anteroposterior plane. In the present study , out of 20 lower limb scans of the pelvis, there was some degree of overlapping of the femoral vein over the femoral artery in 3 limbs (15%). So, in the present study, the incidence of the femoral vein overlapping the femoral artery in an anteroposterior plane is 15% which is lower than that of 65% as quoted by Baun et al.

According to Baun et al in more than 8% of the vessel pairs, more than 25% of the artery overlapped the vein. In the present study, in none of the cases, the artery overlapping the vein was found.

According to Baun et al 22% of the cases, there was no overlapping of the artery and the vein in the anteroposterior plane. In the present study in 85% of the cases there was no overlapping of the artery and the vein in the anteroposterior plane. The femoral vein was found lying medial to the femoral artery and the femoral artery and the femoral vein pairs in those cases in the axial CT scan of the pelvis.

B.Sahin and S.Bilgic (1998) found a rare variation of duplicated deep femoral artery in the right lower limb of a male new born cadaver. In another case deep femoral artery passing in front of the femoral vein was found in the left lower limb of a new born male cadaver.

In the present study, duplicated deep femoral artery was not found.

Faith Kantari .M.B. et al (2003) reported an extremely rare arterial variation, duplication of the superficial femoral artery in a 60 year old male patient with bilateral intermittent claudication. The superficial femoral vein was identified lying posterior to the duplicated femoral artery.

In the present study, no such abnormality found in any of the specimens.

The variation in the anatomical relationship between common femoral artery and the common femoral vein is clinically significant, since the femoral vein puncture can be associated with simultaneous passage of the entry needle through the artery and thus forming arteriovenous fistula. So the knowledge of the relationship between the femoral artery and the femoral vein is essential.

4. Origin of the superficial circumflex iliac artery.

Henry gray (1858) quoted that the superficial circumflex iliac artery arises near the superficial epigastric artery.

George A.Piersol (1907) and Buchannan's(1949) quoted that the superficial circumflex iliac artery arises a little below the superficial epigastric artery.

Morris(1893) quoted that the superficial circumflex iliac artery arises as a separate branch.

Henry Hollinshed (1958) said that the superficial circumflex iliac artery arises independently from the femoral artery.

Ti-sheng- chang, Sheng Hsui-chu (1986) quoted that that the superficial circumflex iliac artery originates from the lateral side of the femoral artery.

Taylor and Daniel (1975) from 400 cases of the groin dissections said that in 17% , the superficial circumflex iliac artery arising from the femoral artery and from 20 operated cases the authors found that 45% had the superficial circumflex iliac artery and the superficial epigastric artery arising individually from the femoral artery.

M.Remya and K.Gopinathan (2007)said that the superficial circumflex iliac artery arises from the lateral side of the femoral artery.

In the present study, the superficial circumflex iliac artery arose as a separate trunk from the lateral side of the femoral artery in 90% of the cases.(Chart 2a and Table 14). In all 6 foetal specimens, the superficial circumflex iliac artery arise laterally from the femoral artery as a single trunk only. This finding coincides with the statement of the above scientists, but the incidence is higher than that quoted by Taylor and Daniel. (Chart 2b and Table 15).

Henry Gray (1858) stated that the superficial circumflex iliac artery arises with the superficial epigastric artery.

George A.Piersol (1907) quoted that the superficial circumflex iliac artery may arise in common with the superficial epigastric artery.

Buchannan's (1906) and Morris(1893) said that the superficial circumflex iliac artery may arise in common with the superficial epigastric artery.

Taylor and Daniel(1975) from 400 groin dissections found that 48% had a common trunk for the origin of the superficial circumflex iliac artery and superficial epigastric artery and from 20 operated cases found that 3 cases - 15% had the superficial circumflex iliac artery and the superficial epigastric artery arising from a common trunk.

Robert J.Allen(2002) reported that in 79% the superficial circumflex iliac artery and the superficial epigastric artery arises from a common trunk.

In the present study, in none of the cases the superficial epigastric artery and the superficial circumflex iliac artery arises as a common trunk which varies from the statement of the above workers.

Taylor and Daniel (1975) from 20 operated cases found that in 5 cases (25%) had absence of the superficial circumflex iliac artery and only the superficial epigastric artery .

Mangala M.Pai et al(2006) in a case study found that the superficial circumflex iliac artery was conspicuously absent.

In the present study, in 5 specimens (10%) the superficial circumflex iliac artery was absent. This finding is lower than the incidence of 25% a quoted by Taylor and Daniel. (Chart 2a and 2b).

Taylor and Daniel (1975) from 400 groin dissections found that 17% of the superficial circumflex iliac artery arise from the profunda femoris artery. In the present study, in none of the cases the superficial circumflex iliac artery arise from the profunda femoris artery. So the present study differs from the finding of Taylor and Daniel.

Clinical significance: Groin flaps are nowadays used for the reconstruction of the limb defects, penile reconstruction etc. Groin flaps are mostly based on the superficial circumflex iliac artery and the superficial epigastric artery system. The superficial circumflex iliac artery flaps are advantageous because the superficial circumflex iliac artery is very long and donar sites as wide as 12 to 16 cm is closed directly with minimal disfigurement. For the successful uptake of groin flap the anatomy of the superficial circumflex iliac artery is very essential.

5. Origin of superficial external pudendal artery.

Henry Gray(1858), George A .Piersol(1907), quoted that superficial external pudendal artery arises medially from the femoral artery, close to the superficial circumflex iliac artery.

M.Castro (1998) quoted that external pudendal artery was a single vessel in 55% of the cases .

Osvaldir Lanzoni(2006) quoted that superficial external pudendal artery was found in 46 of 50 (92% of cases). They originated from the femoral artery in 45 cases (90%) and deep femoral artery in only one case(2%).

In the present study out of 50 of the cases in 48 cases (96%) the superficial external pudendal artery was seen arising medially from the femoral artery as a single trunk and passes medially and slightly upward toward the spine of the pubis .So the present study is almost similar to the study of Osvaldi Lanzoni , whereas it is much higher than the incidence found by M.Castro and none of the superficial external pudendal artery was seen arising from the deep femoral artery as quoted by Osvaldir Lanzoni.

In all 6 foetal specimens, the superficial external pudendal artery was seen arising medially from the femoral artery as a single trunk.

M.Castro(1998) quoted that the superficial external pudendal artery was arising as a common trunk with the superficial epigastric artery in 15%.

Taylor and Daniel(1975) from 20 operated cases found that in 3 cases (15%) had a common trunk for cases the superficial epigastric artery and the superficial external pudendal artery.

In the present study out of 50 adult specimens, in two specimens (ie) 4%, the superficial external pudendal artery arose as a common trunk with the superficial epigastric artery. This observation is less than the incidence of 15% mentioned by M.Castro and that mentioned by Taylor and Daniel from 20 operated cases (15%)

Clinical significance:

Nowadays superficial external pudendal artery flaps are used widely in the vulvar reconstruction, reconstruction of hand injuries, reconstruction of male genitalia etc. In order to create a successful flap, it is important to understand the arterial anatomy of superficial external pudendal artery which promotes its vascularisation.

6. Relationship between external pudendal artery and Great saphenous vein

M.Donnelly et al (2005) quoted that external pudendal artery crossed anterior to long saphenous vein in 16.8%

Preethi (2008) quoted that out of 50 cases in 5 cases (10%) the superficial external pudendal artery was anterior to the great saphenous vein

In the present study, out of 50 adult specimens in 16 specimens (32%) the superficial external pudendal artery was anterior to the great saphenous vein. This finding is higher than the incidence quoted by M. Donnelly and Preethi. .(Chart 3 and Table 16).

Henry Gray (1858) stated that superficial external pudendal artery passes medially usually deep to long saphenous vein.

Ass Ndaiye et al (2006) quoted that the external pudendal artery crossed beneath the arch of Great saphenous vein in 56% of cases out of 54 inguino femoral regions dissected .

Preethi 2008 quoted that out of 50 cases in 8 cases (16%) the superficial external pudendal artery was found to be posterior to the great saphenous vein.

In the present study, the superficial external pudendal artery is posterior to great saphenous vein in 26 specimens -52%. This finding is similar to the incidence found by Ass Ndaidye , but is greater than the incidence quoted by Preethi. .(Chart 3 and Table 16).

Donnelly et al (2005) stated that superficial external pudendal artery was not visualized in 73.1% of dissections.

Preethi (2008) quoted that out of 50 cases in 37 cases (74%) the superficial external pudendal artery was not visualized at the sapheno femoral junction.

In the present study the superficial external pudendal artery was not visualised at the sapheno femoral junction in 8 specimens (16%).This finding is lower than the incidence quoted by Donnelly et al and Preethi.(Chart 3 and Table 16).

Clinical significance: The clinical significance of the relationship between the superficial external pudendal artery and the great saphenous vein is that it is important in ensuring that the saphenofemoral junction is managed safely and adequately in patients with varicose veins. Failure to appreciate these variations may account for a significant proportion of inadequate primary varicose vein surgery. So knowing and taking the variations into account are essential to prevent recurrences after surgical treatment of varies of pelvic limbs.

7. Origin of the superficial epigastric artery

Henry Gray (1858) said that the superficial epigastric artery arises from the femoral artery.

Henry Hollinshed (1958)quoted that the superficial epigastric artery tends to arise from the anterior surface of the femoral artery.

George A.Piersol (1907) said that arteria epigastric superficialis arise from the anterior surface of the femoral artery.

Boyd et al (1956) said that the superficial epigastric artery arise from the anterior aspect of the femoral artery.

In the present study , out of 50 adult specimens in 48 specimens (96%) , the superficial epigastric artery arose anteriorly from the femoral artery as a single trunk.

In all 6 foetal specimens, the superficial epigastric artery arises anteriorly from the femoral artery as a single trunk only.

M.Remya and Gopinathan (2007) reported a case where the superficial epigastric artery and the superficial external pudendal artery were seen arising as a common trunk from the medial side of the femoral artery.

M.Castro; E.Brenda; A. Marques; M.D.Pererria (1998) found that the superficial external pudendal artery arising as a common trunk from the femoral artery in 15% of cases.

In the present study out of 50 adult specimens , in 2 specimens the superficial epigastric artery was found to arise from a common trunk with the superficial external pudendal artery .This finding coincides with the report of M.Remya et al, but is lower than the incidence quoted by M.Castro**.**

Taylor and Daniel (1975) from 400 groin dissections found that 35% had a deficient superficial epigastric artery and only the superficial circumflex iliac artery. In the present study in all the 50 adult specimens and the 6 foetal specimens the superficial epigastric artery was present.

Robert J. Allen (2002) stated that in 79% the superficial epigastric artery and the superficial circumflex iliac artery arises as a common trunk.

Taylor and Daniel (1975) from 400 groin dissections stated that 48% had the superficial epigastric artery and the superficial circumflex iliac artery arising as a common trunk and from 20 operated cases the authors found that in 3 cases (15%) had a common trunk for the superficial epigastric artery and the superficial circumflex iliac artery.

In the present study in none of the adult and the foetal specimens, the superficial epigastric artery and the superficial circumflex iliac artery arose as a common trunk. This finding differs from the finding of Robert J.Allen and Taylor and Daniel.

7. Origin of deep external pudendal artery

Henry Gray (1858) stated that the deep external pudendal artery arises medially from the femoral artery.

George A.Piersol (1907) quoted that the deep external pudendal artery arises from the medial surface of the femoral artery.

Russel T.WoodBurne (1957) and Barry J.Anson (1971) said that the deep external pudendal artery arises from the medial aspect of the femoral artery.

Sir John Bruce, Robert Wamsley, James A. Ross (1964) stated that the deep external pudendal artery arises from the femoral artery and runs medially to supply the skin of the scrotum and the labium majus.

In the present study, in all 50 adult specimens the deep external pudendal artery arises from the medial surface of the femoral artery as quoted by the above authors.

In all 6 foetal specimens also the deep external pudendal artery arises from the medial surface of the femoral artery.

8. Origin of the profunda femoris artery

a. Origin of the profunda femoris artery below the inguinal ligament

(Chart 4a , 4b ; Table 17 and 18).

According to Quain's classification the distance of origin of the profunda femoris artery below the inguinal ligament is grouped as

Less than 2.5cm.

2.5cm to 3.8cm

3.8cm to 5.1cm and

Greater than 5.1cm .

Less than 2.5 cm

Quain (1844) said that the distance from the inguinal ligament and the origin of the profunda femoris artery was less than 2.5cm in 24.6%.

In the present study out of 50 adult specimens that the distance from the inguinal ligament and the origin of the profunda femoris artery was less than 2.5cm in 6 specimens (12%) which is lower than that quoted by Quains.

In all 6 foetal specimens, the distance from the inguinal ligament and the origin of the profunda femoris artery was between 1.2cm to 1.8 cm. The mean distance is 1.33cm, which was not reported by any scientists.

2.5 to 3.8 cm

Quain (1844) stated that that the distance from the inguinal ligament and the origin of the profunda femoris artery was between 2.5 to 3.8 cm in 42.6%.

Henry Gray (1858) quoted the profunda femoris artery is a large branch that arises 3.5 cm distal to the inguinal ligament.

Renan uflacker (1997) said that the arteria profunda femoris has its origin about 3.5 cm from the inguinal ligament.

In the present study out of 50 adult specimens in 34 specimens 68% the distance from the inguinal ligament and the origin of the profunda femoris artery was between 2.5 to 3.8cm and the average distance is 3.6cm. This finding is higher than the incidence quoted by Quains 42.6%.(Chart 4b and Table 18).

3.8 to 5.1 cm

Quain (1844)stated that that the distance from the inguinal ligament and the origin of the profunda femoris artery was between 3.8 to 5.1 cm in 25.34%.

Buchannan's(1906) and Lockhardt Hamilton (1959) quoted that the distance of origin of the profunda femoris artery below the inguinal ligament is 1.5 to 2 inches.(3.75 to 5 cm)

John L.Cameron (1984) said that the common femoral artery divides into superficial femoral artery and the deep femoral artery 3 to 5 cm below the inguinal ligament.

Keith L. Moore (1980) said that the profunda femoris artery arises 1 to 5 cm inferior to the inguinal ligament.

In the present study, out of 50 adult specimens, in 10 specimens (20%) the distance of the profunda femoris artery and the inguinal ligament was between 3.8 to 4.2 cm which coincides with the above scientists record , but is lower than the percentage quoted by Quains. .(Chart 4b and Table 18).

George A.Piersol(1907) ; Barry J.Anson (1971) and Morris (1893)said that the deep femoral artery arises 4 cm distal to the inguinal ligament.

D.J.Cunningham, (1902), Sir John Bruce, Robert Wamsley, James A. Ross(1964), Robert Rutherford (1976) also stated that the profunda femoris artery arises 4 cm distal to the inguinal ligament.

R.J.Last (1954); Snell (1973) quoted that the profunda femoris artery arises 4cm 1½ inches below the inguinal ligament.

Padmanabhan Siddharth (1985) said that the deep femoral artery originates at a median distance of 4.4cm from the inguinal ligament.

W.Henry hollinshed (1958) stated that the profunda femoris artery is given off approximately 4 to 5 cm below the inguinal ligament.

In the present study, the average distance from the distance from the inguinal ligament and the origin of the profunda femoris artery was 3.6cm which is more closer with the above authors statement..

Quain (1844) stated that the distance of origin of the profunda femoris artery below the inguinal ligament is greater than 5.1cm in only 7.4% of cases.

Russel .T. Wood Burne (1957) and Harold Ellis (1960) quoted that the distance of origin of the profunda femoris artery below the inguinal ligament is 5 cm.

In the present study in none of the cases the distance of origin of the profunda femoris artery below the inguinal ligament is 5cm. So the present study differs with the statement of Quain, Russell.T. Woodburne and Harold Ellis.

b. **Origin of profunda femoris artery in relation to the femoral artery**

(Chart 4c; 4d ; Table 19 and 20).

Lateral

Quain(1844) stated that profunda femoris artery arises laterally from the femoral artery in most of the cases

Henry Gray (1858) Buchannans (1906) George A Piersol (1907) said that profunda femoris artery arises laterally from the femoral artery

R.J.Last (1954)Russel. T. Wood Burne (1957) quoted that profunda femoris artery, the largest and important branch arises from the lateral side of the femoral artery

Lockhart Hamilton (1959) Sir John Bruce (1964) stated that profunda femoris artery the largest branch arises from the lateral side of the femoral artery

Robert Snell (1973) stated that profunda femoris artery is a large and important branch arises from the lateral side of the femoral artery.

Robert B Rutherford (1976); Keith L Moore (1980) quoted that profunda femoris artery originates from the lateral side of the femoral artery

Vani and Saritha (2004) said that arteria profunda femoris is a large branch arising laterally from the femoral artery.

None of the above scientists mentioned about the incidence. In the present study, out of 50 adult specimens, in 38 specimens(76%), profunda femoris artery arises from the lateral side of femoral artery and also in all the 6 foetal specimens , profunda femoris artery arises laterally from the femoral artery.(Chart 4c and Table 19).

Posterolateral

Morris(1893) stated that the profunda femoris artery arises from the back and the lateral part of the femoral artery.

Henry Hollinshed (1958) ; John L.Cameron (1984) said that the profunda femoris artery is usually given off at the posterolateral aspect of the femoral artery.

Renan Uflacker(1997) said that the profunda femoris artery arises laterally and posteriorly from the femoral artery.

Dixit D. P. Metha Kottari (2001) quoted that the profunda femoris artery originated from the posterolateral side of the femoral artery in 35.41%.

In the present study, out of 50 adult specimens ,in 8 specimens (16%) the profunda femoris artery arises posterolaterally from the femoral artery. This is lower than the incidence quoted by Dixit D.P. Mehta (35.41%)..(Chart 4c and 4d).

Posterior

Quain (1844)stated that the profunda femoris artery rarely arises from the posterior aspect of the femoral artery.

Dixit D.P. Mehta(2001) quoted that the profunda femoris artery arises from the posterior aspect pf the femoral artery in31.25%

In the present study, out of 50 adult specimens in 4 specimens (8%) , the profunda femoris artery arises posteriorly from the femoral artery. this incidence is lower than that quoted by Dixit D. P. Mehta. .(Chart 4c and 4d).

Medial

Schrutz (1894) reported a case where the profunda femoris artery arose medially from the femoral artery.

Quain (1844)stated that the profunda femoris artery sometimes arises medially from the femoral artery.

In the present study, in none of the cases the profunda femoris artery was seen to arise medially from the femoral artery.

Anterior

Ercan Tanyeli et al(2006) found in a male cadaver where the deep femoral artery was originating from the anterior aspect of the femoral artery.This was not found in the adult and in the foetal specimens in the present study.

9. ORIGIN OF THE DESCENDING GENICULAR ARTERY

Henry gray (1858)quoted that the descending genicular artery the distal branch of the femoral artery, arises just proximal to the adductor opening.

Buchannan's (1906) ,George A .Piersol (1907), quoted the descending genicular artery arises from the femoral artery, just before the femoral artery passes through the adductor hiatus.

Russell T.Woodburne(1957) said that the descending genicular artery arises from the femoral artery towards the distal end of the sub sartorial canal.

W. Henry Hollinshed (1958) said that just before the femoral artery penetrated the adductor magnus it gives off its last branch the descending genicular artery

Umar H. Choudry (2008)quoted that the origin of the descending genicular artery is just proximal to the adductor hiatus.

In the present study, in all the 50 adult specimens and 6 foetal specimens, the descending genicular artery rises just proximal to the adductor hiatus in the sub sartorial canal.

10. Presence of abnormal branches from the femoral artery

(Chart 5 and Table 21).

Henry Gray (1858)quoted that the lateral circumflex femoral artery may arise from the femoral artery

Adachi (1928) said that the 3 main branches of the femoral artery, the profunda femoris artery, the medial circumflex femoral artery and the lateral circumflex femoral artery must be considered as independent units which can arise in all kinds of combinations and variations of points of origin. If the the profunda femoris artery is associated with the medial circumflex femoral artery and the lateral circumflex femoral artery arising from the femoral artery it is truncus profundo circumflexus medialis.

Poirier (1909) classified the lateral circumflex femoral artery arising fro the femoral artery corresponding to the truncus profunda circumflexus medialis as type 3.

Keen (1961) found that the incidence of the lateral circumflex femoral artery from the femoral artery (type 3 by Poirier) as 20%.

Henry Hollinshed (1958) said that the lateral circumflex femoral artery rises less frequently from the femoral artery above the origin of the profunda.

M.T.Vazquez (2006) stated that the incidence of one of the arteries the lateral circumflex femoral artery or the medial circumflex femoral artery from

the femoral artery and the another from the deep femoral artery as 20.5% (ie) 90 cases out of 346 cases and classified them as type II. In this the lateral circumflex femoral artery arising from the femoral artery is 22.2%

Ercan Tanyeli et al (2006) found a 72 year old male cadaver where the lateral circumflex femoral artery was arising from the lateral aspect of the femoral artery , distal to the origin of the profunda femoris artery.

Marina Baptist (2007) observed in a case the lateral circumflex femoral artery originating directly from the femoral artery unilaterally.

In the present study, out of 50 adult specimens , the lateral circumflex femoral artery was seen arising from the femoral artery in 3 cases (6%). This incidence is less than that quoted by Keen (20%).

In 2 cases the lateral circumflex femoral artery was seen arising from the femoral artery proximal to the origin of the profunda femoris artery and in 1 case , the lateral circumflex femoral artery was seen arising from the femoral artery distal to the origin of the profunda femoris artery which coincides with the finding of Ercan Tanyeli.

In all 6 foetal specimens , the lateral circumflex femoral artery was not arising from the femoral artery .

Free anterolateral thigh flaps for extremity reconstruction is largely based on the lateral circumflex femoral artery for which the knowledge of the anatomy of the lateral circumflex femoral artery is considered essential.

Henry Gray (1858) stated that the the medial circumflex femoral artery often originates from the femoral artery .

Adachi (1928) quoted that if the profunda femoris artery is associated with the lateral circumflex femoral artery and the medial circumflex femoral artery arising from the femoral as the truncus profundo circumflexus lateralis.

Poirier (1909) classified the medial circumflex femoral artery arises from the femoral, corresponding to adachis truncus profundo circumflexus lateralis as type 2.

Keen (1961)found that the incidence of medial circumflex femoral artery from the femoral artery (type 2 by Poirier) as 31%

Henry Hollinshed (1958) quoted that the medial circumflex femoral artery typically arises from the medial or posteromedial aspect of profunda or the femoral artery .

Padmanabhan Siddharth (1985)said that the medial circumflex femoral artery arose separately from the femoral artery or more proximal in 26% of specimens.

M.T.Vazquez (2006) et al quoted that the incidence of the medial circumflex femoral artery arose from the femoral artery as 15.9%.

Marina Baptist (2007) found in 1 case the medial circumflex femoral artery was seen emerging from the femoral artery at the level of origin of the profunda femoris artery

In the present study in 1 case (2%) the medial circumflex femoral artery was seen arising from the femoral artery as per the statement of above scientists at the level of origin of the profunda femoris artery as per the statement of the above scientists. The level of origin coincides with the finding of Ercan Tanyeli but the incidence is lower than that quoted by Keen(31%) and Padmanabhan Siddharth(26%). (Chart 5 and Table 21).

In the present study in all 6 foetal specimens the medial circumflex femoral artery was not seen arising from the femoral artery.

The medial circumflex femoral artery is the important source of blood supply to the head of femur and is important when undertaking clinical procedures in the femoral region and in hip joint replacement.

Christina.A.Evans (2007) observed an unusually long trunk for the medial circumflex femoral artery and the lateral circumflex femoral artery that arises from the femoral artery inferior to subcutaneous branches. In the present study common trunk for the medial circumflex femoral artery and the lateral circumflex femoral artery arising from the femoral artery was not observed.

M.Remya and Gopinathan (2007) found in the right lower limb of an adult male cadaver 2 thick branches from the femoral artery are seen. One from the medial side and the other from the lateral side of the femoral artery. The thick medial branch resembled the profunda femoris artery . The other branch from the lateral side of the femoral artery gave a small branch to the lateral side and then continued medially behind the femoral vessels like the medial circumflex femoral artery, its lateral branch resembled the lateral circumflex femoral artery . In the present study no such abnormality was found.

CONCLUSION

Femoral artery, the chief artery of the lower limb and the vessel of surgical and radiological importance, has been studied in detail by dissection, radiological and histological methods. The origin of the femoral artery in relation to mid inguinal point , diameter of the femoral artery branching pattern of femoral artery have been observed and correlated with the findings of already existing studies.

The following conclusions are derived from the parameters:

- The origin of the femoral artery coincided with the mid inguinal point in most of the cases (80%). However , the origin of femoral artery is lateral to mid inguinal point in 12% of the cases and medial to mid inguinal point in 8% of the cases.

- The mean diameter of femoral artery is 7.26 mm in males and 5.8mm in females. The minimal luminal diameter in females is lower than that in males

- In all the specimens the femoral vein is medial to femoral artery at the base of the femoral triangle; in the distal femoral triangle and in the upper part of the adductor canal the femoral vein is posterior to the femoral artery; and in the distal part of the adductor canal the vein is posterolateral to the femoral artery.

- In majority of specimens the superficial circumflex iliac artery arises as a separate trunk from the femoral artery (90%). In 10% of the cases , the superficial circumflex iliac artery is absent.

- In 96% of specimens superficial external pudendal artery arises from the femoral artery as a single trunk.

- In 96% of specimens superficial epigastric artery arises from the femoral artery as a single trunk. In 4% of the cases the superficial external pudendal artery and superficial epigastric artery have a common trunk of origin from the femoral artery.

- The superficial external pudendal artery is anterior to the arch of great saphenous vein in 52% of cases and posterior to the arch of great saphenous vein in 32% of cases.

- In all cases the deep external pudendal artery arises from the medial surface of the femoral artery

- The distance of the origin of profunda femoris artery below the inguinal ligament is less than 2.5cm in 12% of cases, between 2.5-3.8cm in 68% of cases, between 3.8-5.1cm in 20% of cases

- The origin of the profunda femoris artery is lateral to the femoral artery in most of the cases (76%). In 16% of the cases the origin of profunda femoris artery is posterolateral to the femoral artery and in 8% of the cases the origin of the profunda femoris artery is posterior to the femoral artery.

- In all the specimens, the descending genicular artery arises just proximal to the adductor opening to the distal end of adductor canal.

- In 84% of cases both lateral circumflex femoral artery and medial circumflex femoral artery arises from the profunda femoris artery.

- In 2% of cases, the medial circumflex femoral artery arises from the femoral artery.

- In 6% of cases the lateral circumflex femoral artery arises from the femoral artery. In these 6% the origin of the lateral circumflex femoral

artery was proximal to the origin of the profunda femoris in 4% of cases. In another 2% the origin of the lateral circumflex femoral artery was distal to the origin of the profunda femoris artery.

Based on this study, I here by conclude that femoral artery has a complex variation in its origin, relationship with the arch of great saphenous vein and its branching patterns. I hope that this study of the branching pattern and surgical anatomy of the femoral artery will be definitely useful to the cardiologists, radiologists, plastic surgeons and vascular surgeons in the future.

STAINING PROCEDURE FOR FORMALIN FIXED SPECIMENS

Dehydration with graded alcohol

↓

Cleaning with xylol

↓

Impregnation with wax

↓

Embedding

↓

Sectioning

↓

Mounting of Sections

↓

Staining

Staining

↓

Deparaffinization

↓

Hydration with graded alcohol

↓

Haematoxylin and Eosin Staining

↓

Dehydration

↓

Cleaning

↓

Mounting the slide with DPX

(Cytoplasm – Pink)
(Nucleus – Purple)

Table 1

Origin Of Femoral Artery In Relation To Mid Inguinal Point.

BODY NO	S.No	Gender	Side of the limb	Distance between pubic symphysis and anterior superior iliac spine(in cms)	Mid point of the distance between pubic symphysis and anterior superior iliac spine-mid inguinalpoint	Distance of origin of femoral artery and pubic symphysis
1	1	F	R	14.8	7.4	7.1
	2		L	14.8	7.4	7.1-MEDIAL
2	3	M	R	16.4	8.2	8.2
	4		L	16.4	8.2	8.2
3	5	M	R	17.6	8.8	9.1
	6		L	17.6	8.8	9.1-LATERAL
4	7	F	R	14.2	7.1	7.1
	8		L	14.2	7.1	7.1
5	9	M	R	18	9	9.3
	10		L	18	9	9.3-LATERAL
6	11	M	R	16	8	8
	12		L	16	8	8
7	13	M	R	16.8	8.4	8.7
	14		L	16.8	8.4	8.7-LATERAL
8	15	F	R	16.8	8.4	8.2
	16		L	16.8	8.4	8.2-MEDIAL
9	17	M	R	17	8.5	8.5
	18		L	17	8.5	8.5
10	19	M	R	18	9	9
	20		L	18	9	9
11	21	F	R	16.2	8.1	8.1
	22		L	16.2	8.1	8.1

BODY NO	S.No	Gender	Side of the limb	Distance between pubic symphysis and anterior superior iliac spine(in cms)	Mid point of the distance between pubic symphysis and anterior superior iliac spine-mid inguinalpoint	Distance of origin of femoral artery and pubic symphysis
12	23	M	R	18	9	9
	24		L	18	9	9
13	25	M	R	16.6	8.3	8.3
	26		L	16.6	8.3	8.3
14	27	F	R	15	7.5	7.5
	28		L	15	7.5	7.5
15	29	M	R	17.2	8.6	8.6
	30		L	17.2	8.6	8.6
16	31	M	R	16.6	8.3	8.3
	32		L	16.6	8.3	8.3
17	33	M	R	15.8	7.9	7.9
	34		L	15.8	7.9	7.9
18	35	M	R	16.4	8.2	8.2
	36		L	16.4	8.2	8.2
19	37	F	R	15.6	7.8	7.8
	38		L	15.6	7.8	7.8
20	39	F	R	18	9	9
	40		L	18	9	9
21	41	M	R	14.6	7.3	7.3
	42		L	14.6	7.3	7.3
22	43	F	R	18.8	9.4	9.4
	44		L	18.8	9.4	9.4
23	45	M	R	19.2	9.6	9.6
	46		L	19.2	9.6	9.6
24	47	M	R	17.4	8.7	8.7
	48		L	17.4	8.7	8.7
25	49	M	R	18	9	9
	50		L	18	9	9

Table –2

Origin Of Femoral Artery In Relation To Mid Inguinal Point.

S.No		No. of adult Cases	Percentage
1	Origin of femoral artery coinciding with to mid inguinal point	40	80%
2	Origin of femoral artery lateral to mid inguinal point	6	12%
3	Origin of femoral artery medial to mid inguinal point	4	8%

Table - 3

Diameter Of The Femoral Artery By Direct Dissection Method

S.No	Gender	Diameter (in mm) right side	Diameter (in mm) left side
1	F	5	5
2	M	7	7
3	M	8	8
4	F	7	7
5	M	8	8
6	M	8	8
7	M	8	8
8	F	6	6
9	M	8	8
10	M	7	7
11	M	6	6
12	M	8	8
13	M	8	8
14	F	5	5
15	M	8	8
16	M	7	7
17	M	7	7
18	M	8	8
19	F	6	6
20	F	7	7

The mean diameter of common femoral artery in males is 7.25 mm and in females is 5.8 mm. The range of the intra luminal diameter in females is 5-7mm and the range of the intra luminal diameter in males is 7-8mm

Table - 4

Diameter of the femoral artery by moulds prepared from silicone gel

The diameter of the femoral artery measured by direct dissection method was confirmed by moulds prepared from silicone gel in 10 adult femoral artery specimens and tabulated as follows:

S.No	Body no	Gender	Diameter on right side	Diameter on left side
1	8	FEMALE	6	6
2	3	MALE	8	8
3	10	MALE	7	7
4	19	FEMALE	6	6
5	21	MALE	8	8

The mean diameter in males is 8cm and that in females is 6cm. Also the minimal luminal diameter in females is less than that in males.

Table - 5

Origin Of Superficial Circumflex Iliac Artery

S.No	Superficial circumflex iliac artery	No. of adult specimens	Percentage
1.	Arising as a separate trunk	45	90%
2.	Absence of SCIA	5	10%

Table - 6

Origin of Superficial External Pudendal Artery

Origin Of Superficial External Pudendal Artery	No. of adult specimens	Percentage
Arising as a separate trunk from femoral artery	48	96%
Arising as a common trunk with superficial epigastric artery	2	4%

Table – 7

Relationship of superficial external pudendal artery and great saphenous vein

S. NO.	Relationship Of Superficial External Pudendal Artery And Great Saphenous Vein.	No of Specimens	Percentage
1	EPA NOT VISUALISED	8	16%
2	EPA POSTERIOR	16	32%
3	EPA ANTERIOR	26	52%

Table - 8

Origin Of Superficial Epigastric Artery

S. No.	Origin of superficial epigastric artery	No. of adult specimens	Percentage
1	Arose as a separate trunk from the femoral artery	48	96%
2	Arose as a common trunk with superficial external pudendal artery.	2	4%

Table - 9

Distance between the origin of profunda femoris artery from the inguinal ligament

S.No	Gender	Distance of origin of PFA from inguinal ligament (RIGHT SIDE) in cms.	Distance of origin of PFA from inguinal ligament (LEFT SIDE) in cms.
1	F	3.8	3.8
2	M	3.6	4
3	M	3.7	3.8
4	F	1	1
5	M	3.7	3.7
6	M	3.8	3.6
7	M	1	3.6
8	F	3.6	3.8
9	M	3.7	3.7
10	M	1.5	3.8
11	F	3.7	3.8
12	M	4.0	3.6
13	M	3.7	3.7
14	F	3.8	3.7
15	M	3.6	1.5
16	M	3.7	3.5
17	M	3.5	4
18	M	2	3.7
19	F	3.8	3.5
20	M	3.5	3.7
21	M	3	4
22	M	4	4.2
23	M	4	3.8
24	M	3.8	4.0
25	M	4.0	4

The mean distance between the origin of profunda femoris artery from the inguinal ligament is 3.4 cm

Table - 10

Distance Between The Origin Of Profunda Femoris Artery From The Inguinal Ligament In Foetal Specimens

S.No	Gender	Distance of origin of PFA from inguinal ligament (RIGHT SIDE) cm	Distance of origin of PFA from inguinal ligament (LEFT SIDE) cm
1	M	1.5	1.5
2	M	1.2	1.2
3	M	1.8	1.8

Mean 1.33 cm

Table – 11

Origin of profunda femoris artery from the femoral artery

S.No	Type	No of adult specimens	Percentage
1	Lateral	38	76%
2	Posterolateral	8	16%
3	Posterior	4	8%

Table - 12

Diameter of femoral artery by 64 slice computerised tomographic scan of pelvis

S.No	Gender	Diameter of femoral artery –right side (mm)	Diameter of femoral artery –left side(mm)
1	M	9.3	9.3
2	F	8.3	8.4
3	M	6	10
4	F	6	8
5	M	7.3	7.3
6	M	7.3	7.3
7	F	6.1	6.1
8	M	6.6	6.6
9	M	9.3	9.4
10	M	8.4	8.4

Table-13

Origin of the Femoral Artery in Relation to the Mid Inguinal Point-Present study

S.No	Origin of the femoral artery in relation to the mid inguinal point	No. of adult cases	Percentage
1.	Origin of the femoral artery coinciding with the mid inguinal point	40	80%
2.	Origin of the femoral artery lateral to the mid inguinal point	6	12%
3	Origin of the femoral artery medial to the mid inguinal point	4	8%

Table 14

Origin of the Superficial Circumflex Iliac Artery-Present study

S.No	Superficial circumflex iliac artery	No. of adult cases	Percentage
1.	Arising as a separate trunk	45	90%
2.	Absence of Superficial circumflex iliac artery	5	10%

Table –15

Origin of the Superficial Circumflex Iliac Artery

S.No	Origin of the Superficial Circumflex Iliac Artery	Taylor and Daniel from 400 groin dissections	Taylor and Daniel from 20 operated cases	Robert J. Allen	Present study
1.	SCIA arising as a separate trunk from the femoral artery	17%	45%	_	90%
2.	SCIA arising as a common trunk with SEA	48%	15%	79%	_
3.	Absence of SCIA	_	25%	_	10%
4.	Origin of SCIA from the femoral artery	17%	_	_	_

Table 16

Relationship of the Superficial External Pudendal Artery and Great Saphenous Vein

S.No		M. Donnelly	Ass ndaiye	Preethi	Present study
1.	Superficial external pudendal artery anterior to the great saphenous vein	16.8%	_	10%	32%
2.	Superficial external pudendal artery posterior to the great saphenous vein	4.6%	56%	8%	52%
3.	Superficial external pudendal artery not visualized at the sapheno femoral junction	73.1%	__	74%	16%

Table -17

Origin of Profunda Femoris Artery below the Inguinal Ligament - Present study

S. No		No. of adult cases	Percentage
1.	Less than 2.5 cm	6	12%
2.	2.5-3.8 cm	34	68%
3.	3.8 – 5.1 cm	10	20%

Table –18

Origin of Profunda Femoris Artery below the Inguinal Ligament

S.No	Origin of profunda femoris artery below the inguinal ligament	Quain	Present study
1.	Less than 2.5 cm	24.6%	12%
2.	2.5 to 3.8 cm	42.6%	68%
3.	3.8 – 5.1 cm	25.34%	20%
4.	Greater than 5.1 cm	7.4%	-

Table 19

Origin of the Profunda Femoris Artery in Relation to the Femoral Artery-Present study

S.No		No. of adult cases	Percentage
1.	Lateral	38	76%
2.	Posterolateral	8	16%
3.	Posterior	4	8%

Table 20

Origin of the Profunda Femoris Artery in Relation to the Femoral Artery

S.No.		Dixit D.P. Mehta	Present study
1.	Lateral	-	76%
2.	Posterolateral	35.41%	26%
3.	posterior	31.25%	8%

Table 21

Presence of Abnormal Arteries from the Femoral Artery

S.No.		Keen	Present study
1.	Both LCFA and MCFA from PFA	42%	92%
2.	LCFA from FA	20%	6%
3.	MCFA from FA	31%	2%
4.	Both LCFA and MCFA from FA	7%	-

LEGEND

1. EIA—EXTERNAL ILIAC ARTERY.
2. FA---FEMORAL ARTERY.
3. FV---FEMORAL VEIN.
4. FN---FEMORAL NERVE.
5. AL---ADDUCTOR LONGUS.
6. Sar---SARTORIUS.
7. AM---ADDUCTOR MAGNUS.
8. VM---VASTUS MEDIALIS.
9. IL—INGUINAL LIGAMENT.
10. PS—PUBIC SYMPHYSIS.
11 ASIS—ANTERIOR SUPERIOR ILIAC SPINE.
12. MIP—MID INGUINAL POINT.
13. GSV—GREAT SAPHENOUS VEIN.
14. SCIA—SUPERFICIAL CIRCUMFLEX ILIAC ARTERY.
15. SEPA—SUPERFICIAL EXTERNAL PUDENDAL ARTERY.
16. SEA—SUPERFICIAL EPIGASTRIC ARTEY.
17. DEPA—DEEP EXTERNAL PUDENDAL ARTERY.
18. DGA—DESCENDING GENICULAR ARTERY.
19. PFA—PROFUNDA FEMORIS ARTERY.
20. MCFA—MEDIAL CIRCUMFLEX FEMORAL ARTERY.
21. CT—COMMON TRUNK.
22. LCFA – LATERAL CIRCUMFLEX FEMORAL ARTERY.
23. TI—TUNICA INTIMA.
24. TM—TUNICA MEDIA.
24. TA—TUNICA ADVENTITIA.
25. IEL—INTERNAL ELASTIC LAMINA.
26. EEL—EXTERNAL ELASTIC LAMINA.

BIBLIOGRAPHY

1. **Adachi.B. (1928)** Das Arteiensystem des Japaner Kyoto vol I pg 8 205, 208, 210, 280, 309, 315 322, 357 358, 365 ,368, 389. Vol II PG 137 147, 152, 154, 197, 200, 204 206, 227 242, 262, 269.

2. **Ass Ndiaye; Abd Ndaiye; J.M.Ndoye; O.Diarra; M.Diop; A. Dia, M.Ndaiye and M.L Sow** in Surgical and Radiological Anatomy . vol 28/no.1/ march 2006

3. **Barry.J.Anson & Chester.B.McVay** in his book- Anatomy (1971) pages 1118-1121.

4. **Boyd et al** in text book of human anatomy. (1956) pages 363-365.

5. **Buchannan's** in Buchannan Manual of Anatomy. (1906) pages 581-587.

6. **Castro.M; E.Brenda; A.Marques; M.D.Pereria** in European Journal of Plastic surgery vol 21/no 2/Jan 1998.

7. **Christina A.Evans, Kent S Smith and Kirby.L.Jarolim** in the Faseb Journal,2007;21:776-11

8. **Cunningham D.J.** in Cunningham"s Textbook of Anatomy(1902) pages 995-99.

9. **Dixit; D.P.Mehta; Kothari.M.L.**-Journal of Anatomical Society of India 50(1)-6-7(2001).

10. **Donnelly.M, Tierney, T.M. Feeley** ln Anatomical Variation at the Saphenofemoral Junction in British Journal of Surgery vol 92, issue 3, pages 322-325 March 2005.

11. **Dr.Bharat Trivedi** in Journal of Anatomical society of India vol 54;no.1 (2005)

12. **Dr.Scott P.D; P.L.T.William** in a study of surface markings of the Inguinal region in Clinical Anatomy. Vol 4/issue 3/pages 216-222. published on 24 Jan 2005.

13. **Ercan Tanyeli, Mehmet Yildrim; Mehmet Uzel; and Feridun Vural** in Surgical and Radiological Anatomy.vol 20/issue 2/pages 211-213, May 2006.

14. **Fatih Kantarci ,M.D., Ismail Mihmanli, M.D., Hilmi Aksoy.M.D., Hakan Barutca,M.D., Bengi Gurses, M.D., and Kamil Kaynak M.D.** in Journal of Ultrasound Medicine 22: 641-643 (2003).

15. **George .A.Piersol M.D.** in Historical Title Page of Human Anatomy (1907).

16. **Haimovici's** in Haimovici's Vascular Surgery (2004).

17. **Harold Ellis** in Clinical Anatomy 7th edition (1960). Pages 292-294.

18. **Henry Gray** (1858) in Grays Anatomy-39th edition.

19. **Henry Hollinshed W**. in Anatomy for surgeons vol III 2nd edition 1958 Pages 725-731.

20. **Hughes P; C.Scott and A.Bodenham** in British Journal of Anaesthesia 2000; vol 84; no 668-669.

21. **Jeremy.A.Hunt, John.P.Harris** Is the mid inguinal point an accurate landmark for the common femoral artery . in ANZ Journal of surgery vol 66/ issue 1 page-43-45,Jan 1996.

22. **John.L.Cameron** in current surgical therapy 7th edition 1984(pages 905-907)

23. **Johnston. –**A rare anamoly of the arteria profunda femoris. Anat. Anz. 42 :269 -1912.

24. **Keen.J.A**. (1961) a study of the arterial variations of the limbs, American Journal of Anatomy vol 108, March, May 1961 , pages 254-256.

25. **Keith.L.Moore; Arthur.F.Dalley** in his book clinically oriented anatomy 4th edition (1980) page 545-546.

26. **Last** in Last's Anatomy 1954 9th edition. Pages 154-155.

27. **Lockhardt.R.D; G.F.Hamilton in Anatomy of the human Body.(1959).**

28. **Mangala M Pai; Latha V Prabu; Prakash; Varsha Nayak** In Brazil Journal Of Cardiovascular Surgery 2006.

29. **Marina Baptist; Ferdose Sultana; Tassaduq Hussain** In Professional Medicine Journal Sept 2007 14(3):523-7

30. **Massoud T.F and E.W.L.Fletcher** in surgical and radiological anatomy vol 19, no 2/ March 1997.

31. **Morris** in Morris human anatomy -11th edition (1893)

32. **Nurhan Seyahi; Arzu Kahveci, Mehmet R Altiparmak; Kamil Serdengercti and Ekrem Erek** in Nephrology dialysis transplantation: vol 20: no.9: June 2005.

33. **Osvaldir Lanzoni La Falce; Joao Dias Ambrosio; Romeu Rodrigues De Souza** In Clinics Vol.61;No.5 Sao Paulo Oct 2006

34. **Padmanabhan Siddharth: Noel.L.Smith Robert.A.Mason Fabio Giron** in the anatomical record; vol 212,issue 2, pages 206-209(1985).

35. **Plillip.A. Baum.M.D. Alan H. Matsumoto M.D.George. P.Teitelbaun.M.D. Rebecca A. Zuurbier M.D; Klenmens H.Barth M.D.** in Cardio vascular Radiology 173:775-777 1989.

36. **Poirier,** Traite and Anatomie Humaine vol 2,1909.

37. **Preethi Remya** in a study of great saphenous vein including it's surgical and radiological importance, page no.45,2008.

38. **Quain R (**1844).The anatomy of arteries in human body.

39. **Remya M and K Gopinathan** In Journal Of Anatomical Society Of India Vol 56; No 1; 2007.

40. **Renan Uflacker** in Atlas of Vascular Anatomy 1997 pages 608,635.

41. **Richard.S.Snell** (1973) in Clinical Anatomy for Medical students- 5th edition pages 530-533.

42. **Robert .J.Allen .M.D.;F.A.C.S. and Andreas. S. Heitland.M.D**., in Seminars in Plastic Surgery.vol 16/no1/2002.

43. **Robert. B. Rutherford** in his book of vascular surgery 6th edition (1976) page 657.

44. **Russell T. Woodburne, A.M.,**Ph.d in Essentials of human anatomy(1957).

45. **Sahin.B and S.Bilgic** in Surgical and Radiological Anatomy vol 20/no 3/July 1998.

46. **Sandgren.T, Sonesson.B, Ahlgren.R, Lanne.T** in Journal of vascular surgery March 1999; 29(3):503-10.

47. **Scheibel.M; W.Schmidt; M. Thomas; G.Von Salis Soglio** in Surgical and Radiological Anatomy.vol 24;no1/ Jan 2002

48. **Schnyder et al** in Journal of Invasive Cardiology 16(5):247-250.2004

49. **Schrutz.A. Zu Zaaijer's Artikel: Seltene Abweichung du**. A. profunda femoris anatomy Anat .Anz.9:727,1894.

50. **Sir John Bruce, Robert Wamsley, James.a.Ross (1964)** in Manual Of Surgical Anatomy pages 455-459.

51. **Taylor (1975)** G.J. the Anatomy of several free flap dornar sites / Plastic and Reconstructive surgery 1975; 56:243-246 15

52. **Tisheng Chang, Sheng hsiu.chu, Chung Cheng Wang** in Principles Techniques And Application In Microsurgery (1986) page 175-176.

53. **Umar H Choudry Md; Karim Bakri Md ; Stevan L Moran Md; Zey**nep **Karacor MD; and Alexander Y Shin MD** in Annals of Plasic Surgery.Vol 60/No.2/Feb 2008.

54. **A.Vani and S.Saritha** in the Journal of Anatomical Society of India, June 2004.

55. **Varquez M T; J Murillo: E Maravillo; I Parkin; J.Sanudo** in Clinical Anatomy vol 20/ issue 2/ pages 180-185; 2006.

Fig. 1: CARDIAC CATHETERISATION THROUGH FEMORAL ARTERY

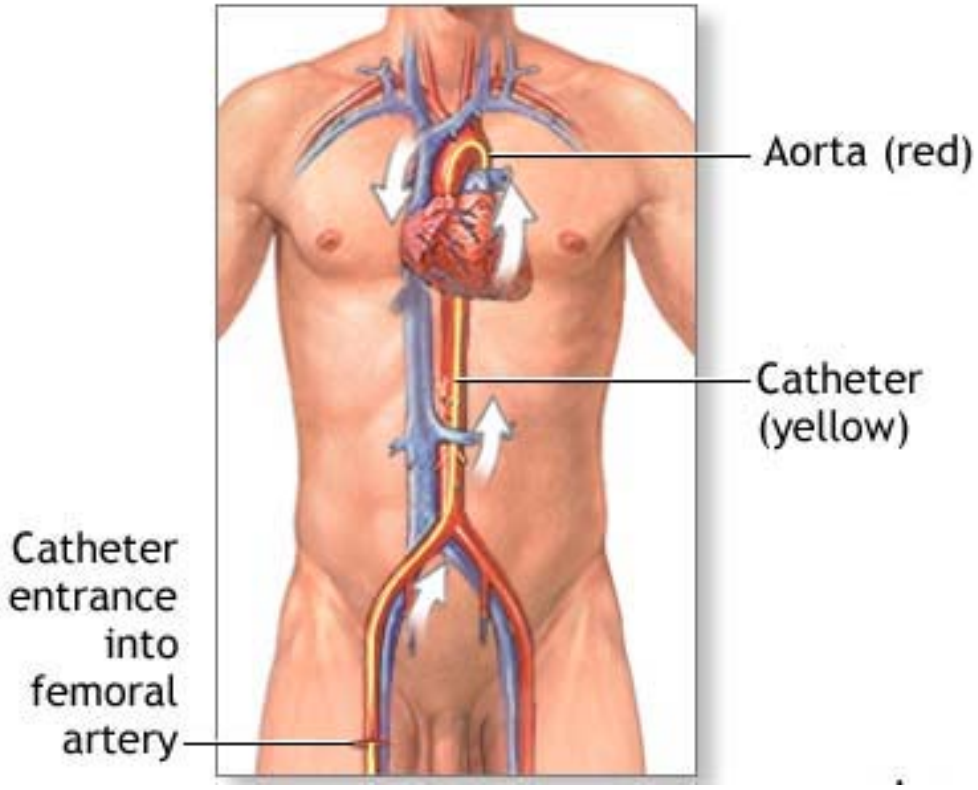

Fig. 2: BLOOD VESSELS OF GROIN FLAP

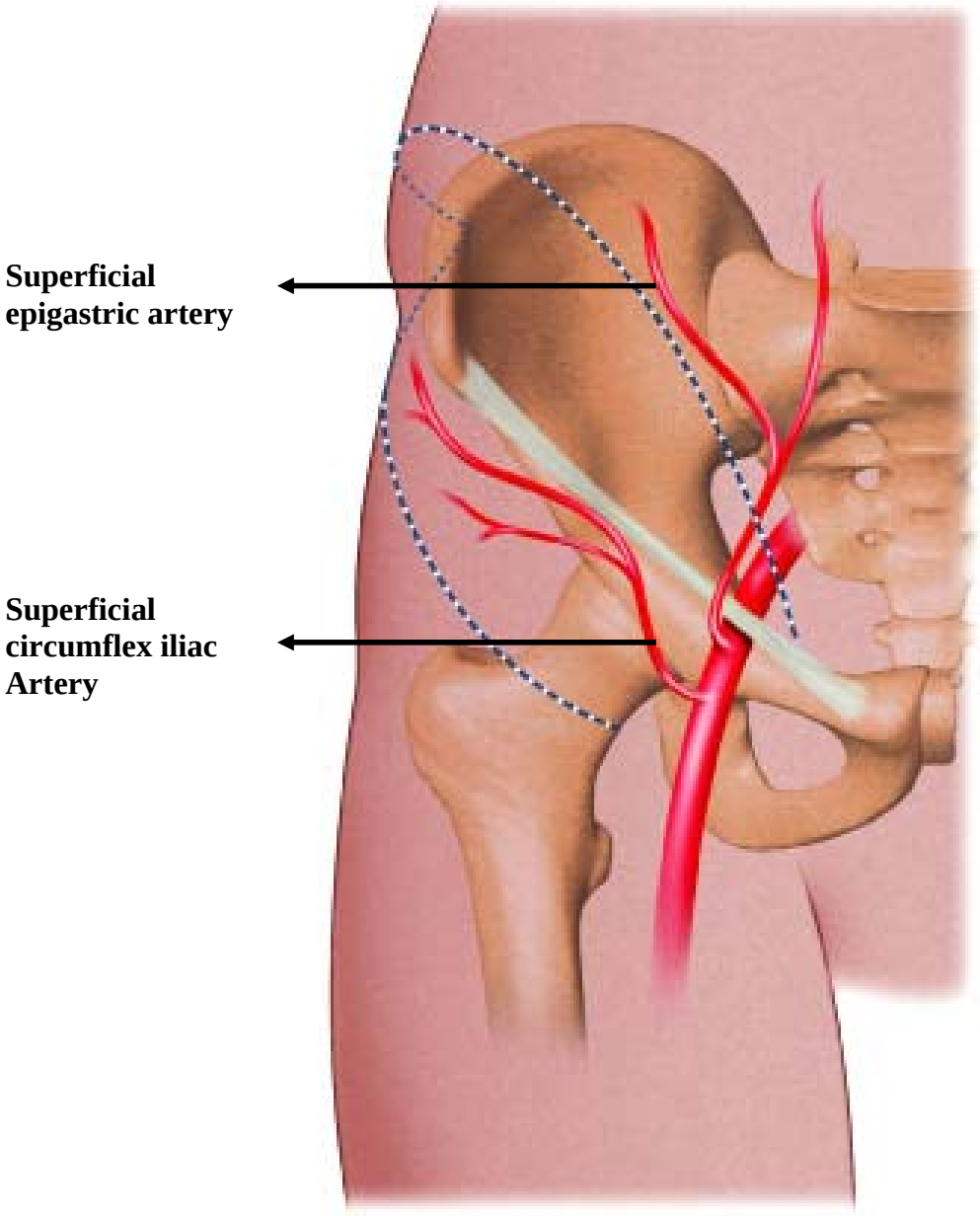

Fig. 3: ARTERIES OF THE HIP

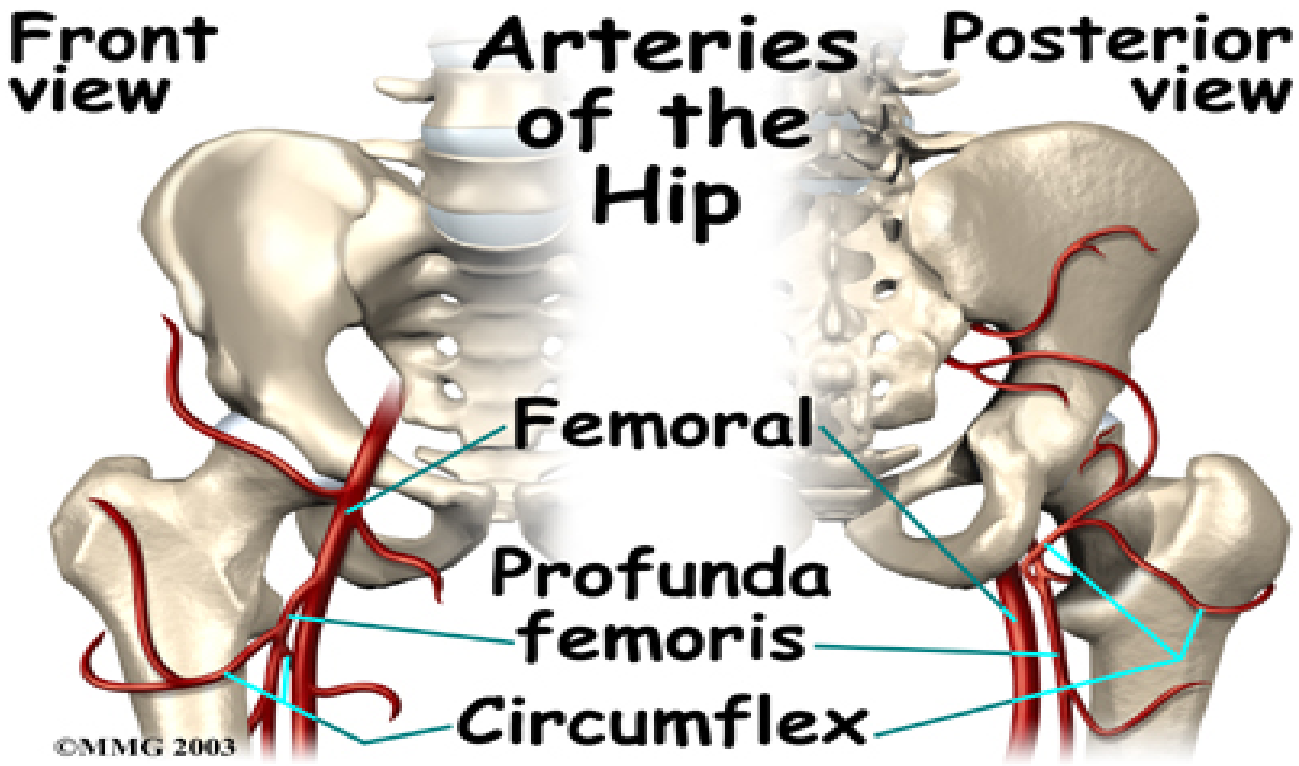

Fig. 8: SUPERFICIAL EXTERNAL PUDENDAL ARTERY ANTERIOR TO GREAT SAPHENOUS VEIN

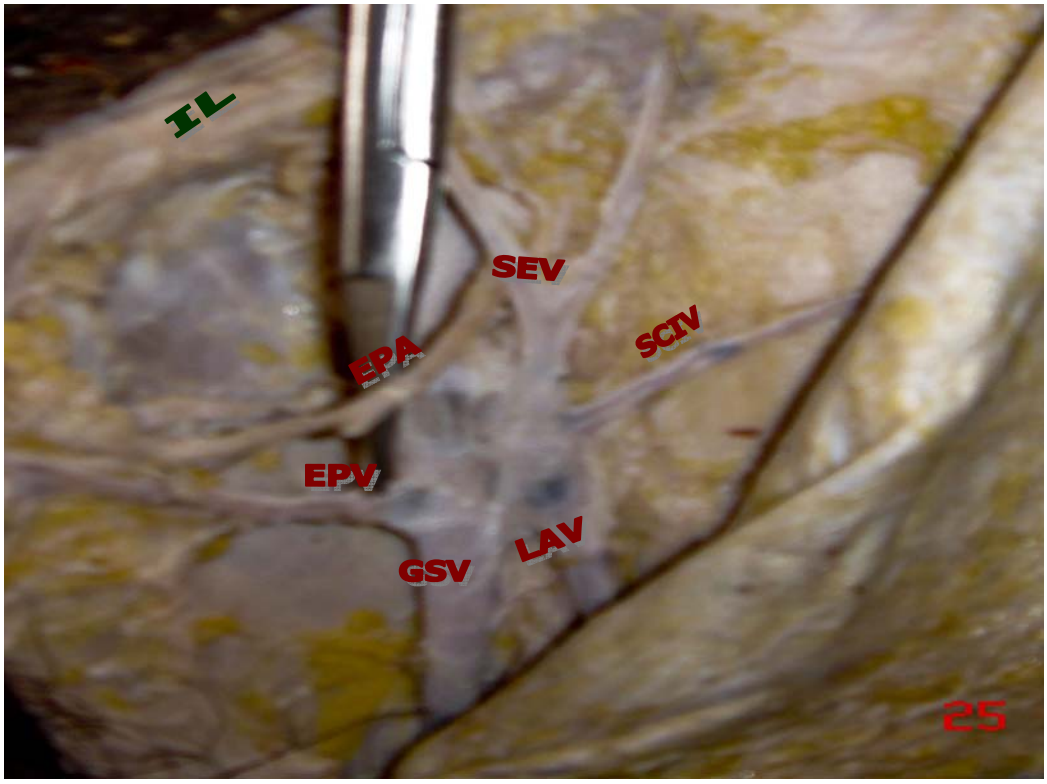

Fig. 9: SUPERFICIAL EXTERNAL PUDENDAL ARTERY POSTERIOR TO GREAT SAPHENOUS VEIN