

VARICOSE VEINS*

FURTHER FINDINGS BASED ON ANATOMIC AND SURGICAL DISSECTIONS

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THE THERAPY of varicose veins was improved greatly by the introduction of high ligation of the long saphenous vein.¹ Nevertheless, it has become evident to students of the subject that this procedure alone or in association with retrograde or other forms of injection often fails to produce maximum benefits. Many workers, including this author, believed that the failure of this form of therapy was due to incompetent thigh perforator veins.² Studies that were undertaken to establish the role of these veins in the etiology of varices were the subject of an earlier report.³ They involved anatomic dissections on 73 cadavers (137 thighs) and 465 patients (703 limbs). This work clarified the anatomy of the saphenous vein on the medial aspect of the thigh and knee and also established a method of locating perforator veins in the area. This knowledge was then applied to the operative care of varicosis. The surgical dissections confirmed the anatomic pattern but surprisingly demonstrated that thigh perforators are not as frequently incompetent as was previously believed. This knowledge made it imperative to search elsewhere for the solution of the problem.

The investigations were then directed to the study of the perforator veins distal to the knee. In the course of this work, dissections were carried out on 63 cadavers (92 legs) and observations were made on 482 patients involving 901 lower extremities. It was found that incompetent leg perforators are very numerous and much more often responsible for incomplete therapy than are the thigh perforator veins.

It is the purpose of this paper to present the results of these anatomic and surgical studies and to describe additional operative technics that have been devised to deal with the new findings.

ANATOMIC STUDIES

The distribution of perforator veins connecting the two saphenous systems with the deep veins in the leg varies somewhat, but if adjustments are made for differences in height, a remarkable constancy in their placement is observed, similar to that in the thigh. The anatomic placement of perforators in the lower extremity may be divided into five main groups: first, those on the medial aspect of the lower extremity; second and third, the lateral aspects of leg and foot; fourth, the short saphenous system; and fifth, muscular perforators in the calf.

The first of these divisions deals with the medial aspect of the entire lower extremity. Figure 1 shows the venous pattern on the medial aspect of the

* Submitted for publication, December, 1948.

thigh, in a somewhat more simplified form than was previously reported.³ Figure 2 illustrates the scheme of veins on the medial aspect of the leg. In the thigh the main long saphenous vein B'' (Fig. 1) is situated beneath the superficial layer of the deep fascia. This deep fascial layer is continued uninterruptedly down the leg to the base of the toes, as a distinct enveloping

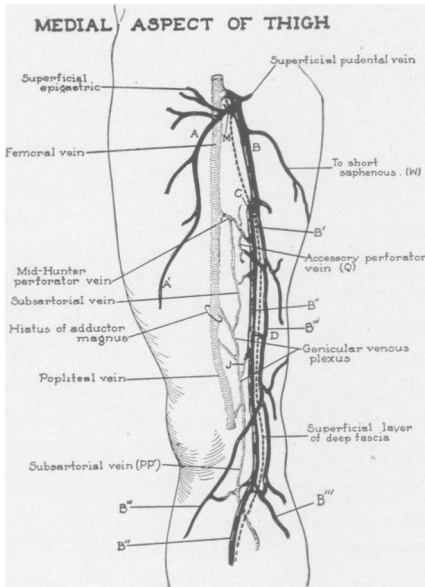


FIG. 1.—Drawing showing the saphenous as A, A', and B, B', B'', B'''. Veins A, A', B lie superficial to the deep fascia; whereas distal to C, veins B', B'' lie beneath the superficial layer of the deep fascia. B''' emerges from beneath the deep fascia at D.

The constant mid-Hunter canal perforator vein connects the main saphenous vein B' with the femoral vein.

The genicular venous plexus connects the femoral and popliteal veins with the subsartorial vein. The subsartorial vein makes connections with the main long saphenous vein B'' in the thigh and continues distally in the leg to make connections with B'', B''' and posterior tibial vein.

Accessory perforator vein Q emerges into the superficial fascia without making direct connections with the main saphenous stem B', B''. Perforator vein J makes direct connection between main saphenous stem B'' and the subsartorial vein.

Line M illustrates the danger of mistaking superficial vein A for the main long saphenous vein in patients who possess double long saphenous veins.

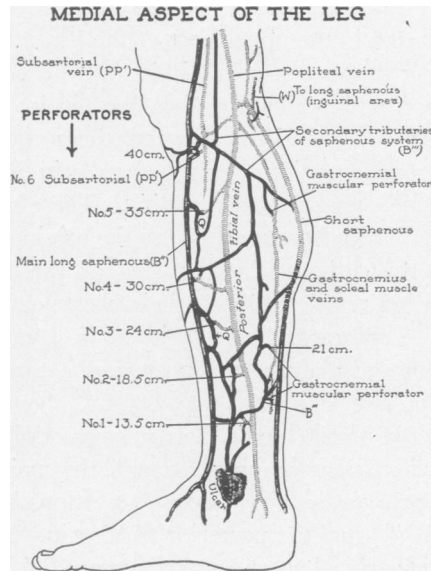


FIG. 2.—Drawing showing the saphenous systems as B'', B''' and short saphenous vein. The secondary saphenous tributaries B''' are black and indicate their placement within the superficial fascia. The lightest tinted crosshatching indicates veins situated beneath the traditional deep fascia. The medium tinted cross hatching (vein B'' and lower part of short saphenous vein) depicts veins lying between the extension of the deep fascia of the thigh and the traditional deep fascia.

Perforator veins 3, 4 and 5 connect the posterior tibial vein with the main long saphenous vein B''. Perforator veins 1 and 2 connect the posterior tibial vein with secondary saphenous veins B''', Perforator No. 6 connects the posterior tibial and subsartorial veins with veins B'' and B'''.

Accessory perforator vein Q emerges into the superficial fascia without making direct connections with vein B''.

All measurements start from the sole of the foot.

sheath, separate from and overlying the traditional deep (crural) fascia of the leg. The primary main long saphenous vein B'' continues down the leg between this extension of the deep fascia of the thigh and the traditional deep fascia of the leg. Vein B'' lies adjacent to the medial border of the tibia, makes connections with the deep veins of the leg by perforators and communicates with the more superficial veins (B''') by vessels that pierce the extended superficial fascial layer of the deep fascia of the thigh.

An analysis of Figure 2 shows that perforator veins 3, 4, 5 and 6, located in the upper part of the leg, make direct connections between the main long saphenous vein (B'') and the posterior tibial vein. On the other hand, perforator veins 1 and 2, located in the lower part of the leg, rarely make direct connections between these main veins. Instead, they connect with secondary veins (described as vein B''') which in turn join with the main long saphenous vein (B''). These secondary saphenous veins (B''') are significant because they are the origin of most of the leg perforators. A closer study of the perforator veins on the medial side of the leg demonstrates that within restricted limits their placements and patterns are quite constant.

Perforator No. 1 (Fig. 2) is situated about 13.5 cm. above the sole of the foot and about 2 cm. posterior to the medial border of the tibia. Perforator No. 2 is located about 18.5 cm. above the sole of the foot and about 1 cm. medial to the medial border of the tibia. Rarely do either of these perforators make direct connections with the main long saphenous vein (B''). Instead, nearly always they make connections between superficial secondary tributaries (B''') and the posterior tibial vein. Incidentally, these perforators often join a superficial secondary tributary (B''') that connects the main long saphenous vein (B'') and the short saphenous vein.

Perforators Nos. 3, 4 and 5 (Fig. 2) are adjacent to the medial border of the tibia. They are situated about 24 cm., 30 cm. and 35 cm. above the sole of the foot, respectively. They usually make direct connections between the long saphenous vein (B'') and the posterior tibial veins, and their locations are quite constant. Occasionally one of these perforators is absent, in which case its function is compensated for by an adjacent perforator. These perforators also usually possess accessory perforator (Q) veins or collaterals, which make independent junctions with secondary veins (B''').

Perforator No. 6 is located about 40 cm. above the sole of the foot and 1 cm. medial to the medial border of the tibia. It makes connections between the main long saphenous vein (B'') and superficial veins (B'''), on the one hand, and the subsartorial vein (PP') and the posterior tibial vein, on the other hand. As described in a previous article³ and also indicated in Figure 1, PP' is a continuation of the genicular plexus. Proximally it communicates with the highest, superior and inferior genicular veins, and distally courses deeply beneath the traditional (crural) deep fasciae, to make the connections with the veins above described. During anatomic dissections it has been observed that this vein (PP') may continue distally, even as far as perforator No. 2,

and has been seen to make connections with any of the perforators from 2 to 6 inclusive.

Perforators on the medial aspect of the foot and ankle also exhibit much constancy. The anterior medial malleolar perforator is located about 5 cm. above the ankle joint. It arises from the main long saphenous vein (B'), adjacent secondary veins (B''), and deep veins of the foot. From the anterior medial aspect of the foot it courses behind the tendons of the tibialis anterior and extensor hallucis longus to join with the anterior tibial vein.

There are three perforator veins about 4 cm. above the sole of the foot on the medial side. They are located about 9 cm., 8 cm. and 5 cm. anterior to the posterior border of the heel, respectively. They make connections between superficial veins (B''), vein B', on the one hand, and the deep veins of the foot, on the other.

A group of three or more perforators is located about 3.5 cm. anterior to the posterior border of the tendo achillis, and they range from 5 cm. to 10 cm. above the sole of the foot. A fairly constant perforator is located near the upper edge of the internal malleolus about 5 cm. anterior to the posterior border of the tendo achillis. These four or more perforators connect secondary tributaries B'' and the medial tributary of the short saphenous vein, on the one hand, and the posterior tibial vein and deep veins of the foot, on the other. No drawings were made of the perforator veins on the medial aspect of the foot and ankle, as their clinical significance seems relatively unimportant.

The second general division concerns those perforator veins on the lateral aspect of the leg which usually lie in the intermuscular septum between the peroneal longus and brevis muscles, on the one hand, and the gastrocnemius and soleus muscles, on the other (Fig. 3). They make connections between the superficial secondary veins (B'') and the peroneal vein. In the proximal part of the leg these superficial veins usually connect indirectly with the posterior tibial, anterior tibial or popliteal veins. These perforators also usually make connections with the veins draining the gastrocnemius and soleal muscles. Often, instead of lying in the intermuscular septum, they pierce the lateral border of these muscles to connect with the peroneal vein as well as with the muscular veins. In addition, the peroneal perforators make connections with the veins draining the peroneal muscles. Although considerable variation in their longitudinal placement is observed, and some perforators may be absent, in general they are found at about 5 cm. intervals between points 10 cm. and 45 cm. above the sole of the foot.

The third group of perforators, also located on the lateral side of the leg, lies in the intermuscular septum between the peroneal longus and the brevis muscles posteriorly, and the tibialis anticus and extensor longus digitorum muscles anteriorly. They connect the superficial secondary tributaries (B'') with the anterior tibial vein at about 16, 22, 29, 31, 35 and 39 cm., respectively, above the sole of the foot.

In general, the perforator veins on the lateral aspect of the foot and ankle unite the short saphenous and secondary veins (B'') with the deep veins of

the foot. At a varying level from 5 to 10 cm. above the sole of the foot and just anterior to the tendo achillis there is a group of three or more perforators. These may also course deep or superficial to the tendo achillis to anastomose with the posterior tibial vein. Numerous other perforators are found in this region. They may be identified by measuring their relationship respectively to the posterior line of the heel and to the sole of the foot. The placement of these perforators is 3.5 to 4.5; 4 to 6.5; 4 to 5, 6 to 3; 8 to 3; 7.5 to 4 and 10 to 3 cm., respectively.

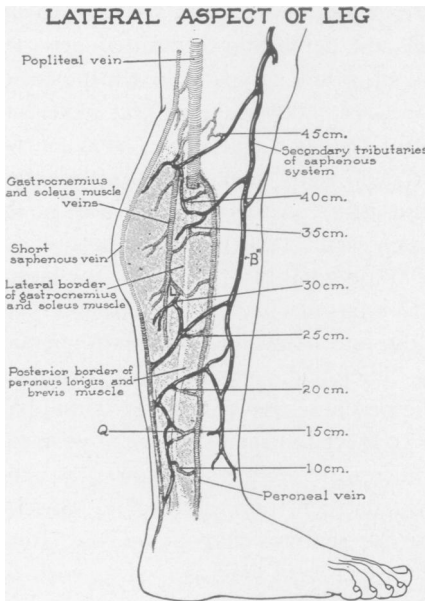


FIG. 3.—Drawing showing perforator veins situated in the intermuscular septum between the gastrocnemius and soleus muscles, on the one hand, and peroneal muscles, on the other. The perforator veins connect the peroneal vein with secondary saphenous tributaries B'''.

A perforator vein (L) is depicted as emerging through the lateral border of the gastrocnemius or soleus muscles. Connections between the perforator and muscular veins are indicated.

Accessory perforator vein Q emerges to connect with secondary saphenous tributary B''' at a different site than a companion perforator vein.

All measurements start from the sole of the foot.

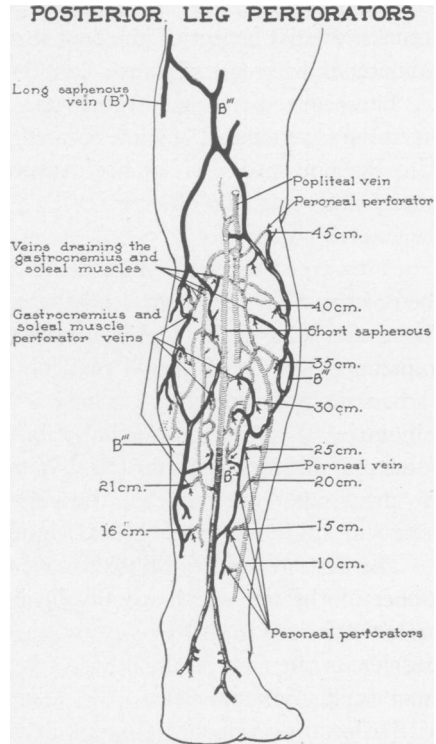


FIG. 4.—Composite drawing showing sites of perforator veins on the posterior aspect of the leg. Perforators connect the short saphenous vein and secondary saphenous tributaries B''' with muscular veins draining the gastrocnemius and soleus muscles. In general, there are four longitudinal lines of perforators. Two of these are within 2 cm. of either side of the midline, and the other lines are three or more centimeters lateral or medial to the midline. There are usually four or more perforators in each of the three medial lines and only one or two in the lateral longitudinal line. In the latter group the absence of perforators is compensated for by drainage through the peroneal perforator veins.

Arrows indicate site of perforators.

Note perforators indicated at 16 and 21 cm. They might be confused with perforator No. 1 or 2, as shown in Figure 2.

All measurements start at the sole of the foot.

The fourth group is located posteriorly and mainly concerns the short saphenous vein. The upper part of the latter vein is situated beneath the traditional (crural) deep fascia of the leg, whereas in the lower part of the leg and foot it lies more superficially between the traditional deep fascia and the extension of the superficial layer of the deep fascia of the thigh, in which respect it is similar to the main long saphenous vein (B'') in its placement between fascial layers. The short saphenous usually makes a single or double connection with the popliteal vein in the hollow of the knee, but variations are numerous. Of these variations, several are outstanding and occur more often than is generally believed. The short saphenous may have no connection with the popliteal vein, or the connection may be a very small one. Instead, it may unite with deep thigh veins, especially with those veins draining either the lateral or the medial (hamstring) muscles. Again, the short saphenous vein may continue proximally up the thigh to make its connection at various levels with the inferior gluteal or profundis femoris vessels. An outstanding divergence is a short saphenous vein that again makes only trivial, if any, connection with veins in the popliteal area. Instead, this vein W (Figs. 1 and 2) courses proximally up the posterior and the medial aspect of the thigh to join with the saphenous vein about 5 cm. distal to the saphenofemoral junction. Other perforators near the midline posteriorly make direct connections with the short saphenous vein and indirect connections with the veins draining the gastrocnemius and soleal muscles (Fig. 4).

The last group of perforators (Fig. 4) comprises the veins that make connection between the superficial veins (B''') and the short saphenous vein, on the one hand, and the muscular veins of the gastrocnemius and soleal muscles, on the other. Only a few of these veins make direct union with the short saphenous; most of them connect with the very superficial secondary B''' tributaries of both the long and the short saphenous systems. They enter deeply, and within the muscles communicate with other muscular veins, terminating in larger veins which join the posterior tibial vein about a centimeter distal to the traditional saphenopopliteal junction. As a generalization, there are four longitudinal lines of perforators; two are within two centimeters of either side of the midline and the other two lines are three or more centimeters lateral or medial to the midline. The most proximal of these is 45 cm., and the most distal one is 10 cm. above the sole of the foot. There are about four perforators in each of the three medial lines and only one or two in the lateral longitudinal line. In the latter group the absence of perforator veins is compensated for by drainage through the peroneal perforator veins.

Three principal findings resulted from these anatomic dissections: (1) The main long saphenous vein (B''), in the leg and foot, courses distally adjacent to the medial border of the tibia and is situated deep to a distinct fascial layer that is continuous with the deep fascia of the thigh. (2) The lower part of the short saphenous vein, although superficial to the traditional deep fascia of the leg, is also deep to the fascia which is a continuation of the deep fascia of the

leg. (3) The perforator veins of the leg and foot are numerous, and, in general, fit into a rather easily established pattern.

SURGICAL APPLICATION

The successful treatment of incompetent perforator veins depends upon a full understanding of the patterns described, and especially of the characteristics of the saphenous tributaries B, B', B'', B''', the mid-Hunter canal perforator system, the genicular plexus and the anatomic distribution of perforator veins in the leg. The significance of this understanding is illustrated by the observation that although the elimination of the deep, long saphenous stem B' and B'' disconnects the direct communication of the saphenous vein with the femoral or popliteal veins, it does not destroy the indirect connection through the accessory perforator veins (Q, Fig. 1). In like manner, in the leg, eradication of the main long saphenous vein (B'') disconnects direct communication of the saphenous vein (B'') with the posterior tibial vein but does not eliminate the accessory perforator veins (Q, Fig. 2).

The surgical procedure based upon the information gained from the anatomic studies described has, in our hands, improved the results of the therapy of varicose veins. It consists of a combination of injection of veins, high ligation, elimination of the main saphenous stem (B', B''), eradication of the mid-Hunter canal perforator vein, elimination of incompetent perforators connected with the genicular venous plexus and excision of all incompetent perforators in the leg or foot. The judicious use of a sclerosing solution,⁴ as an agent for the suppression of hemorrhage, especially in the lesser saphenous tributaries, is very helpful in controlling bleeding at the time of operation.

PROCEDURE

The patient is examined for evidence of systemic disease, peripheral arterial disorder and postthrombophlebitic sequelae. The presence of edema, eczema, indurated areas or ulcerations is noted. Much importance is laid on inspection and palpation of the limbs. Large venous bulbs and especially defects in the fascia are sought, as these abnormalities often have been found to be the site of incompetent perforator vessels. Their locations are recorded and, prior to operation, are identified by skin markings with a weak silver nitrate solution.

Minor varicose veins may be sclerosed by local injection previous to operation. Under spinal analgesia or general anesthesia the saphenofemoral junction is exposed and a standard high ligation is performed. In order to control bleeding more effectively, a retrograde injection of about 3 cubic centimeters of a sclerosing solution may be injected into the saphenous vein. In the majority of patients with double long saphenous veins, most of the tributaries at the upper end of the saphenous system arise from vein A (Fig. 1). A ligation performed as indicated by M (Fig. 1) would leave the main long saph-

enous vein B patent, and the operative procedure would fail to accomplish its purpose.

The next step is the elimination of the saphenous and perforator veins in the thigh. Although incompetent perforator veins in the thigh are not common, nevertheless occasionally huge perforators exist and the vein B'', which lies under the superficial layer of the deep fascia, must be diligently explored for possible incompetent perforators. If any are found they must be eliminated. A description of this procedure was detailed in a previous article.³

The next step consists of elimination of varices and incompetent perforator veins in the leg (Fig. 2). An incision about 4 cm. long is made on the inner aspect of the leg, just below the knee. This is made obliquely, with the lateral end about 2 centimeters distal to the medial end. Thus the veins B'' and B''', which were previously removed from the thigh, are exposed. From either or both of these veins superficial tributaries often course anteriorly or posteriorly. If they are varicose they are excised. In particular, the secondary tributary (B''') that courses posteriorly often connects with the short saphenous vein in the mid-calf area, and along its route incompetent perforators may be found. They pierce the deep fascia and extend deep in the gastrocnemius muscle. When present, they are dissected within the gastrocnemius muscle, where they are ligated and transected.

The main long saphenous vein (B'') is grasped and examined for possible incompetent perforator veins 5 and 6, which are located about 35 cm. and 40 cm. above the sole of the foot, approximately in the middle of the upper third of the leg. Vein B'' is then followed distally, stripping the vein digitally, and at the same time feeling for large perforator veins. Very small competent perforators are broken off with the fingers, but over any incompetent perforators a longitudinal incision is made and the perforator eradicated deeply. Next, a longitudinal incision, 3 cm. in length, is made about 25 cm. above the sole of the foot at the medial border of the tibia (Fig. 2). This incision allows B'' to be picked up and perforators 3 and 4 examined. As there is a possibility of perforators not connecting directly with vein B'', judicious use of the dissecting fingers and retractors will aid in locating pathologic perforators. This incision may be extended distally or proximally, as necessary.

For perforator No. 2, a longitudinal incision is made about 19 cm. above the sole of the foot and 1 cm. medial to the medial border of the tibia, and this area is searched for secondary tributaries. Such veins are meticulously followed until one or more are found that course deeply, the deeper tributary very likely being the perforator. Also very helpful is the use of digital dissection. The subcutaneous tissue is stripped away from the deep fascia and either a weakness in the fascia can be felt or the perforator is located by hooking the index finger around it as it emerges through the deep fascia.

Superficial secondary veins (B''') in this area can be followed distally and posteriorly and may connect with perforator No. 1 or with medially located calf perforators.

Perforator veins located at a greater distance than 1.5 cm. medial to the medial border of the tibia, in this area, are usually gastrocnemius or soleal muscular perforator veins.

If perforator No. 1 is suspected of being incompetent, a longitudinal incision is made about 14 cm. above the sole of the foot, 2 cm. medial to the medial border of the tibia (Fig. 2). Superficial secondary veins (B'') are sought, especially the one that often makes connection between vein B' and the short saphenous (Fig. 2). With meticulous dissection deeply penetrating veins are sought. After eliminating this perforator, vein B' is stripped to a point about level with the ankle, where it is ligated and transected.

Attention is then given to perforators on the lateral aspect of the leg. A longitudinal incision is made over previously marked sites and carried down to the deep fascia by blunt dissection. The area is explored with the index finger; and the subcutaneous tissue is stripped away from the deep fascia, so that the finger is hooked about the offending perforator, which is then dissected for at least 2 cm. below the deep fascia, where it is ligated and transected.

The next step is elimination of the rarely involved perforators at the medial or lateral aspect of the ankle or foot. They are treated in like manner.

The patient is turned over and the marked sites on the calf are explored. The perforator in this area must be followed deep within the muscle before ligating and transecting. If the short saphenous vein is involved, it is ligated and transected at its junction with the popliteal vein, or if perchance no such connection appears to exist, at least the ligation is made adjacent to the popliteal artery. All tributaries of the short saphenous must be ligated and transected. Occasionally, as a variation, a large short saphenous vein makes only a trivial connection with deep veins within the popliteal space. It may course, first proximally on the posterior aspect of the thigh, and then medially to connect with the long saphenous vein 4 to 6 cm. distal to the saphenofemoral junction W (Figs. 1 and 2). If such a condition exists, it may be excised if desired, but the retrograde flow of blood is, of course, eliminated by the high ligation at the saphenofemoral junction.

Although not common, incompetent perforators on the lateral or posterior aspect of the thigh occasionally exist. If present, they should be ligated at a point deep beneath the fascia and if possible at their junction with a major vessel of the deep venous system.

In order to emphasize the meticulous care that must be exercised in order to efface reflux of blood through incompetent perforator veins, Figures 5 to 8, inclusive, are presented. The method of treating perforators on the medial aspect of the leg (perforators 1 to 6 inclusive) is illustrated by perforator pattern (Fig. 5). Two perforators are depicted as emerging through the same fascial opening. If the ligation should be performed at the indicated incorrect site, the reflux of blood would route itself through the accessory (Q) perforator. In order to secure success, the ligation must be made very deep beneath the fascia, at the point noted as the "correct site for ligation of per-

forator." Figure 6 is similar to Figure 5 except that the possibility of the accessory (Q) perforator emerging from a different opening in the fascia is shown. The behavior of the perforators on the lateral aspect of the leg is indicated in Figure 7. The placement of the perforator is shown to be mainly in the intermuscular septum between the soleus and the gastrocnemius muscles, on the one hand, and the peroneus longus and brevis, on the other hand. The correct site for ligation is shown to be very deep in order to eliminate reflux of blood through either the main perforator or the accessory perforator (Q) vein. This drawing also illustrates the connection of the peroneal perforators

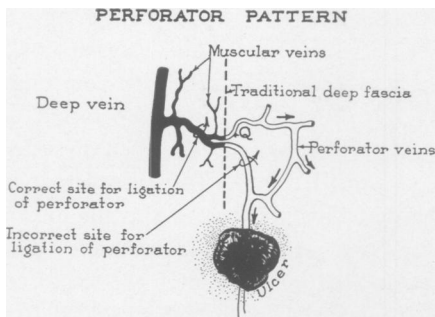


FIG. 5.—Drawing illustrating method of treating incompetent perforator veins on medial aspect of the leg. Two perforators are shown as emerging through a single fascial opening. If ligation were performed at the indicated incorrect site, the reflux of blood would route itself through the accessory perforator Q vein, as indicated by the arrows. The ligation must be made very deep beneath the fascia at the point noted as the "correct site for ligation of the perforator."

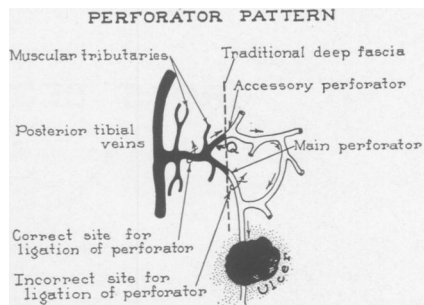


FIG. 6.—Drawing illustrating method of treating incompetent perforator on the medial aspect of the leg. This figure is similar to Figure 5, except that the possibility of the accessory Q perforator vein emerging from a different opening in the fascia is shown. If the ligation were not performed at the indicated correct site, the reflux of blood would route itself through the accessory perforator Q vein, as indicated by the arrows.

with the veins draining the gastrocnemial and soleal veins. In fact, the main peroneal (P) vein may be absent, its function being supplanted by the Q vein near the lateral border of the gastrocnemius or soleus muscles. Hence, in such exceptions, although the perforator (Q) vein must be followed through the muscle, nevertheless the correct site for ligation is the same as depicted in the drawing. In this case the connection between the Q and gastrocnemial vein (G) must also be severed. Figure 8 concerns the treatment of perforators in the calf of the leg. Again it is to be observed that, in order to eliminate reflux of blood through incompetent perforators, the dissection must be made deep within the muscle.

The futility of the so-called stripping procedure or eversion of the long saphenous vein by the Babcock probe method is illustrated by comparing Figure 9 with Figure 2. These drawings are identical except that in Figure 9 the main long saphenous vein (B'') has been removed. Although some direct connections between the main long saphenous vein (B'') and the deep veins

have been interrupted, the collateral and accessory perforator (Q) veins have been left intact and the procedure has failed to accomplish its purpose.

The operative time for one extremity is approximately three hours. Usually both lower extremities are treated simultaneously, in which case the presence of at least one additional competent surgeon is advisable. Teamwork is very helpful.

Following operation, the patient is wrapped from the groin to the ankle in roller gauze, and adhesive bandages are snugly applied in order to prevent swelling. Because of the multiplicity of incisions, the patient is given 300,000 units of duracillin every 12 hours from the time of admission until discharge.

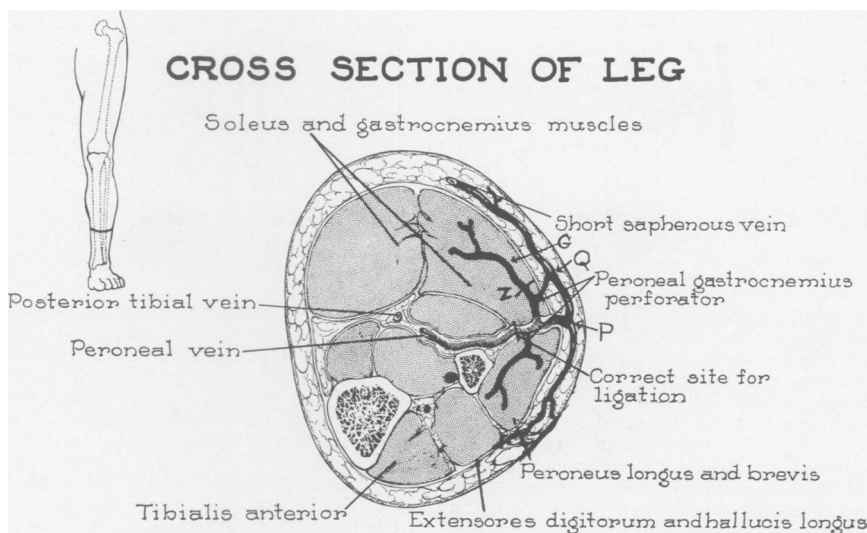


FIG. 7.—Drawing illustrating a method of treating incompetent perforators on the lateral aspect of the leg. The perforator is shown to be in the intermuscular septum between the gastrocnemius and soleus muscles, on the one hand, and the peroneus longus and brevis, on the other. In order to prevent the reflux flow of blood through either the perforator P vein or the accessory perforator Q vein, the ligation must be made very deep at the point noted as the "correct site for ligation." The connections between the main perforator vein, the accessory perforator Q vein, and the G veins draining the gastrocnemius and soleus are indicated. The muscular G vein must also be ligated at point Z.

When sufficiently recovered from anesthesia, patients are instructed to move their legs vigorously in bed and are encouraged to walk. The following morning all patients are thoroughly ambulated and are personally conducted up and down stairs. They leave the hospital the same day with verbal and printed instructions. They are particularly instructed to walk at least 5 out of every 30 minutes during the day. Any type of activity is encouraged. The sitting position is not allowed for four weeks, except for short intervals to partake of meals. When tired, they lie down. They are also informed that a temperature up to 102 degrees Fahrenheit is not unexpected.

VARICOSE VEINS

DISCUSSION

Recent surgical experience since 1944 has confirmed the belief that a new method of thinking is essential to adequate correction of varicosities. The present commonly accepted procedure of high ligation with or without retrograde injection, although of considerable benefit in some patients, leaves very much to be desired. It is believed that to obtain ideal results a much more radical surgical approach is necessary.

I do not agree with the opinion that incomplete filling of veins in 30 or more seconds as observed in the Trendelenburg "positive" tests indicates the

LONGITUDINAL SECTION OF CALF

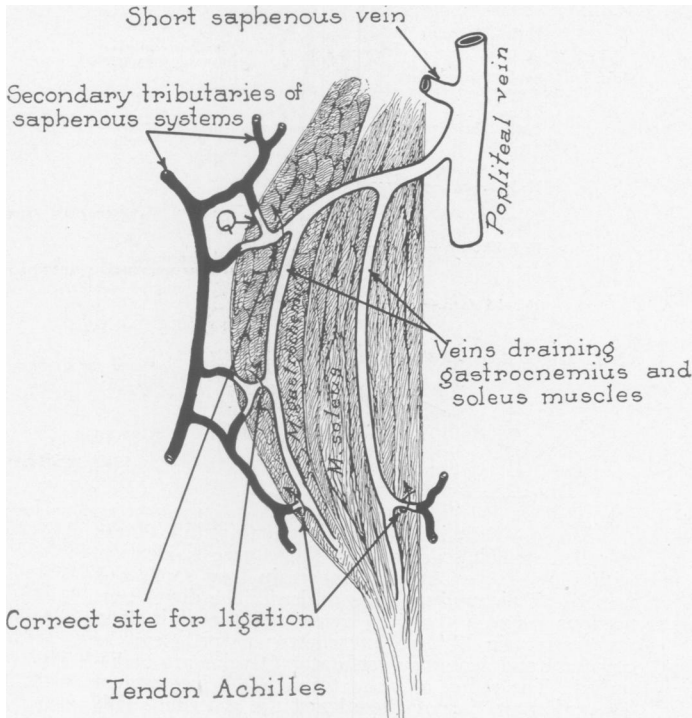


FIG. 8.—Drawing illustrating method of treating incompetent perforator veins in the calf. In order to prevent reflux of blood through the accessory Q vein, the ligation must be deep within the muscle at the point designated as "correct site for ligation."

absence of incompetent perforator veins in the leg or thigh.⁵ Indeed, about 95 per cent of the surgically treated cases were Trendelenburg "positive" and in 823 out of 901 lower extremities obvious pathologic perforator veins were found (Table I).

The failure of high ligation entirely to prevent recurrences of varicose veins was correctly believed to be due to incompetent perforators below the saphenofemoral junction. During multiple tourniquet tests, the fact that the

filling of veins occurred much less rapidly when the tourniquet was placed below the knee than when placed at the groin resulted in the assumption that most of the deficiency was due to incompetencies in the thigh. The failure of the multiple tourniquet tests to locate the incompetent thigh perforators² led

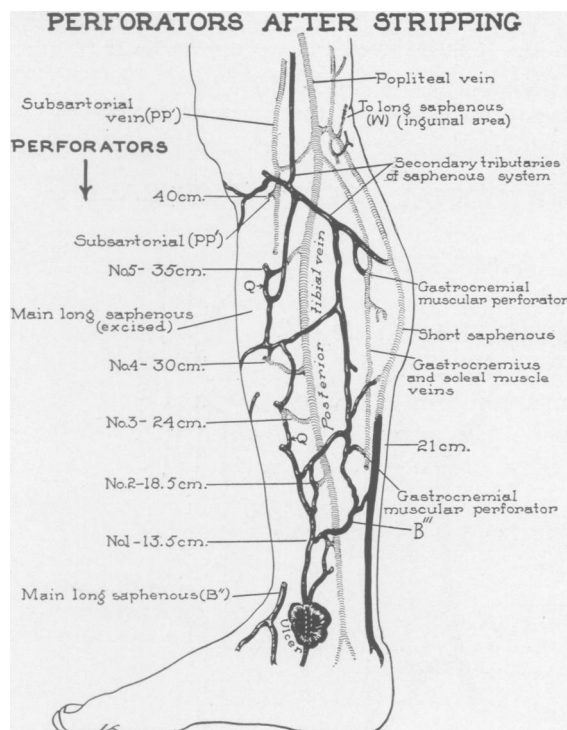


FIG. 9.—Drawing illustrating the futility of the so-called stripping procedure. This figure is identical with Figure 2, except that the main long saphenous vein B' is pictured as being excised. The direct connections between the deep veins and the main long saphenous vein B' are interrupted; nevertheless the collateral and accessory perforator Q veins are undisturbed. The reflux of blood through the incompetent leg perforators is not altered and the procedure fails to accomplish its purpose.

All measurements start from the sole of the foot.

to further anatomic and surgical studies. These explorations revealed that incompetencies in the thigh are relatively rare (about 9 per cent) and therefore could not be responsible for the inadequate results so frequently observed (Table II). Similar studies on the leg, however, showed incompetent perforator veins to be very common and often of huge size. These latter findings adequately explain the frustration experienced by many of us when attempting to locate incompetent perforators in the thigh. They seldom existed.

The number of incompetent perforators in a single extremity varies. The largest number found was 14, the smallest, one. The numerical and percentage

distribution of incompetent perforators is detailed in Table II. The most common offender is perforator No. 2 (34.8 per cent). The high incidence of incompetent short saphenous vein (15.2 per cent), perforator No. 3 (19.8 per cent) and perforator No. 1 (16.6 per cent) should be noted. On the lateral

TABLE I.—*Distribution of Incompetencies in Operated Cases*

Number of patients.....	482
Number of lower limbs.....	901
Number of right lower limbs.....	452
Number of left lower limbs.....	449
Number of lower limbs with perforators.....	823
Number of lower limbs without perforators.....	78

aspect of the leg, as shown in Table II, most incompetent perforators are found in or near the intermuscular septum between the gastrocnemius and the soleus muscles, on the one hand, and the peroneal muscle group, on the other. The perforators most often responsible for the nonhealing of ulcers in order of importance are perforators Nos. 2, 3, 1 and the short saphenous vein.

It is very important to realize that there is no known key vein governing vulval varicosities. The incompetent perforator or perforators responsible for this reflux flow of blood cannot be eradicated and consequently it is

TABLE II.—*Distribution of Incompetent Perforator Vessels on 901 Lower Limbs*

	Number Right	Per Cent	Number Left	Per Cent
Saphenofemoral junction.....	452	100	449	100
Saphenopopliteal junction.....	67	15	70	15.5
Mid-Hunter canal perforator.....	31	7	29	6.7
Genicular perforators.....	13	2.9	9	1.6
Lateral thigh perforators.....	8	1.8	6	1.3
Perforator No. 1.....	72	15.9	77	17.3
Perforator No. 2.....	155	34.3	158	35.2
Perforator No. 3.....	90	20	85	19.6
Perforator No. 4.....	59	13	57	12.7
Perforator No. 5.....	30	6.6	31	7
Perforator No. 6 (PP').....	19	4.2	14	3.1
Perforators in calf.....	54	12	50	11.2
Perforators between gastrocnemius and peroneal muscles.....	113	25	108	24
Perforators between tibialis anticus and peroneal muscles.....	14	3.1	12	2.9
Perforators lateral border of tibia.....	1	.02	2	.04
Lateral foot perforators.....	9	2	11	2.4
Medial foot perforators.....	16	3.5	12	2.9

obviously unwise to operate on women in the child-bearing age.⁶ The operation does no harm, but subsequent pregnancies dramatically demonstrate the futility of the procedure. After the menopause, in order to alleviate the varicose condition, the suggested operation may be performed, with the realization that the results are not entirely satisfactory.

Although 1,367 radical surgical dissections have been made, adequate knowledge of perforator veins in the leg has only been attained since the latter part of 1944. Accordingly, the surgical results are based only on these recent cases (Table III). The failure to achieve perfect results can, in most

cases, be traced to one or more incompetent perforators, usually small, that were overlooked during the operation. In the entire group of varicose-vein patients no deaths or massive hematomas have occurred. There were 23 mild infections and 3 rather severe infections. Seven mild embolisms occurred. Six of these had, as the only symptom or physical finding, a slight lancinating pain in the chest of two or three days' duration. The seventh patient, who had slightly bloody sputum, was without symptoms after two weeks. The average time of hospitalization was 2.14 days. All patients were walking

TABLE III.—*Study of Cases 3, 2 and 1 Years, Respectively, After Operation**

	Right Limb			Left Limb		
	1 Year	2 Years	3 Years	1 Year	2 Years	3 Years
Number of cases	157	98	58	154	96	56
Average per cent improvement	98.6	97.8	97.6	98.1	97.5	97.3

* 19 cases possessing vulval varicosities and 9 cases of preoperative thrombo-phlebitic sequelae not classified.

within 28 hours after operation. The average time of returning to work was 15 days. Ace bandages are worn until all edema subsides (about six weeks).

As a result of these studies I have become convinced that the efficacy of any treatment of varicose veins is in direct proportion to the ability of the operator to eradicate incompetent perforator veins wherever they are located.

SUMMARY

1. A general scheme of arrangement of the saphenous systems in the leg exists, and locations of perforator veins are fairly constant.
2. The occurrence of a heretofore unrecognized location of the main saphenous vein and lower portion of the short saphenous vein between deep fascial layers is described.
3. Incompetent perforator veins are relatively rare in the thigh.
4. Incompetent perforator veins are very common in the leg, and one of the usual interpretations of the Trendelenburg "positive" test is challenged.
5. Suggestions are made for what appears to be a more effective operative therapy.

REFERENCES

- ¹ de Takats, G., and L. Quillin: Ligation of the Saphenous Vein: A Report of Two Hundred Ambulatory Operations. *Arch. Surg.*, **26**: 72-88, 1933.
- ² Ochsner, A., and H. R. Mahorner: The Modern Treatment of Varicose Veins as Indicated by the Comparative Tourniquet Test. *Ann. Surg.*, **107**: 927-951, 1938.
- ³ Sherman, R. Stanton: Varicose Veins: Anatomic Findings and an Operative Procedure Based Upon Them. *Ann. Surg.*, **120**: 772-784, 1944.
- ⁴ McPheeters, H. O., and J. K. Anderson: Injection Treatment of Varicose Veins and Hemorrhoids. Philadelphia, Davis, 1938.
- ⁵ Allen, E. V., N. W. Barker and E. A. Hines, Jr.: *Peripheral Vascular Diseases*. Philadelphia, Saunders, 1946, p. 62.
- ⁶ Homans, J.: *Circulatory Diseases of the Extremities*. New York, Macmillan, 1939.
- ⁷ Ogden, Eric, and R. Stanton Sherman: Physiologic Considerations in the Care of Patients with Varicose Veins. *Arch. Surg.*, **52**: 402-420, 1946.