



Original Article

Study of Branching Pattern and Surgical Anatomy of Femoral Artery

Authors

Dr Rekha Bhasin^{1*}, Dr Sajad², Dr Sunanda Raina³

¹MD Tutor Demonstrator, Anatomy Department, Govt. Medical College, Jammu

²Faculty Anatomy

³Prof & HOD Anatomy, Govt. Medical College, Jammu

Corresponding Author

Dr Rekha Bhasin

MD Tutor Demonstrator, Anatomy Department, Govt. Medical College, Jammu, India

Email: drrekhabhasin@rediffmail.com

Abstract

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. 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, We have done a cadaveric study about femoral artery, its branching pattern and variations, with its clinical application. The origin of the femoral artery coincided with the mid inguinal point in most of the cases. The origin of the profunda femoris artery is lateral to the femoral artery in most of the cases. Based on this study, we here by conclude that femoral artery has a complex variation in its origin, and its branching patterns. We 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.

Keywords: Femoral Artery; Branching Pattern; Surgical Anatomy.

Introduction

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 behind the inguinal ligament midway between anterior superior iliac spine & pubic symphysis descends along the anteromedial part of the thigh in the femoral triangle, enter and passes through the adductor canal and becomes popliteal artery as it passes through adductor canal near the junction of middle and distal thirds of thigh. Its first three or four centimetres are 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.

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, We have done a cadaveric study about femoral artery, its branching pattern and variations, with its clinical application

Material & Methodology

The study materials consists of 15 adult lower limb specimens (11 males and 4 females) Which were dissected while demonstrating Cadaveric anatomy to the first year MBBS students. 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 midpoint 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.

Observation

The femoral artery and its branching patterns were studied. 15 (4 female limbs and 11 male limbs) lower limbs from adult cadavers were taken for study. The findings were noted and summarized as follows under the following headings.

Origin of femoral artery in relation to mid inguinal point

In all 15 cases the distance between pubic symphysis and anterior superior iliac spine was measured using a measuring tape and defined as inguinal distance. The midpoint 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 15 adult specimens, only in 14 specimens the origin of femoral artery coincided with the mid inguinal point. In 1 specimens the origin of femoral artery is lateral to the mid inguinal point, more towards midpoint of inguinal ligament.

Relationship between femoral artery and femoral vein

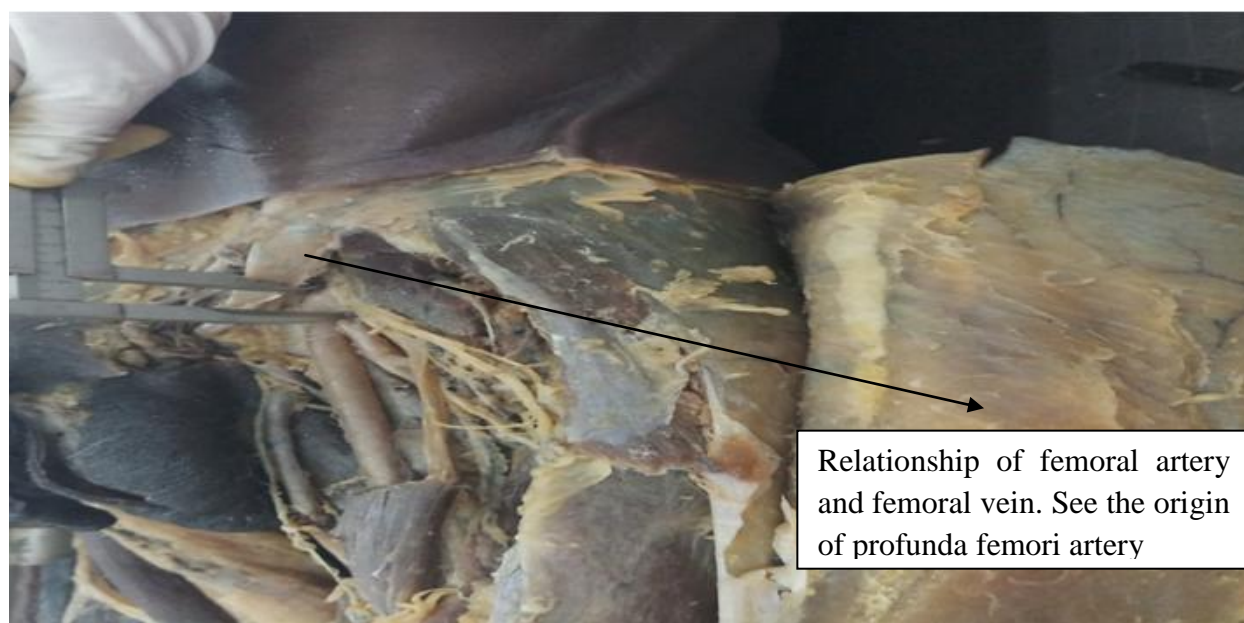
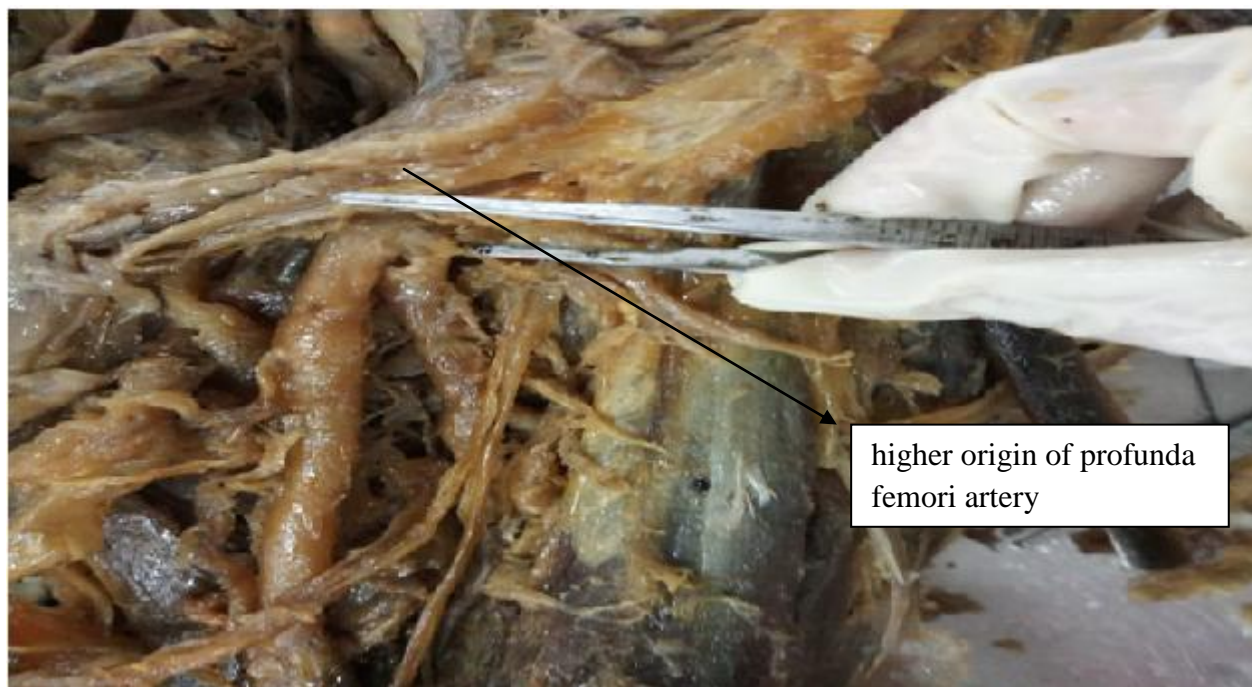
In all 15 adult specimens, at the base of the femoral triangle the femoral vein is medial to the femoral artery; in the distal femoral triangle and in the proximal part of the adductor canal, the femoral vein is posterior to the femoral artery; in the distal adductor canal the femoral vein is posterolateral to the femoral artery.

Origin of the profunda femoris artery**Distance of origin of profunda femoris artery from the inguinal ligament**

Out of 15 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.

Origin of the Profunda femoris artery in relation to the femoral artery

Out of 15 adult specimens, profunda femoris artery arose laterally from the femoral artery in majority, whereas in some cases profunda femoris artery arose poster laterally from the femoral artery.

**Discussion**

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),⁽¹⁻⁶⁾ have reported that the origin of femoral artery is midway between anterior superior iliac spine and pubic symphysis.

In the present study the origin of femoral artery was between anterior superior iliac spine and pubic symphysis in 15 adult specimens, which coincides with the statement of the above scientists. But they have not mentioned any statistical data about the incidence.

Barry J. Anson Chester B. McVay (1971), Haimovici's (2004), (7,8) have said that femoral artery enters the thigh midway between anterior superior iliac spine and pubic tubercle.

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)⁽⁷⁾ 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⁽⁵⁾ 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 15 adult specimens 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 Gray 1858, Buchannan's 1906, Barry J. Anson 1971 and Keith L. Moore.^(1,5,7,9) Barry J. Anson, Chester B. McVay (1971)⁽⁷⁾ also mentioned that occasionally the femoral vein is found anteriorly or laterally. A. Vani and S. Saritha (2004)⁽¹⁰⁾ 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)⁽¹¹⁾ quoted that in most patients there was some degree of overlap of the artery over the vein.

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.

Origin of the profunda femoris artery: Origin of the profunda femoris artery below the inguinal ligament. According to Quain's⁽¹²⁾ 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)⁽¹²⁾ 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 15 adult specimens that the distance from the inguinal ligament and the origin of the profunda femoris artery was less than 2.5cm in 2 specimens (12%) which is lower than that quoted by Quain's⁽¹²⁾. Quain (1844)⁽¹²⁾ stated that the distance from the inguinal ligament and the origin of the profunda femoris artery was between 2.5 to 3.8 cm in 46.6%. D. J. Cunningham, (1902), Sir John Bruce, Robert Wamsley, James A. Ross (1964), Robert Rutherford (1976)⁽¹³⁻¹⁵⁾ also stated that the profunda femoris artery arises 4 cm distal to the inguinal ligament. R.J. Last (1954); Snell (1973)^(6,16) quoted that the profunda femoris artery arises 4cm 1½ inches below the inguinal ligament. W. Henry Hollinshed (1958)⁽¹⁷⁾ 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)⁽¹²⁾ stated that the distance of origin of the profunda femoris artery below the inguinal ligament is greater than 5.1cm in only 2 of cases. Russel .T. Wood Burne (1957) and Harold Ellis

(1960)^(18,19) quoted that the distance of origin of the profunda femoris artery below the inguinal ligament is 5 cm. Quain (1844)⁽¹²⁾ stated that profunda femoris artery arises laterally from the femoral artery in most of the cases. Henry Gray (1858)⁽¹⁾ Buchannans (1906)⁽⁹⁾ George A Piersol (1907)⁽²⁾ said that profunda femoris artery arises laterally from the femoral artery. R. J. Last (1954)⁽¹⁶⁾ Russel. T. Wood Burne (1957)⁽¹⁸⁾ quoted that profunda femoris artery, the largest and important branch arises from the lateral side of the femoral artery. Lockhart Hamilton (1959)⁽²⁰⁾ Sir John Bruce (1964)⁽⁴⁾ stated that profunda femoris artery the largest branch arises from the lateral side of the femoral artery. Robert Snell (1973)⁽⁶⁾ stated that profunda femoris artery is a large and important branch arises from the lateral side of the femoral artery.

Robert B Rutherford (1976)⁽¹⁵⁾; Keith L Moore (1980)⁽⁵⁾ quoted that profunda femoris artery originates from the lateral side of the femoral artery. Vani and Saritha (2004)⁽¹⁰⁾ 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 15 adult specimens, in 12 specimens, profunda femoris artery arises from the lateral side of femoral artery

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.

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 distance from the inguinal ligament and the origin of the profunda femoris artery was less than 2.5cm in 2 specimens (12%) which is lower than that quoted by Quains⁽¹²⁾. Quain (1844)⁽¹²⁾ 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 46.6%.

Based on this study, I hereby conclude that femoral artery has a complex variation in its 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.

References

1. Henry Gray (1858) in Grays Anatomy-39th edition.
2. George .A.Piersol M.D. in Historical Title Page of Human Anatomy (1907).
3. J.D. Boyl, W j Hamilton (1956)
4. Sir John Bruce, Robert Wamsley, James a. Ross (1964) in Manual Of Surgical Anatomy pages 455-459.
5. Keith. L. Moore; Arthur. F. Dalley in his book clinically oriented anatomy 4th edition (1980) page 545-546.
6. Richard. S. Snell (1973) in Clinical Anatomy for Medical students- 5th edition pages 530-533.
7. Barry. J.Anson & Chester. B. Mc Vay in his book- Anatomy (1971) pages 1118-1121.
8. Haimovici's in Haimovici's Vascular Surgery (2004).
9. Buchannan's in Buchannan Manual of Anatomy. (1906) pages 581-587.
10. A.Vani and S. Saritha in the Journal of Anatomical Society of India, June 2004.
11. Hughes P; C. Scott and A. Bodenham in British Journal of Anaesthesia2000; vol 84; no 668-669.

12. Quain R (1844).The anatomy of arteries in human body.
13. Cunningham D.J. in Cunningham's Textbook of Anatomy(1902)
14. 14) Sir John Bruce, Robert Wamsley, James. a. Ross (1964) in Manual Of Surgical Anatomy pages 455-459.
15. Robert. B. Rutherford in his book of vascular surgery 6th edition (1976) page 657.
16. Last in Last's Anatomy 1954 9th edition. Pages 154-155.
17. Henry Hollinshed W. in Anatomy for surgeons vol III 2nd edition 1958
18. Russell T. Woodburne, A.M., Ph.d in Essentials of human anatomy(1957).
19. Harold Ellis in Clinical Anatomy 7th edition (1960). Pages 292-294.
20. Lockhardt. R.D; G.F. Hamilton in Anatomy of the human Body.(1959).