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Anatomical Study of Tributaries Draining at the Saphenofemoral Junction

[1]Jinu. T. Eldho, [2]R.S. Praveen, [3]Ananthapadmanabhan and [4]Kiran Gopal

[1]Department of Anatomy, Sree Uthradom Thirunal Academy of Medical Sciences, Thiruvananthapuram, India
[2]Department of Anatomy, Sree Narayana Institute of Medical Sciences, Ernakulam, India
[3]Department of Anatomy, Dr. Somervell Memorial CSI Medical College, Thiruvananthapuram, India
[4]Department of Microbiology, Government Medical College, Thiruvananthapuram, India

ABSTRACT

Great saphenous vein is the largest and thickest walled superficial vein of the lower limb. It ascends on the medial border of the tibia to the posteromedial surface of the knee and inclines anteriorly over the thigh to enter the femoral vein through the saphenous opening. The centre of the opening is 2.5-3.5 cm inferolateral to the pubic tubercle. Among various venous anatomical variations in lower limbs, most important and significant variations occur at the saphenofemoral junction. The study was conducted on 80 surgical cases who underwent Trendelenburg surgery and in 30 cadavers from the department of Anatomy. The specimens were dissected according to the steps in Cunningham's Manual of Practical Anatomy. Saphenofemoral junction was studied in detail with emphasis on number of tributaries, variation in the drainage pattern of tributaries, duplication of great saphenous vein and age-related histological changes. Data obtained were consolidated, statistically evaluated using SPSS software version 16 and results obtained were represented using charts and tables. According to the study varicosity of the great saphenous vein was more prevalent in the age group 41-50 years (25%). The number of tributaries at the SFJ varied from 1-7 with highest frequency of three tributaries in 57% of cases. Distance of saphenofemoral junction from pubic tubercle varied from 2.60-4.20 cm. Duplication of great saphenous vein was noted in 16.7% of cadavers. In 66.7% of cases draining pattern was normal. The thickness of tunica intima varied from 39.41-74.03 micrometre and was found to increase as age advanced. A significant variation of tributaries at the saphenofemoral junction and age related histological changes were noted. Although knowledge in venous anatomy and variations may not be necessary in conservative approach, interventional treatment modalities may necessitate expertise. Hence, if important anatomical variations are not recognised, surgical or less invasive procedures might result in incomplete saphenofemoral junction surgery.

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Key Words
Great saphenous vein, saphenofemoral junction, duplication, histology of saphenofemoral junction

Corresponding Author
Kiran Gopal,
Department of Microbiology, Government Medical College, Thiruvananthapuram, India

Author Designation
[1-4]Assistant Professor

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INTRODUCTION

Great saphenous vein is the largest and thickest walled superficial vein of the lower limb. It begins on the medial side of the dorsum of the foot and runs upwards and backwards anterior to the medial malleolus and then on the medial surface of the distal third of the tibia. It then ascends on the medial border of the tibia to the posteromedial surface of the knee and inclines anteriorly over the thigh to enter the femoral vein through the saphenous opening[1]. The centre of the opening is often said to be 2.5-3.5 cm inferolateral to the pubic tubercle. However, the saphenous opening varies greatly in size and disposition so that this centre is not a reliable surface marking for the saphenofemoral junction[2]. Saphenofemoral junction is a sophisticated structure comprising of the arch of great saphenous vein, terminal and pre- terminal valves plus a number of tributaries[3]. In the thigh near the saphenofemoral junction, the great saphenous vein receives posteromedial and anterolateral veins. The superficial epigastric vein, superficial circumflex iliac vein and superficial external pudendal vein enter the great saphenous vein at the fossa ovalis[4]. Today the treatment of varicose veins continues to evolve as newer techniques and technology have brought this ancient staple of surgery into the 21st century. With the advent of minimally invasive techniques, improved ultrasound technology and a multidisciplinary approach, the treatment of superficial venous disease has become a major discipline unto itself[5]. Ligation of saphenofemoral junction in flush with the femoral vein after ligating and dividing the known and unknown tributaries (Trendelenburg's procedure) is a time tested method of treating saphenofemoral incompetence in primary varicose veins[6]. Among various venous anatomical variations in lower limbs, most important and significant variations occur at the saphenofemoral junction. The junction is identified 2.5 cm inferior and 4 cm lateral to pubic tubercle[7]. An incision made at this point however fails to accurately reach the saphenofemoral junction frequently, thereby more chance of injury to femoral vessels and failure in flush ligation accurately results in recurrence[6]. A complete knowledge about anatomical variation in SFJ and variations in tributaries of great saphenous vein is important during surgery ensuring that the junction is safely managed in the least aggressive and most effective way. The major causes of recurrences of varicose veins were identification of GSV stump with non-ligated tributaries, a completely intact SFJ, non-identification of bifid system and presence of non-ligated junctional tributaries[7]. Vascular grafts have been widely used in recent years for myocardial reperfusion following coronary artery occlusion. First Sabiston and then Lewis used grafts from the great saphenous vein to bypass an occluded coronary artery and today this is still one of the most commonly used grafts[8]. Histological examination of saphenous veins in varicose vein patients demonstrated morphological changes mainly of fibrosis of the intima and longitudinal muscular layer of the tunica media. The use of frozen histological sections of the saphenous vein in patients undergoing aortocoronary bypass operations could be considered in order to discard unsuitable grafts and to direct the surgeons to alternative conduits[9]. Histological examination of vein biopsies of patient with varicose veins showed changes in intima, smooth muscles of the tunica media and adventitia. This suggests primary weakness in vessel wall as cause of varicosity[10].

In this study, tributaries draining at the Saphenofemoral junction have been studied anatomically.

MATERIALS AND METHODS

Study place: The study was conducted at the Department of Anatomy, Govt. Medical College, Thiruvananthapuram.

Study design-descriptive study: Inclusion criteria- Patients who underwent Tredenlenburg surgery in the department of General Surgery and Cadavers from Department of Anatomy, Govt. Medical College, Thiruvananthapuram.

Exclusion criteria: Patients with history of previous surgical procedures at groin such as femoral hernia repair, inguinal lymph node excision etc. which may accidentally injure the tributaries at the saphenofemoral junction, who underwent surgery for recurrent varicose veins and Cadavers with traumatic lesion, pathological lesion and surgical intervention at the groin.

Sample size: Sample size was calculated by the formula:

$$n = z\alpha pq/d^2$$

$$z\alpha = 3.84,\ p = 78.3$$

$$q = 100\text{-}p,\ d = 10\%\ of\ p$$

According to the study done by Vaz *et al.*[12]

$$N = 3.84\times78.3\times21.7/7.8^2 = 108$$

Sample size was taken as 110, out of which 80 samples were taken from Department of Surgery and 30 samples were obtained from cadavers of Dept. of Anatomy.

Data analysis: Data obtained were consolidated, statistically evaluated using SPSS software version 16 and results obtained were represented using charts and tables.

Ethical considerations: Institutional Ethical Committee permission was obtained before beginning the study.

The first five centimetres of great saphenous vein was explored and thoroughly studied in patients who underwent Trendelenburg surgery. In cadavers, dissection was carried out according to Cunningham's Manual of Practical Anatomy. Incisions were made extending from the anterior superior iliac spine to the midline and then along the medial side of thigh. The skin flap was reflected laterally. The great saphenous vein was identified in the superficial fascia of the medial part of the anterior surface of the thigh. The upper part of the vein was cleaned thoroughly and its tributaries were identified at the saphenofemoral junction. Specimens were then painted using fine brushes and photographs were taken. Sections of the vein were taken from the saphenofemoral junction for histological study. Tissue was kept in 10% formalin for 24 hrs for fixing it. Then the specimens were subjected to routine histological processing that included dehydration, clearing, embedding, deparaffinisation of sections and staining with H and E and special stains. Special stain used was Van Gieson Verhoeff's Iron Haematoxylin stain. Photographs of the stained slides were taken using photomicrograph.

RESULTS

Out of 80 cases, 23.8% belonged to the age group 40 and less, 25% belonged to the age group 41-50 years, 22.5% belonged to 51-60 years, 20% belonged to the age group 61-70 years and 8.8% belonged to the age group 71 and above years of age. The mean age was found to be 52 years with a standard deviation of 13. Minimum age was 27 and maximum was detected to be 81 years of age. Highest frequency (25%) belonged to the age group 41-50 years of age (Table 1).

The number of tributaries draining at the saphenofemoral junction was noted in cadavers as well as patients who underwent Trendelenburg surgery. In both samples, the maximum number of tributaries identified was seven and minimum number was one. The mean was found to be 3.20 with a standard deviation of 1.324. Range of variation was found to be 6. In 57% of surgical patients and in 53.3% of cadavers three junctional tributaries were identified (Table 2).

Distance of saphenofemoral junction from the pubic tubercle was measured The distance varied from 2.80-4.20 cm in patients who underwent surgery. The mean distance was 3.66 cm with a standard deviation of 0.47 on the right side. On the left side, the mean

Table 1: Age distribution

Age	Frequency	Percent
≤40	19	23.8
41 to 50	20	25.0
51 to 60	18	22.5
61 to 70	16	20.0
≥71	7	8.8
Total	80	100.0

Table 2: Number of Tributaries in cadavers and surgical patients

Number	Frequency	Percent
1	2	6.7
2	5	16.7
3	16	53.3
4	2	6.7
5	3	10.0
6	1	3.3
7	1	3.3
Total	30	100.0
Number of tributaries in surgical patients		
1	3	3.8
2	8	10.0
3	46	57.5
4	9	11.3
5	8	10.0
6	3	3.8
7	3	3.8
Total	80	100.0

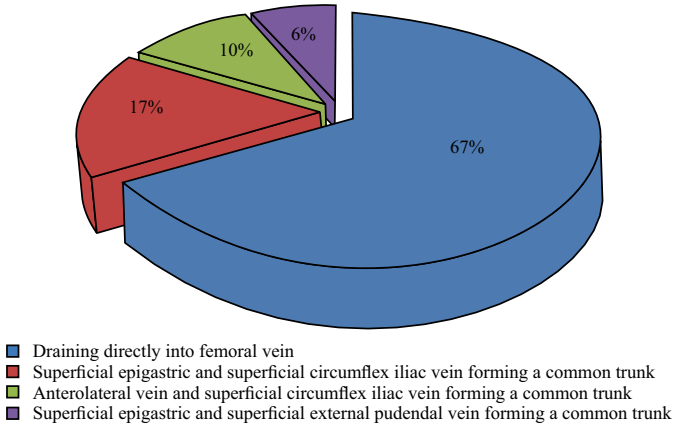

Fig. 1: Exploded pie chart showing various pattern of drainage of tributaries at the saphenofemoral junction

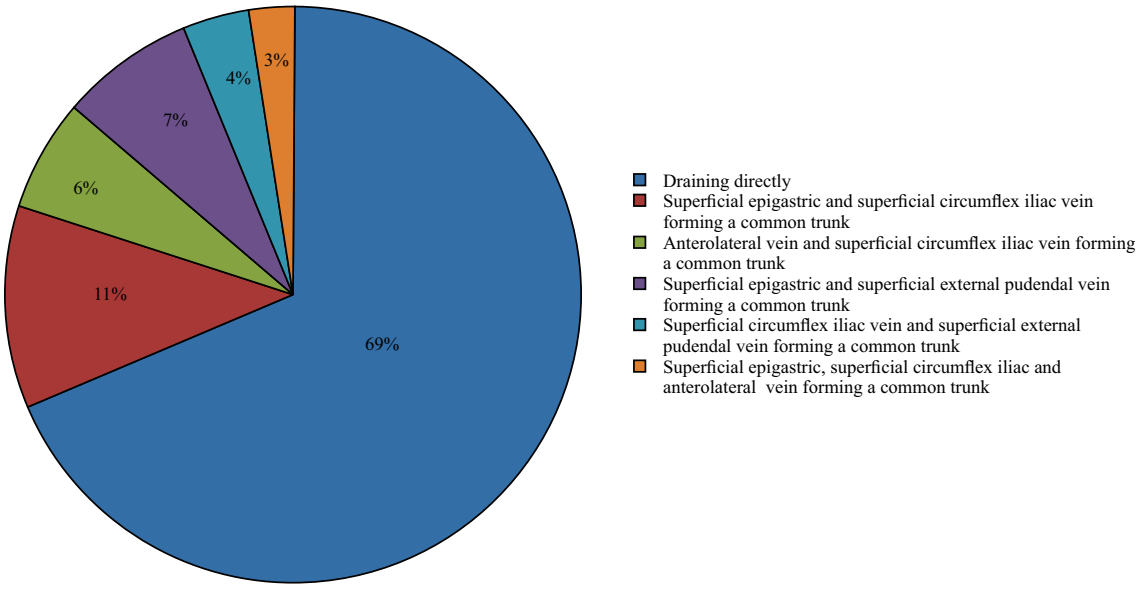

Fig. 2: Pie chart showing various pattern of drainage of tributaries at the saphenofemoral junction in surgical cases

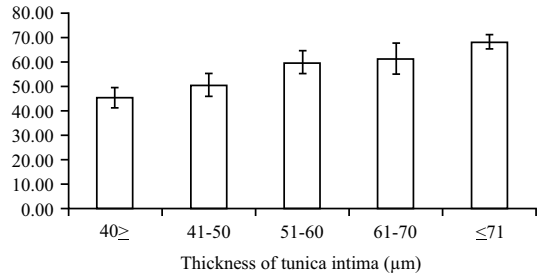

Fig. 3: Box plot graph demonstrating thickness of tunica intima in various age groups

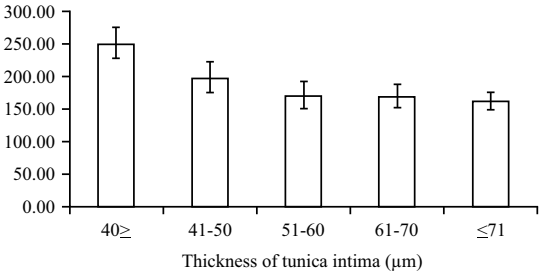

Fig. 4: Box plot graph demonstrating thickness of tunica media in various age groups

distance was measured to be 3.51 cm with a standard deviation of 0.35. There was not much statistical variation between the sides (Table 3).

Duplication of great saphenous vein was noted in 16.7% of cadavers while it was normal in 83.3% cases. 12.5% of surgical patients presented with duplication of the same. Most of the duplication was present in the age group 41-50 years of age(Table 4, Fig. 1 and 2).

Table 3: Distance of Saphenofemoral junction from pubic tubercle (cm) in Surgical cases

Distance (cm)	Frequency	Percent
2.80	3	3.8
2.90	3	3.8
3.00	8	10.0
3.10	1	1.3
3.20	4	5.0
3.30	2	2.5
3.40	6	7.5
3.50	14	17.5
3.60	13	16.3
3.70	7	8.8
3.80	3	3.8
3.90	8	10.0
4.00	4	5.0
4.10	2	2.5
4.20	2	2.5
Total	80	100.0

Table 4: Frequency distribution of duplication of great saphenous vein in cadaveric specimens and surgical cases

Duplication in cadaveric specimens	Frequency	Percent
Present	5	16.7
Absent	25	83.3
Total	30	100.0
Duplication in surgical cases	**Frequency**	**Percent**
Present	10	12.5
Absent	70	87.5
Total	80	100

In 66.7% of cases draining pattern was normal while in other cases, the tributaries joined to form a common trunk to drain into the saphenofemoral junction. A similar variation was observed in surgical patients also. In none of the cases the tributaries drained into the femoral vein separately (Fig. 3).

The thickness of tunica intima varied from 39.41-74.03 µm. The mean thickness was 54.96 µm with a standard deviation of 8.8. The thickness was found to increase as age advances. It mainly comprised of endothelium, connective tissue comprising of elastic fibres and collagen and scattered smooth muscle cells (Fig. 4).

The thickness of tunica media varied from 142.38-281.23 µm. The mean thickness was 195.87 µm with a standard deviation of 39.34. The thickness was found to decrease as age advances. The tunica media mainly comprised of smooth muscle cells arranged in circular layer and connective tissue. The amount of smooth muscle was found to decrease with age with an increase in the amount of connective tissue (Table 5).

DISCUSSION

The objective of this study was to study the anatomy of the saphenofemoral junction. Variables such as number of tributaries, drainage pattern of the tributaries, distance of saphenofemoral junction from the pubic tubercle and age variation and duplication of the vein were noted.

The minimum age of the study population was 27 years and maximum was detected to be 81 years of age. Maximum frequency (25%) belonged to the age group 41-50 years of age.

Brand *et al.*[11] found in their survey that the prevalence of varicose veins among people younger than 30 years was less than 1% for men and less than 10% for women. However, from age 70 years and older, the estimates increased substantially to 57% and 77% in men and women respectively. In the study done by Thrisuli *et al.*[6], prevalence of varicose veins was more among the age group 40-50 years (38.3%). Vaz *et al.*[12] reported in their study that the mean age of the study population was 42.4 years with a standard deviation of 12.4. Surgical dissection associated with statistical analysis did not find a linear relation between the age and total number of tributaries dissected.

In the present study, number of tributaries varied from one to seven. The mean was found to be 3.20 with a standard deviation of 1.324. Range of variation was found to be 6. The highest frequency was observed to be three tributaries in 57.5% of cases. According to the study done by Riordon Dickson *et al.*[3] in 29% of cases, one or more tributaries were identified. The maximum total number of tributaries identified was four which was demonstrated in 4% cases. In one limb, there was no tributary. In the study conducted by Kshitij *et al.*[7], the number of tributaries at the saphenofemoral junction varied from 2 (2%) to 6 (2%). Most frequent number of tributaries was 3 in 42% cases. The number of tributaries as noted by Kluess *et al.*[13] varied from 2 to 8 and that of Donelly M varied from 1 to 10[14].

In above study, distance of saphenofemoral junction from the pubic tubercle was measured. It varied from 2.60-4.20 cm on the right side and 2.70-3.90 cm on the left side. The mean distance was 3.53 cm with a standard deviation of 0.38 on the right side. On the left side, the mean distance was measured to be 3.54 cm with a standard deviation of 0.33. There was not much statistical variation between the sides. Our findings were in accordance with most of the previous studies quoted below. Thrisuli *et al.*[6] reported the ultrasound guided location of saphenofemoral junction was at mean distance of 3.641 cm below and lateral to pubic tubercle. Intraoperatively it was found that the position of saphenofemoral junction was at mean distance of 3.475 cm. This shows that USG duplex scan for marking is not an accurate investigating tool for identifying the exact location of SFJ. Reason for veracity of USG duplex scan may be due to more concentration of fat in the groin site itself and direction of USG probe held during marking. Study done by Mirjalili stated that the centre of saphenofemoral junction was 2.4±0.6 cm below and lateral to pubic tubercle (range: 2.5-4.0)[15] while the distance reported by Kshitij *et al.* was 3.77±0.61 cm[7]. Chandni Gupta *et al.*[16] found that the mean distance was 4.66 cm with a standard deviation of 0.65. Range was between 3.5 and 6.2 cm.

The earliest study on duplication of GSV was done by Glasser in 1942. He performed anatomical dissection on 100 limbs and found duplicated saphenous vein in 3 limbs[17]. In a study conducted by Shah[18], duplication of the GSV was found in 35% of the cases. Capuano and colleagues conducted a study in 1975 in which GSV was found in 12.5% of cases

In the above study, in 66.7% of cases draining pattern was normal while in other cases, the tributaries joined to form a common trunk to drain into the femoral vein. A similar variation was observed in surgical patients also. In none of the cases the tributaries drained into the femoral vein separately. According to the study done by Udhaya *et al.*[4] 21 out of 70 specimens (30%) showed a normal pattern of superficial circumflex iliac vein, superficial epigastric and superficial external pudendal vein draining directly at saphenofemoral junction. The posteromedial vein drained along with superficial external pudendal vein in 5.7% of cases. The posteromedial vein drained directly into great saphenous vein at fossa ovalis in 7.14% cases. In 24.2% specimens, anterolateral vein drained with superficial circumflex iliac vein and superficial epigastric vein. In 7.14% cases anterolateral vein drained directly at saphenofemoral junction, in 2.85% it drained along with superficial circumflex iliac vein.

Chandler *et al.*[19] reported that in 15% of the saphenofemoral junctions, superficial circumflex iliac vein and superficial epigastric vein have a common trunk. Donelly M reported that in 33.4% specimens, one or more junctional tributaries joined the long saphenous vein or common femoral vein[14]. Tributaries draining directly to common femoral vein were detected in 2.5% cases in the study done by Tavlasoglu *et al.*[20].

In the above study, we studied the age related histological changes of great saphenous vein at the saphenofemoral junction. It was found that the thickness of tunica intima varied from 39.41-74.03 µm. The mean thickness was 54.96 µm with a standard deviation of 8.8. The thickness was found to increase as age advances. It mainly comprised of endothelium, connective tissue comprising of elastic fibres and collagen and scattered smooth muscle cells. The thickness of tunica media varied from 142.38-281.23 µm. The mean thickness was 195.87 µm with a standard deviation of 39.34. The thickness was found to decrease as age advances. The tunica media mainly comprised of smooth muscle cells arranged in circular layer and connective tissue. The amount of smooth muscle was found to decrease with age with an increase in the amount of connective tissue. Kyaparissi *et al.*[8] observed that intimal thickness was due to accumulation of smooth muscle fibres, fibroblasts, collagen fibres, foam cells, neovasculature and presence of an extracellular matrix as well as thickening of basement membrane. Nayak *et al.*[21] observed that most of the vasa vasora were present in the adventitial layer of the vein. In certain sections, vasa vasora were seen proceeding towards tunica media. The luminal area of the vein varied from 63.86-2051.14 µm[2]. Meissner[22] in their histologic studies suggested that varicose veins have reduced contractility. Saphenous smooth muscle content was reduced in patients with varicose veins and effective contraction was further compromised by fragmentation of the muscle layers. Varicose veins showed an increased collagen and decreased venous elasticity.

CONCLUSION

Variations and abnormalities are more frequently reported in veins than arteries. Pre- operative knowledge of each individual's saphenous vein is important for several reasons. It permits accurate placement of skin incisions and minimizes a major source of frustration during the operative procedure. Recurrent varicose veins after surgery is a common problem which has different causes such as inadequate assessment for the presence of DVT, anatomical variation at saphenofemoral junction, post-operative neovascularization etc. Varicose vein may be due to weakness of the vein wall as a result of structural problems. However, there are conflicting findings in the literatures about these problems. While some reported muscle hypertrophy, others have shown muscle loss with replacement of fibrous tissue. Hence, it becomes important to have a study on structural wall abnormalities of varicose veins. Great saphenous vein is used for coronary bypass surgery, in the treatment of cerebrovascular diseases and as grafts in peripheral vascular surgery. To conclude, the knowledge and identification of anatomical variations at the saphenofemoral junction play an important role in increasing the success and efficacy of surgical treatments and in decreasing recurrence rates.

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