THE MODERN TREATMENT OF VARICOSE VEINS AS INDICATED BY THE COMPARATIVE TOURNIQUET TEST

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ONE year ago we described a new test[1] for evaluating circulation in the venous system of the lower extremity affected by varicosities, and indicated the significance of this test in directing the proper treatment of varicose veins.

The modern trend in the treatment of varicose veins is a combination of ligation of the internal saphenous vein and injection of varicosities with some sclerosing solution. A very prevalent teaching concerning ligation is that the internal saphenous vein should be sectioned and ligated high above any of its tributaries in order to keep at a minimum the incidence of recurrence. The test which we present shows why this alone is insufficient treatment in many cases of varicose veins; in addition, the test will indicate where the retrograde flow from the deep to the superficial system occurs, *i.e.,* whether the reflux takes place through the internal saphenous vein alone or through communicating veins from the deep to the superficial system as well.

TESTS FOR EVALUATING THE CIRCULATION IN THE VENOUS SYSTEM OF THE LOWER EXTREMITY AFFECTED BY VARICOSITIES

With the several tests which have been advocated for investigating the circulation in varicose veins, the following information should be determined:

(1) Competency of the valves in the long saphenous vein.

(2) Competency of the valves of the communicating veins.

(3) Patency of the veins communicating between the superficial and deep system.

(4) Patency of the deep veins.

(5) Relative impairment of the arterial supply to the extremity.

To obviate unnecessary repetition in describing these tests, which have been previously reported,[1] we will consider only two of them: The Trendelenburg-Brodie test, and the comparative tourniquet test of Mahorner and Ochsner.[1] The first of these, described initially by Brodie[2] and later, but apparently independently, by Trendelenburg,[3] was employed by Trendelenburg as follows: The patient reclines on a table and the leg is elevated so that the veins are above the level of the heart. The veins promptly empty. The patient assumes the sitting position and then the standing position, and it is noted whether the veins fill quickly or slowly. The same performance is now repeated, but after the veins are emptied the hand of the observer is placed over the upper end of the long saphenous vein firmly enough to prevent the passage of blood through it. The patient, with this pressure maintained, then sits up and again stands. The pressure is maintained only momentarily, and when

released the observer notes the blood as it rushes downward through the internal saphenous system to suddenly distend the varicosities. The immediate distension of the veins when the pressure is released indicates incompetency of the valves in the saphenous vein, and in such instances the Trendelenburg test is considered to be positive.

A further adaptation of this test is the determination of the so-called doubly positive reaction. Instead of releasing the pressure over the internal saphenous vein, the observer maintains it for 35 seconds, to determine if the varicosities distend in spite of the continued pressure over the saphenous vein. If the varicosities become distended to their full prominence within 35 seconds, it indicates that the blood, unable to return through the saphenous vein with its incompetent valves, has found another shortcut by way of the communicating veins, whose valves, therefore, must have become incompetent since the flow through these communications is normally from the superficial to the deep system. If the varicosities take 35 seconds or longer to distend fully, with the observer exerting pressure over the internal saphenous vein, the interpretation is that the valves of the communicating veins are competent. The blood, not being able to return through the varicosed saphenous vein with incompetent valves because of pressure exerted by the observer, and not being able to return through the communicating veins because their valves are competent, must, therefore, reach the varicosed superficial veins by the normal route passing through the capillaries; and it requires approximately 30 seconds for sufficient blood to do this in order for it to distend large varicosities.

The comparative tourniquet test described by Mahorner and Ochsner[1] combines the advantages of the several other tests and when correctly interpreted gives one extensive information concerning the condition of the circulation in the varicose veins of the lower extremity.

The patient is observed standing, draped so that the two legs and thighs can be seen. The observer sits with the light behind him and with the level of vision low so that the veins of the calves and thigh can be easily seen. The patient walks to and fro in front of the observer (Fig. 1). Even with no tourniquet on the varicosities become less prominent when the patient is walking, because the peripheral pumping action of the muscles on the deep veins sucks the blood from the superficial system and helps return it to the heart. The patient then stops and a tourniquet is applied around the upper third of the thigh sufficiently tight to compress the superficial veins and obstruct the flow of blood through that segment. The patient walks again over the same course and at the same speed. The prominence of the varicosities is noted and compared with their prominence when walking without the tourniquet and again when walking with the tourniquet around the middle third of the thigh and again when walking with the tourniquet around the lower third of the thigh. The prominence of the varicosities is thus observed under five different conditions: Standing; walking without the tourniquet; walking with the tourniquet around the upper third of the thigh; around the

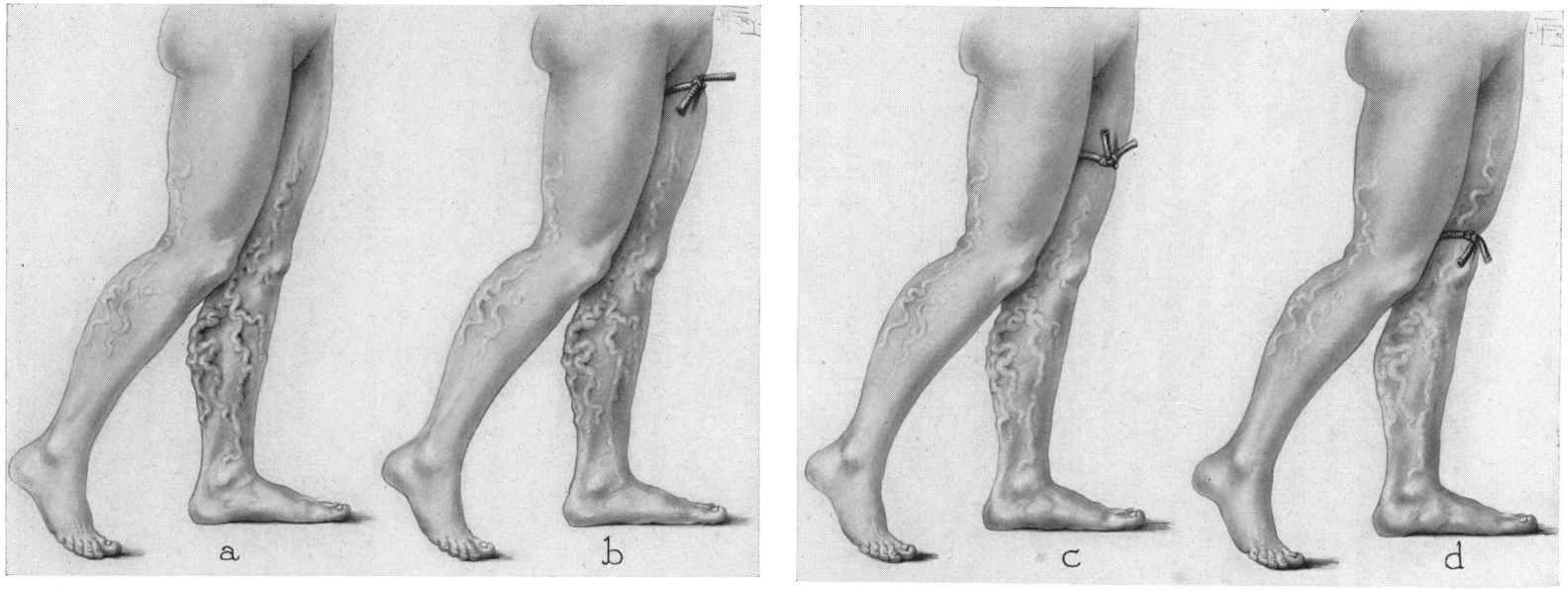


FIG. 1.—Drawings illustrating performance of the comparative tourniquet test for determining the competency of the valves of the veins communicating between the deep and the superficial systems and patency of the deep veins of the leg (Mahorner and Ochsner: Archives of Surgery, 33, 479–492, 1936). The patient walks at a normal gait, and the prominence of the veins of the calf is noted (a). Thereafter the tourniquet is applied to the upper third of the thigh (b), sufficiently tight to compress the superficial veins. Observations are made for comparative changes in the appearance of the veins of the calf. The tourniquet is likewise applied to the middle and the lower third of the thigh (c) and (d). The patient walks over the same course, and the prominence of the veins is noted. If the deep and communicating veins of the thigh are patent there is diminished prominence of the veins of the calf when the patient walks with the tourniquet applied. If the valves of the communicating veins are incompetent when the patient walks with the tourniquet around the upper third of the thigh, there is some diminution in the prominence of the varicosities, but they do not entirely disappear because the blood spills through the incompetent communicating veins from the femoral to the long saphenous vein. When the tourniquet is below the lowest communicating vein of the thigh in which the valves are incompetent (d), the varicosities of the calf collapse or disappear. When valves of the communicating veins are incompetent high ligation alone is not sufficient, and low ligation also must be performed to interrupt retrograde flow through communicating veins. If the varicosities of the thigh and leg completely collapse, *i.e.*, disappear, when the tourniquet is around the upper third of the thigh and there is no further improvement when the tourniquet is around lower levels, then the valves of the communicating veins are competent and high ligation and section of the saphenous vein are sufficient to interrupt the retrograde flow from the deep system. In (b) slight improvement (diminution in prominence) is shown over that indicated in (a), in a case in which the blood spills through the communicating veins below the level of the tourniquet. In (c) more improvement in the veins of the calf is shown, and in (d) the greatest improvement appears. If the improvement shown in (b) were complete, the test would indicate competency of the valves of the communicating veins of the thigh, but incompetency of the valves of the internal saphenous vein.

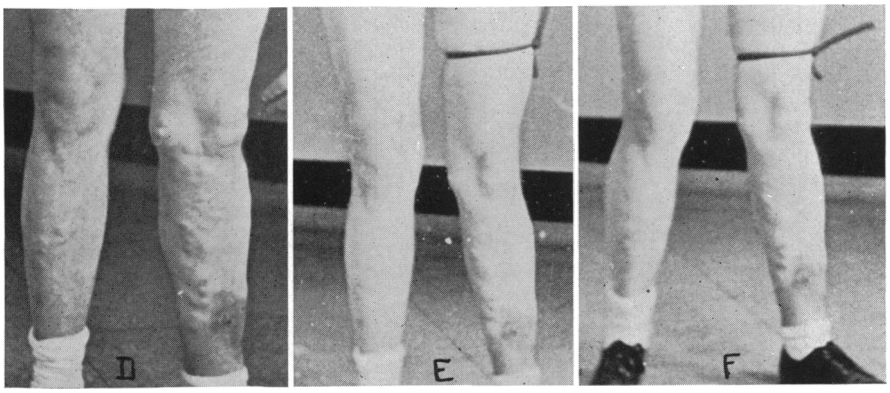
middle; and around the lower third of the thigh. When the patient walks with the tourniquet applied, the varicosities are less prominent than when standing still or walking without the tourniquet, but in certain instances there are different degrees of improvement with the tourniquet at different levels (Fig. 2-A, B, C, D, E, F.).

The interpretation is as follows: If there is greater improvement (less prominence) in the varicosities below the tourniquet when the tourniquet is around the lower third of the thigh than when it is around the upper third, it is evident that not only is there a retrograde flow from the deep to the superficial system through the main opening of the internal saphenous, but that there is also a reflux through communicating veins below the level of the fossa ovalis (Fig. 3). If a maximum improvement occurs when the tourniquet is at the highest level, that is, around the upper end of the internal saphenous (Figs. 4 and 5), and there is no further improvement when the tourniquet is around the middle third or around the lower third of the thigh, then only one source exists for retrograde flow into the superficial system of veins and that source is through the main opening of the internal saphenous into the femoral (Figs. 4 and 5). There is never a greater diminution in the size of the varicosities when the tourniquet is in the upper third than when it is in the lower third of the thigh. It does sometimes happen that the veins *above* the tourniquet, when it is around the lower third, are more prominent than the same veins when the tourniquet is around the upper third. In severe cases this is expected and does not vitiate the test. The test depends upon the condition of the varicosities below the tourniquet.

In interpreting the test, Grade IV improvement means complete or practically complete disappearance of the varices; Grade I, slight; II, moderate; and III, marked improvement. Of course, improvement indicates diminution in the pressure in the veins and in some instances where the vein walls are extremely thick the improvement may be detected more accurately by palpation then by vision. The improvement is recorded for each level. If the improvement on the right leg is Grade IV in the upper third and Grade IV in the lower third (Figs. 4 and 5), ligation at the highest level will accomplish complete obstruction to the reverse flow of blood. If in the same individual the other leg shows a Grade II improvement with the tourniquet in the upper third, Grade III in the middle, and Grade IV in the lower third (Fig. 2), then there must be incompetency not only of the valves in the saphenous vein but also of the valves of the veins communicating between the deep and superficial systems of the thigh (Fig. 3). Though high ligation will suffice in the right leg of this patient it will be insufficient to stop the retrograde flow in the left leg. Something additional must be done. It is not feasible to ligate, independently, each communicating vein as was attempted by deTakáts and Quillian.[4] This converts the operation into a major procedure and extirpation of the veins by any of the described methods has been discarded because of the severity of the procedures and because of the mortality. We believe, because of our experience and that of others, that low ligation alone is not

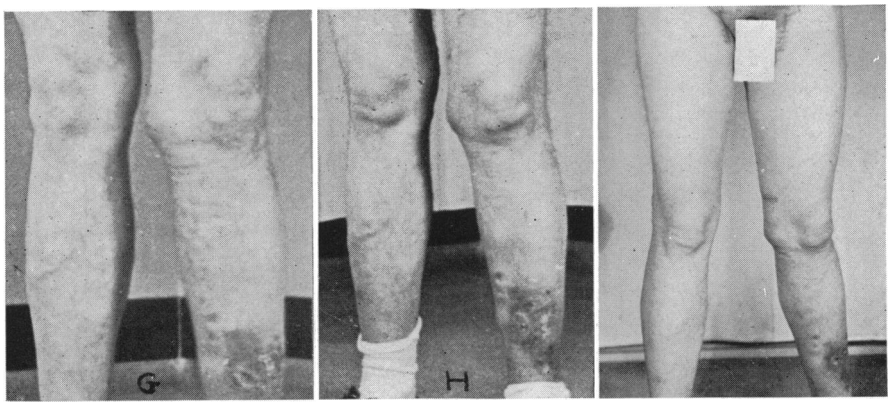
BEFORE TREATMENT

COMPARATIVE TOURNIQUET TEST



Tourniquet high | Midthigh | Lower thigh

APPEARANCE AFTER LIGATION



After high ligation | After low ligation | One month after ligations

FIG. 2.—Enlargements from moving picture. (A, B. C.) Patient before treatment, showing huge varicosities in the left leg, some on the right. (D, E, F.) The improvement in appearance of varicosities during the comparative tourniquet test. D, is walking with the tourniquet high; E, around the middle of the thigh; and F, around the lower third of the thigh, all sufficiently tight to compress the superficial circulation. Notice that the prominence of varicosities is less marked with the tourniquet around the middle and lower thirds (E, F.) of the thigh than when the tourniquet is around the upper third as in D. The valves of the communicating veins in this thigh are thus shown to be incompetent. G, the patient ten days after ligation and section of the internal saphenous at the fossa ovalis. H, patient ten days after an additional low ligation in the lower third of the thigh. I, patient one month after completion of high and low ligation of the left saphenous vein and high ligation of the right saphenous vein.

sufficient because in a high percentage of cases recurrences readily take place through collaterals subsequently.[5] If high ligation is performed to prevent recurrences, low ligation should also be made in these instances to completely obstruct the retrograde flow from the incompetent valves of the com-

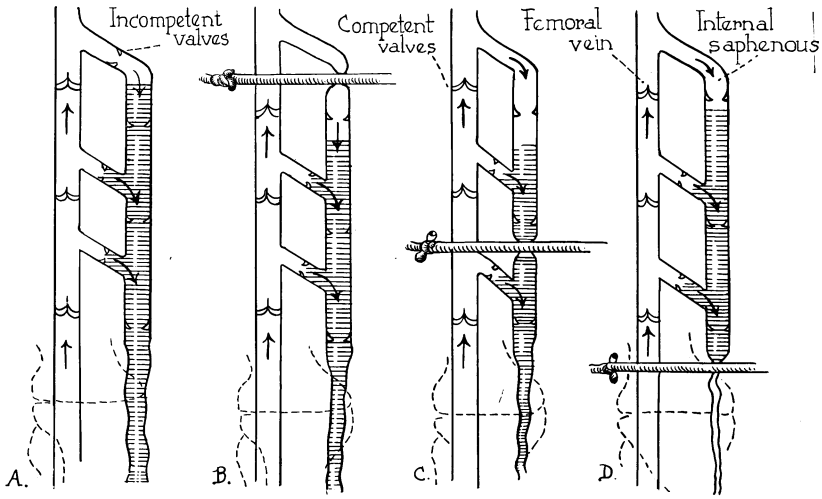


FIG. 3.—The physiology involved in the comparative tourniquet test in the left leg of the patient shown in Fig. 2; that is, when the valves of the communicating veins as well as of the internal saphenous are incompetent. When the tourniquet is high, it stops retrograde flow through the internal saphenous, but there is an abnormal flow from the deep to the superficial systems below the tourniquet through the communicating veins, and only when the tourniquet is below the lowest communicating vein with incompetent valves, as in D, is there collapse of the varicosities.

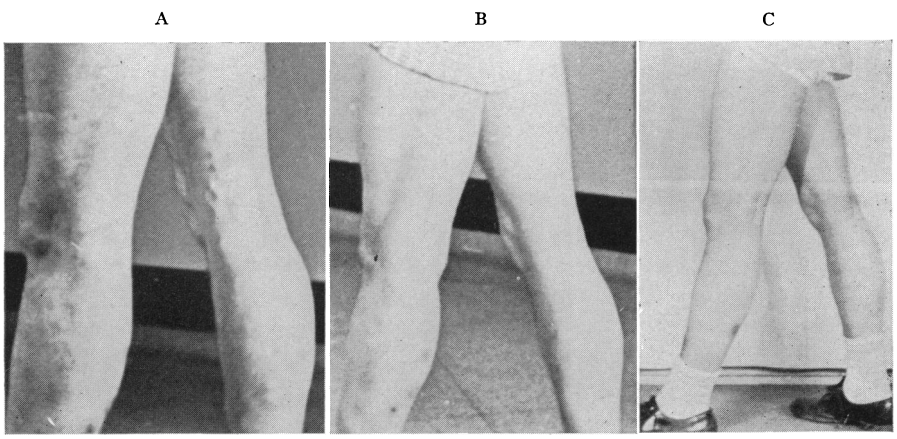


FIG. 4.—Enlargements from moving pictures. Same patient as in Fig. 2. (A) the varicosities of the right leg before treatment. (B) before treatment the patient walking with the tourniquet high on the thigh. The varicosities have entirely disappeared, thus showing that although the valves of the saphenous vein are incompetent, those of the communicating veins are competent and high ligation alone is sufficient to interrupt the retrograde flow from the deep to the superficial system. (C) ten days after high ligation and section of the right internal saphenous vein.

municating veins. It is true that high and low ligations do not preclude the possibility of recurrences through collateral channels around the lowest transection and ligation, but such a possibility is more acceptable than the complete removal of the saphenous vein because the latter is a more formidable operation with a probable, similar incidence of recurrence, and a probable, greater risk (Table I). "Probable" is used advisedly because of the difficulty of estimating recurrences and mortality from available statistics.

In rare instances the improvement with the patient walking and with the

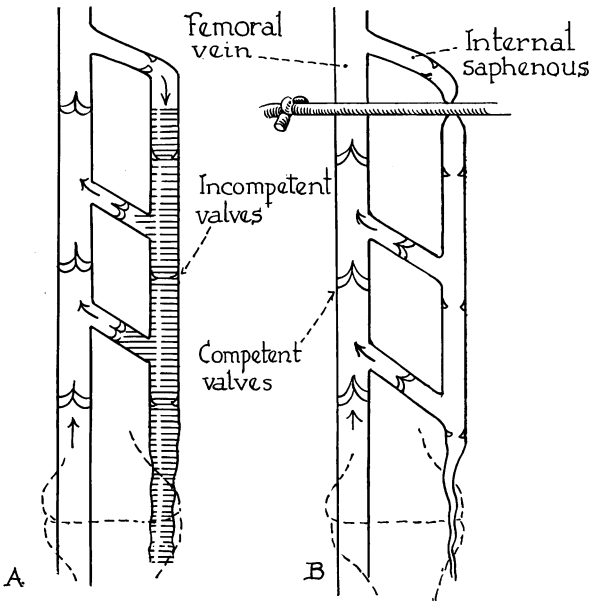


FIG. 5.—Physiology involved in the right leg of the patient shown. When the tourniquet is placed high there is complete collapse of the varicosities since the valves of the communicating veins are competent and since retrograde flow which is occurring through the saphenous vein alone is abstructed. (Compare with Fig. 3.)

tourniquet around the thigh is not complete; that is, cannot be graded IV with the tourniquet around even the lower level of the thigh. There still must be a leak below this tourniquet and this is either directly through the external saphenous system from the popliteal (usually when the external saphenous system in varicose it is due to its connection with the internal saphenous) or through the communicating channels between the deep and superficial systems of the calf. These two sources may be differentiated by putting a tourniquet around the leg below the knee and at the upper end of the external saphenous vein. If reverse flow is occurring through the external saphenous directly from the popliteal, further improvement of the veins of the leg is found when the tourniquet is placed around the upper end of the external saphenous. We have encountered this condition only rarely. Leakage through the communi-

cating veins of the calf (very rare) from the deep to the superficial systems will not be retarded when the tourniquet is placed around the leg below the knee.

The comparative tourniquet test[1] combines the advantages of other tests localizing accurately the veins with incompetent valves. It gives the following information:

(1) Whether the valves of the internal saphenous vein are incompetent.

(2) Whether the valves of the deep veins communicating between the deep and superficial system are incompetent, and where they are incompetent.

(3) Whether there is a direct leak from the popliteal vein into the external saphenous vein.

(4) Whether the communicating veins and the deep veins are patent.

The use of this test safely permits the abrogation of all the other tests except the Trendelenburg-Brodie. The Trendelenburg-Brodie test, by noting the rapidity with which the blood rushes into the varicosities when the pressure is released, gives a better idea of the degree of incompetence of the valves. The doubly positive reaction of the Trendelenburg-Brodie test is not so reliable in detecting incompetence of the valves of the communicating veins as is the comparative tourniquet test. In a group of varicose extremities we found the valves of the communicating veins to be incompetent in 20 per cent by the doubly positive reaction of the Trendelenburg-Brodie test, and in 33 per cent by the comparative tourniquet test in the same group of extremities.[5] Moro,[6] in 1910, found that 55 per cent of 42 cases had retrograde flow not only through the main opening of the saphenous but also through the communicating veins, basing his conclusions upon the recurrences he had after the Trendelenburg operation and the presumption that recurrences meant retrograde flow through the communicating veins, which of course they do not invariably indicate. However, this is the only other estimate we have found besides ours of the relative percentage of leaks through the main opening of the saphenous and through the communicating veins as well.

Historic Notes on the Operative Treatment of Varicose Veins.—Numerous operative procedures have been advocated for varicose veins. It is difficult to evaluate, impartially and correctly, the comparative results of these different methods. The following are, however, among the noteworthy contributions:

Schede,[7] in 1877, described one of the first attempts to perform an operation which would be acceptable from the standpoint of completeness of cure. absence of recurrences, and untoward results. He used principles which had already been employed, but used them much more extensively than formerly. He ligated and sectioned the long saphenous vein in the lower third of the thigh. In those cases in which the wall of the veins was thin and in which, because of the thinness, it would be difficult to separate the vein from the perivenous structures, he used percutaneous ligation. He passed catgut sutures through the skin and under the varicosities in many places and tied the

sutures over a rubber tube the thickness of a finger. He has used as many as 30 ligatures in a single case. Of course, there were many recurrences and this procedure gained no favor.

Madelung[8] described, in 1884, a procedure which consisted of complete excision of the long saphenous and varicose radicals and ligation of the remaining stumps through a long incision on the thigh and the leg. The Madelung operation has been one of the most popular of the radical procedures for varicose veins. It has the disadvantage, however, of being an extensive operative procedure, requiring hospitalization and being attended with a mortality of approximately 0.7 per cent from pulmonary embolism.[9] The principle of the operation is good but has the same fundamental objective as other procedures described at the beginning of the present century (Keller's,[10, 11] Mayo's,[12] and Babcock's[13]) operations, in all of which the vein is removed. In the same article in which Trendelenburg described a test for reversal flow of blood in the long saphenous system, he advocated ligation of the saphenous vein and section of it, but the point of election for him was not high on the vein but where it was prominent in the middle of the thigh. Perthes[14] reported results from this procedure and found recurrences in 22 per cent.

In the early part of the nineteenth century several important advances were made in the treatment of varicose veins. Tavel,[15] in 1904, suggested the treatment of varicosities by a combination of ligation and injection. If spontaneous thrombosis did not occur within 24 to 48 hours after low or high ligation of the long saphenous vein in the thigh, he injected the vein with 5 per cent phenol. Ligation and section alone resulted in thrombosis in only seven of 25 cases. He thought that artificial thrombosis would reduce the percentage of recurrences following ligation. In 1912, he[16] reported 50 cases which had been treated by this method. Though Tavel used the ligation and injection treatment with a period of time intervening, to Schiassi,[17] belongs the credit of introducing simultaneous injection at the time of ligation. Schiassi ligated the long saphenous just above the knee, but when he sectioned the vein he introduced an olivary-tipped glass cannula with an adaptor fitted to a syringe, and injected 30, 40, or 50 cc. of a solution containing iodine Gm.i, potassium iodine grain i, and distilled water 100 cc. into the distal stump. Modifications of this method have been employed widely throughout the world and it is increasing in popularity. Excellent results have been reported from its use by Mazzini,[18] Foa,[19] Putzu,[20] and Schiassi.[21] Nobile[22] modified Schiassi's method by injecting the saphenous vein distally just below the groin and permitting the solution to flow out of the open vein above the knee. Unger[23] modified this method by introducing a ureteral catheter into an incision high in the internal saphenous vein, and as the catheter was slowly withdrawn 1 to 2 cc. of 20 per cent sodium chloride or a sugar solution were introduced for every 5 to 10 cm. of vein.

To return now to an earlier period and to the development of a different type of treatment of varicose veins, one finds that several ingenious instruments and methods were devised for complete removal of the varicosed long

saphenous vein without the necessity of making a long incision as used by Madelung. Keller,[10] in 1905, described removal of segments of vein by passing a wire loop through the lumen, cutting the vein at a distance lower down and tying the tip of the obliquely severed vein to the wire loop. The wire was then withdrawn, the vein segment inverted, and dragged out through its own lumen. He[11] later added mass transfixion of tissues in the region of the vein bed after extraction of the vein. In 1912, he reported 33 cases in which the results were all satisfactory.

In 1906, C. H. Mayo[12] described an instrument for enucleating the vein through a small incision. It consisted of a small ring on a long handle. The incision was made low over the vein and the proximal end of the severed vein was threaded through the ring, and by forcibly shoving the instrument up the tautly stretched vein it was torn from its surrounding connections up to another level where an incision was made and the segment was detached. The remaining stump of the varicose vein was ligated. In the following year, Babcock[13] introduced a modification of the Keller method. Through an incision in the vein he introduced an acorn-tipped guide and passed it through the vein, and at the distal end another incision was made. The vein was severed and the distal end of the segment tied to the tip of the guide. The guide was then withdrawn, the vein with it being pleated on the handle of the guide. The disadvantage of these measures was that there were left many large, lacerated communicating veins in which thrombi were likely to form with the possibility of extension into the deep venous system.

In 1908, Friedel[24] described an operation that was devised and used by Rindfleisch, and which eventually proved to be one of the most atrocious crimes a heavy handed surgeon even inflicted on his patients. The operation which fortunately was reserved for severe cases of varicosities consisted of excision of the internal saphenous vein in the thigh and a spiral incision through the skin and subcutaneous tissue down to the deep fascia, beginning at the knee, encircling the leg four to seven times, and ending at the foot. The bleeding superficial veins were ligated and the wound was packed open, making a deep gutter, which necessitated healing by second intention. Friedel[24] reported seven cases with two recurrences. Meyer,[25] in 1914, reported 42 per cent permanently healed cases and, in 1924,[26] 28 cases with the following results: One death from sepsis, and three other deaths within a year, the cause not given. Of ten cases which he followed for from one to ten years, only seven had a satisfactory result, but as the picture from Friedel's article showed, the optimum result appears atrocious. Fortunately, only Rindfleisch's and Bircher's clinics found this operation acceptable enough to give any expression of approval.

Tavel,[15] in 1904, and Homans,[27] in 1916, called attention to the advisability of ligating the internal saphenous high above any of its collaterals in order to prevent recurrences. This very important point is still not sufficiently appreciated. In cases in which the Trendelenburg test is doubly positive, indicating incompetency of the valves of the deep communicating vein, Ho-

mans[27] recommends extirpation of the vein. deTakáts,[28] in 1930, suggested that ligation of the saphenous vein could be done as an ambulatory procedure, which has proved a noteworthy contribution. From our own experience and from an exhaustive review of the literature, we believe that thrombus propagation and embolus are greatly diminished and prevented by the patient being active. We have found no deaths from embolus recorded where this method has been properly used. Faxon's[29] patient died, but the patient had been put to bed.

Modern Treatment.—A variety of measures are used for treating varicose veins of the lower extremity, and the indications for selecting a method or combination of measures for a particular case vary because of the many factors involved. The following methods, either because of their efficiency or because of various reasons why they should not be used, are worthy of discussion:

(1) Preventive treatment—rest, external support.
(2) Conservative treatment:
    (a) Rest and elevation
    (b) Elastic supports
    (c) Unna's paste boot
(3) Injection treatment—use of sclerosing solutions intravenously without operation.
(4) Operative treatment:
    (a) Extirpation
        Madelung's operation
        Mayo's operation
        Keller-Babcock operation
    (b) Schede operation
    (c) Ligations—single or multiple
    (d) Ligation and simultaneous or preliminary or subsequent injection of sclerosing solutions.

Selection of the proper treatment for the individual case not only calls for considerable knowledge and judgment, but should evoke a fairness in evaluating the different measures rather than persistence in blind adherence to a particular type of therapy.

Contraindications to Active Treatment.—In considering the applicability of a measure a number of points must be weighed, among the most important of which are the age of the patient, the existence of pregnancy, the presence of any debilitating disease, the existence of any severe impairment in arterial blood supply to the part, the study of previous or coexistent phlebitis, and the presence of pelvic tumors or other mechanical obstruction to venous flow. The above conditions may be actual contraindications to the active treatment of varicose veins; there are none to the conservative treatment, which consists of rest and elevation or external support alone.

(1) *Advanced Age.*—Senility, in which the mental or physical condition of the patient promises less from alleviation of varicosities by active measure

than by a simple compression bandage either in point of time (life expectancy) or in faculty of appreciation (the mental ability to do so), may be a contraindication to the active treatment of varicose veins.

(2) *Pregnancy* is more an indication for conservative treatment than it is a contraindication to active treatment. Better expressed, it is an indication for delayed active treatment. The facts leading to this conclusion are: Varicose veins appear or are made worse by pregnancy. Frequently the patients first present themselves for treatment during pregnancy, and it may appear difficult from the intrinsic standpoint of the physician alone to instruct that patient concerning the conservative measures and advise her to return later after the puerperium for the actual treatment of the varicosities. Some of these patients will never submit to active measures later, though such treatment may be advisable, and this small percentage is perhaps the only argument for immediate active treatment. On the other hand, since varicose veins become worse during pregnancy, there is the probability that a goodly number of patients treated at this time may have recurrences even before parturition. Some few patients will have such a marked abatement of varicose veins after the puerperium that they are practically normal and need very little active treatment. In these, the conservative measures (supportive bandages or stockings) are, indeed, preventive measures which in pregnancy also consist of rest in bed and elevation of the legs during the middle of the day. The records of the Hutchinson Memorial Clinic of Tulane University School of Medicine show 285 cases of varicose veins diagnosed at the clinic between September 19, 1932 (when it opened) and January, 1936. There were 9,233 patients registered during that time. Thus one in 32 admissions had varicose veins (3 per cent). One hundred fifty of these varicose vein patients were seen in the Department of Obstetrics alone and did not come to surgery, though others did from that department. There was a total of 1,419 pregnant women seen by the Department of Obstetrics during that time. Thus approximately 10.6 per cent of pregnant women showed varicose veins, and 53 per cent of varicose vein cases were pregnant. Pregnancy was the main reason these 150 patients came to the clinic and varicose veins was only an associated condition. Yet this group represented 52 per cent of the cases of varicose veins registering during that period, and few of these had severe enough varicosities after parturition to make them seek treatment for their veins. The inference is striking; *i.e.,* supportive treatment but not active during pregnancy for this group; active treatment for those that need it in the puerperium. Occasionally, in severe cases, it may be advisable in the early months of pregnancy to use active measures to treat the varicosities.

(3) The presence of certain *debilitating diseases* is a contraindication to the active treatment of varicose veins. It may seem needless and pedantic to mention that patients with metastatic carcinoma or other diseases in which the life expectancy is short should have only conservative treatment for varicosities. Conditions such as severe anemia, diabetes, cardiac affections and

pulmonary disease should be corrected or under absolute control before active treatment of varicosities is undertaken.

(4) The existence of any severe *impairment to the arterial blood supply* may be a contraindication to active treatment of varicose veins. Ligation of the saphenous vein for varicosities may greatly improve the circulation to an extremity in which it is impaired not only by varicose veins but also by arterial sclerosis, and the extremity may be benefited by ligation. On the other hand, in the extremity in which the blood supply is very deficient, any accident such as infection or excessive thrombosis may precipitate a disaster, the possibility of which causes one to hesitate to employ any radical treatment. The injection treatment is possibly even more dangerous to these individuals than high ligation alone, because the injection of sclerosing solution may precipitate excessive thrombosis, causing reaction and edema with which a poorly nourished extremity could not adequately contend. Even with ligation, about 25 per cent of the cases will have a peripherally propagating thrombus which may also be dangerous for similar reasons. Therefore, extreme caution should be employed for cases affected with arteriosclerosis, and because of the nature of thrombo-angiitis obliterans active treatment would always be extremely dangerous. In considerable experience with both conditions, we have rarely seen thrombo-angiitis obliterans and varicose veins associated.

(5) The history of *previous or coexistent phlebitis* may be in the former, and is in the latter instance a contraindication to the active treatment of varicose veins. Active phlebitis of the deep veins is a contraindication to active treatment being directed to the care of varicose veins. Infective thrombophlebitis may be disseminated by active treatment (Hanschell[30]). How long one should wait after an attack of phlebitis of the deep veins before the active treatment of varicosities is under taken is a debatable question. Six months is a minimum period. Where a deep phlebitis has left a residual obstruction to the deep system, which is detectable by the comparative tourniquet test, it is not permissible to obstruct the superficial system either by ligation or injection. However, an obstruction to the deep veins following a recent phlebitis may clear up after a sufficient length of time (six months to two years).

(6) *Tumors of the pelvis* or other mechanical obstruction to the return venous flow, even if not an actual contraindication to the active treatment of the varicose veins, should be corrected before the varicose veins are treated. In the interval conservative measures may be employed.

Selecting the Type of Treatment for the Case.—In selecting the type of treatment best suited for a case we will consider, individually, the four categories of treatment and the type of case which should be managed by each method.

(1) *Preventive Treatment.*—Preventive treatment is most frequently indicated in pregnancy. The obstetrician should instruct patients who have

any predisposition to varicose veins in the preventive measures. These are rest in bed in the midday or midmorning and midafternoon for at least a half hour with the legs slightly elevated. The patient should wear bandages or elastic stockings if varicosities are present.

(2) *The Conservative Treatment* is merely supportive. Presumably the existence of varicose veins is indication enough for therapy, but because of contraindications active treatment is not always feasible. Such cases are those in which age, severe concomitant diseases, arteriosclerosis, *etc.*, make active treatment inadvisable and cases in which pelvic tumors, phlebitis, pregnancy, make the delay of active treatment advisable.

Technic of Conservative Measures.—Bandages consisting of cotton fabric, woven so that there is some elasticity, or silk with fine elastic threads incorporated, are used. There are several varieties. Bandages are usually five yards in length and vary in width. Three and four inch widths are the best sizes. Proper application consists of one turn about the ankle, then one or two turns around the foot, returning to the ankle and wrapping spirally up the leg to just below the knee, wrapping each previous turn one-half the width of the bandage. In some instances two bandages are necessary for one leg, the additional one beginning below the knee and continuing up the thigh. The bandages are applied in the morning and removed at night before retiring. The commonly employed "Ace" bandage is excellent for this purpose.

Elastic stockings generally contain some rubber. They may be effectively used in some cases where the conservative treatment is indicated. The heavy ones have a tendency to roll into creases. For prolonged use in weather which is not uncomfortably hot they are probably more satisfactory to the patient than bandages. There are several varieties and makes, heavy mercerized cotton and rubber or heavy silk and rubber. One of the best varieties, the one we prefer, is the "Lastex," (Bauer & Black). It is thin but effective and scarcely shows under other stockings. The preferable type contains heel and toe, and may be a short one stopping below the knee or the longer stocking which goes to midthigh. Doctor Scholl's is another satisfactory one.

Unna's paste boot is indicated in the preliminary treatment of varicose ulcer, not in uncomplicated cases of varicose veins where bandages and elastic stockings better serve the purpose.

Rest and elevation of the lower extremities are adjuncts to supportive measures. The patient is instructed to recline at midday or in midmorning and midafternoon and elevate the legs slightly on pillows, resting at least one-half hour each period. This is especially indicated in those cases complicated by edema or ulceration.

(3) *Treatment by the Injection of Sclerosing Solutions Only.*—The selection of cases for treatment by the injection of sclerosing solutions, and the use of this measure without operative treatment, involves the difficult problem of comparing the value of this method with the combination of an operative measure and the injection of sclerosing solution. This comparison must take

into consideration the late as well as the immediate results, the mortality, the ease of administration, and relative discomfort to the patient.

TABLE I

RÉSUMÉ OF STATISTICS RELATIVE TO MORTALITY, RESULTS AND RECURRENCES (COMPILED FROM THE LITERATURE)

Injection Treatment Only

Author	Solution	No. of Cases	Cases Followed	Percentage of Recurrence	Time of Follow-Up	Emboli	Fatalities
Howard, Jackson, and Mahon,[42] 1931	Sodium chloride 20%	66	52	98%	1 yr. or more	1	0
Faxon,[43] 1933	Quinine urethane	613	314	63%	Avg. 1.4 yrs.		
Kettel,[44] 1932			225	86.6%	5 yrs.		
Levi,[45] 1927–28	Glucose 66%	60				1	0
Forestier,[46] 1928				15%			
Fränkel,[47] 1929		800		8 to 10%		0	0
Logefield and Dahlstrom,[48] 1929	Invert sugar, sodium chloride	96		2%	6 mos.		
Meisen,[49] 1927	Sodium chloride 10% and sodium salicylate 25%	500		0	9 mos.		
Kilbourne,[35] 1929	Various	Collected cases		6%			1 in 5000
Woolsey and Millzner,[50] 1929	Sodium salicylate 20%, quinine and urethane	150		6%			
McPheeters and Rice,[21] 1928			53,000 collected				7
Schmier,[51] 1930	NaCl, Na salicylate, Quinine HCl and urethane, dextrose	3,000				0	
Scott,[52] 1930	Quinine and urethane	10,000				0	0
Cooperman,[53] 1929	Sodium salicylate 40%	64		18%	3 to 5 mos.		
Keller,[54] 1929	Sodium chloride 20%	1				1	0
Hansen,[55] 1931		107		49%	1 to 3 yrs.		
Kettel,[56] 1931		60,000 collected				10	20 deaths from emboli and other causes
Mundt,[57] 1930							1 death from mercury poisoning
Pennoyer,[58] 1930	Sodium salicylate quinine urethane	218	48	8%	18 mos.		
Silverman,[59] 1931	All	Review literature				In entire literature 19. Adds 1	In entire literature 14. Adds 1
Ochsner and Mahorner,[5] 1937	Sodium morrhuate		25	57.2%	6 mos. to 3½ yrs.		

TABLE II

RÉSUMÉ OF STATISTICS RELATIVE TO MORTALITY, RESULTS AND RECURRENCES (COMPILED FROM THE LITERATURE)

Operative Treatment

Author	Method	No. of Cases	Cases Followed	Percentage of Recurrence	Time of Follow-Up	Emboli	Fatalities
Howard,[32] 1934	Ligation and injection distal stump	68	58	23%	1 yr. to 29 mos.		
Colt,[36] 1928	Keller-Babcock	94	22	18%	4 to 6 yrs.	0	0
Putzu,[20] 1919	Schiassi	32	32	19%			0
Siebner,[37] 1929	Multiple transfixions, Schede	20	15	60%	6 mos. to 2 yrs.		
Keller,[11] 1924	Extraction by inversion	33	33	0	1 yr.		0
Tanner,[38] 1927	Extraction by inversion, Keller-Babcock	52	29	18%	Avg. 22 mos.		0
deTakáts and Quillian,[4] 1933	Ambulatory ligation	200	60	3%		0	0
Müller,[34] 1928	Simple ligation, excision, ligation and injection	100	51	46%	At least 9 mos.	2	1 (1%)
Kilbourne,[35] 1929	Various operations	14,000		30%			0.4%
Tavel,[16] 1912	Ligation and injection	50	50	12%			0
Miller,[33] 1906	Trendelenburg	98 legs	41	22%	6 mos. to 10 yrs.		
Miller,[33] 1906	Schede	19 legs		66%	6 mos. to 10 yrs.		
Berntsen,[9] 1927	Trendelenburg	83	83			8.4%	1.2%
Berntsen,[9] 1927	Extirpation	376				7.2%	0.7%
McPheeters and Rice,[31] 1928	Collected operations by various surgeons	6,771	6,771			72	35 (0.53%)
Faxon,[29] 1934	Ligation and injection	118				1	1
Perthes,[14] 1895	Ligation mostly in lower third of thigh	63	41	22%	5 mos to 9 yrs.		
Ochsner and Mahorner,[5] 1937	High ligation only plus injection	11	11	18%			
Ochsner and Mahorner,[5] 1937	Ligation, midthigh only	12	12	50%			
Bange,[41] 1925	Ligation and multiple subcutaneous discissions	100					1

Tables I and II present a résumé of the statistics relative to mortality, results, and recurrences compiled from the larger series of cases reported in the literature. It will be noted in the report of authors upon series of cases treated by the injection method only, that the recurrence rate is reported from zero in nine months and 2 per cent in six months, to 98 per cent in cases followed for a longer period. In our experience[5] the injection treatment

has been followed by recurrences in 60 per cent. As far as the mortality is concerned, McPheeters and Rice's[31] figures of seven deaths in 53,000 collected cases is proof enough that the injection of sclerosing solutions for varicose veins is a relatively safe procedure. The reported results from operative methods show recurrences from zero to 66 per cent. Ligation combined with injection treatment showed recurrences as follows. Tavel,[16] 12 per cent; Putzu,[20] 19 per cent; Howard,[32] 23 per cent; R. Miller,[33] 22 per cent, and deTakáts and Quillian,[4] 3 to 5 per cent. Operative procedures other than those grouped as ligation alone, including excisions, gave recurrences as follows: Müller,[34] 46 per cent; Kilbourne,[35] 30 per cent; Colt,[36] 18 per cent; Siebner,[37] 60 per cent; Keller,[11] none; Tanner,[38] 18 per cent, and R. Miller,[33] 66 per cent. As regards the mortality for operative procedures, Müller[34] reported 1 per cent mortality in 100 cases; Kilbourne,[35] 0.4 per cent mortality in 14,000 cases, and Berntsen,[9] 0.7 per cent mortality in 376 patients. We have had no deaths in our experience in over 100 ligations with simultaneous or subsequent injection of sclerosing solutions, all of which were managed by ambulatory convalescence. We have found no deaths reported after ligation and injection of sclerosing solutions when an ambulatory convalescence has been enforced. On the other hand, Domanig[39] encountered pulmonary embolism twice, with one fatality, in 43 cases treated by ligation and section and injection of sclerosing solution into the distal lumen, when the patients were kept in bed for ten days.

Although these statistics are very significant, they are not as conclusive in their directions as one would wish them. The wide ranges of reports, if not confusing, at least weaken confidence in the following conclusions which express only in a general way the trend of the statistics; namely, operative treatments such as excision and ablation have a mortality of from 0.4 per cent to 1 per cent, which is far higher than the mortality by the injection treatment. Simple ligation apparently has less risk, which has been shown by our experience, in which ambulation was enforced during convalescence, and by the absence of reports in the literature of deaths when ambulatory regimen was used. Enforced walking during convalescence is a distinct advantage and reduces the danger of pulmonary embolism. Any method which has from 0.5 to 1 per cent mortality for varicose veins must be looked upon with disfavor because of the remarkably low mortality following the injection treatment. On the other hand, the trend of the statistics in recent series of varicose veins treated by injection alone shows an extremely high percentage of recurrences; far more undoubtedly than the incidence of recurrence from ligation and the use of sclerosing solutions.

For these reasons, and our personal experiences, we have reached the following conclusions regarding operative measures with or without the injection treatment versus the injection treatment alone: Procedures such as extirpation and enucleations with strippers or other instruments are too severe and extensive, necessitating the patient having a convalescence in bed, which predisposes to embolism, and a mortality too high to justify their em-

ployment. Ligation combined with the injection treatment is a relatively simple and very safe procedure, and is followed by less frequent recurrence than the injection treatment alone, which is, apparently, quite safe. We take the following attitudes in selecting the cases for these types of treatment:

For the injection treatment alone we select:

(1) Early cases with small varicose veins of the calf or lower leg, which, clinically, do not show a positive Trendelenburg-Brodie phenomenon; even if a recurrence follows, there has at least been a temporary benefit, and if it becomes necessary other measures may be employed later.

(2) Those cases which are suitable for operative treatment and refuse ligation.

(3) Certain cases where the psychologic approach to operation seems best accomplished by an initial and partial injection treatment. In certain instances in studying the case it is surmised that if an operation is immediately advised the patient will not only refuse the operation but also any active treatment, because since the former, which she does not want at the moment, was presented first, everything else seems second best and the wary patient is frightened away from what might be the best procedure for her.

For operative treatment with the combination of the injection of sclerosing solutions, we select all cases with moderate or severe varicosities in whom there are no contraindications to active treatment. As far as the type of operative treatment is concerned we discard, as carrying too high a mortality and being too severe, the complete excision of the saphenous vein and its radicals (Madelung, the Mayo operation, and Keller and Babcock extractions). These radical procedures carry no more promise of permanence of results than ligations and transactions combined with the injection of sclerosing solutions. Schede's operation is followed by many recurrences, so many in fact, that it is not worthy of serious consideration.

(4) *Technic of Operative Treatment.*—Our preference for the high ligation and transection of the internal saphenous vein, just before it enters the femoral vein, and above any of its tributaries, with the simultaneous injection of a sclerosing solution into the distal lumen, and in certain instances, as indicated by the comparative tourniquet test, additional ligations and injections below this level, has been stated.

The technic of ligation of the saphenous vein high is as follows: The patients need no special preliminary preparation; they do not have to fast. The patient is placed in dorsal decubitus. The inguinal and pubic region and adjacent upper part of the affected thigh is shaved. The skin of this area is cleansed with ether and painted with some suitable antiseptic. Draping the field is important. A folded sterile towel is placed in the crotch, protecting the thigh from the genitalia and pubic region. The surface sheets and towels are so spread that an operative field is left which exposes the middle and inner part of Poupart's ligament and the adjacent upper part of the thigh from a line outside the middle to the recessing inner border of the thigh. It is important to have the field large enough to palpate the femoral artery, and to

have adequate room to work mesially because the course of the saphenous vein is sharply posterior from its termination at the saphenous opening. The femoral artery is palpated as it passes under Poupart's ligament. The fossa ovalis is located two fingerbreadths mesial to this and one fingerbreadth below Poupart's ligament, or below the level of the spine or pubis. A longitudinal incision gives a better exposure than the transverse (Fig. 6). With a longitudinal incision, the collateral channels at the upper end of the saphenous vein are exposed more easily and with less dissection. The important tributaries are the external pudendal, the superficial circumflex iliac, the superficial epigastric, thoraco-epigastric, and the external superficial femoral vein (Fig. 7). Anomalies of these vessels are very common. They sometimes enter directly into the femoral vein, two or more of them sometimes forming a common stem before emptying into the saphenous vein. It is very important to see the termination of the following tributaries: The external pudendal, the external superficial femoral, and the external circumflex iliac. The external pudendal should be above the area of injection of sclerosing solution into the long saphenous, because it is not desirable to have any of the solution go into veins of the labia majora or the scrotum, especially if these veins are not varicosed, and at the same time it is desirable to interrupt the flow in the external pudendal, particularly when it is varicosed, because collaterals from this vein into the internal superficial femoral veins are possible channels for reestablishment of a retrograde circulation and thereby predispose to a recurrence. On the other hand, it is desirable to inject the sclerosing solution into the external superficial femoral vein, either by injecting it into the great saphenous vein above the termination of this trunk or into the separately ligated external superficial femoral vein. It is rare, even in severe cases, for the internal saphenous vein to be visualized at its upper end, because it is so deep and is covered by fat and skin. Even palpation may not localize it and Schwartz's test[29, 40] is infrequently of value.

The incision begins at Poupart's ligament and 2.5 cm. mesial to the line of the femoral artery (Fig. 6). The latter landmark is appreciated by palpating the pulsating artery as it passes under the middle of Poupart's ligament. The incision continues for a distance of about 5 cm. straight downward and slightly inward, diverging from the line of the artery. The vein is deep in the subcutaneous tissue, of considerable thickness here, especially in women. One can incise through this without danger but should be cautious of injuring either the vein or its collaterals. Suspicion of the proximity of the vein may be often inferred before the vein has been uncovered, by a peculiar darkness or blueness showing through the fat. The vein is from 0.5 to 2 cm. in diameter. It is isolated and separated from surrounding tissue, to its entrance into the fossa ovalis and downward for about 3.5 cm. The long saphenous vein is not easily confused with the femoral. It is superficial to the deep fascia—that is, the very thick fascia lata—and if there is any doubt it is well to remember that the femoral artery is lateral and contiguous to the

femoral vein. One will note the external pudendal vein emptying into the saphenous vein from the medial aspect, and the superficial circumflex iliac and the external superficial femoral usually a little higher from the lateral aspect (Fig. 7). The latter veins frequently enter directly into the femoral vein. These may be transacted and ligated separately or if the external superficial femoral is low enough the saphenous vein may be doubly clamped, transected, and ligated above it. The long saphenous vein is clamped near its termination with two small curved hemostats, between which the vein is transected. The proximal stump is then transfixed with No. 2 silk or with No. 1 plain catgut, and ligated securely on one side and then by rotating the clamp the ends are

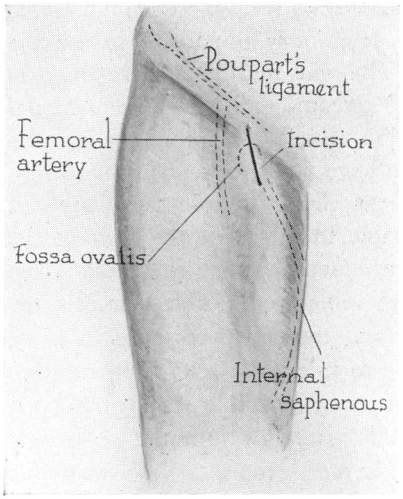


FIG. 6.—Location of the incision for high ligation of the saphenous vein. Two finger-breadths mesial to the pulsating femoral artery, and beginning just below Poupart's ligament; it runs downward and slightly inward.

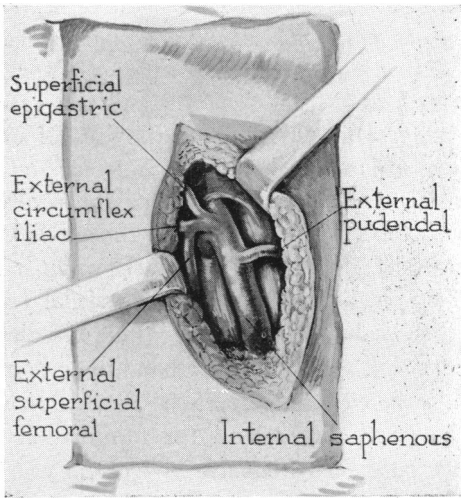


FIG. 7.—Anatomy at upper end of the internal saphenous vein, showing important tributaries which should be ligated separately. In this instance, drawn from the patient shown in Figs. 2 and 4, the superficial epigastric, external circumflex iliac, and superficial femoral veins enter by a common stem at the junction of saphenous with the femoral vein, but they all may enter separately, either at this level or higher or lower. These veins, and the external pudendal, shown should always be ligated and sectioned to obviate recurrences in the collaterals.

brought around the vein and tied again. The vein stump is then ligated again, without transfixing, proximal to the first transfixed ligature on the theoretic grounds that no suture material is exposed in the lumen after secondary ligation, in order not to initiate a thrombus in the free circulation. Otherwise, the transfixing suture may still be exposed to the current of venous blood going directly to the heart. With a small Sana-lok syringe, 2 or 3 cc. of 5 per cent sodium morrhuate (Searle's) or 5 per cent sodium gynocardate are then injected into the distal lumen of the transected vein (Fig. 8). Care must be taken to keep the sclerosing solution from leaking from the vein into the field of operation. This upper end of the distal segment is transfixed and doubly ligated. A thrombus in the segment is desirable. The ends of the cut vein retract several centimeters from each other when released.

The subcutaneous tissue is approximated with No. 2 silk and the skin sutured with dermal.

The patient remains on the table one hour and is then permitted to go home in an automobile, walking to the elevator and car. She is advised to rest for the first few days but not to remain in bed entirely. We insist that she get out of bed and walk around the room every two hours even on the day the operation is performed. She wears a compression "Ace" bandage or an elastic stocking during this period, and after 48 hours, if there is not too much dis-

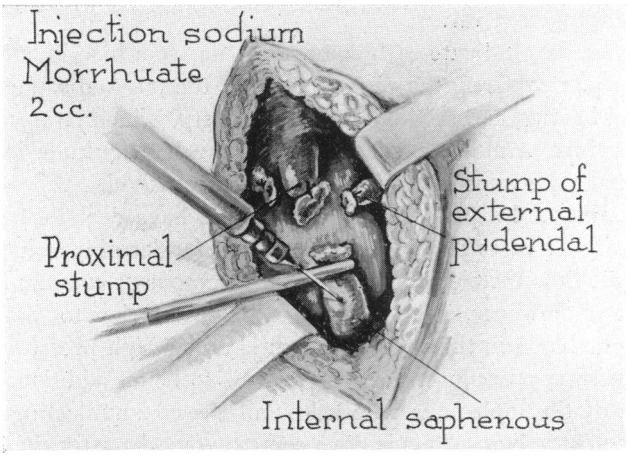


FIG. 8.—After section and ligation of the proximal stump of the internal saphenous vein and its tributaries, 2 cc. of 5 per cent sodium morrhuate are injected into the distal segment. The vein is clamped below this level, transfixed, and ligated.

comfort, the individual is usually fully able to tend to duties. Patients must be reasonable and not stand on their feet for eight hours a day during the first few days after treatment. Frequently a hard palpable vein, which obviously contains a thrombus, can be felt before the patient leaves the table. In approximately 90 per cent of the cases, a thrombus will be found after 48 hours, extending from the operative site to just above the knee in the internal saphenous vein, and in approximately 40 or 50 per cent of instances the thrombus will extend downward into the varicosed radicals of the calf. Not infrequently, however, there will be small ectatic veins on the calf which need to be injected individually ten days or two weeks after the operation.

This completes the treatment in those cases which have incompetence only of the valves of the great saphenous vein, but for that group in which the comparative tourniquet test has also shown that valves of the communicating veins are incompetent something more is advisable in order to interrupt this retrograde flow through the veins communicating between the deep and the superficial systems of the thigh. When a retrograde flow or leak from the deep to the superficial system is occurring below the main opening of the saphenous vein, the communicating veins, which are responsible in this instance, are usually in the thigh, and generally it is not through the communi-

cating veins of the calf or from the popliteal vein through the main opening of the external saphenous into the external saphenous system. If there is a direct retrograde flow from the popliteal vein into the external saphenous system, it is advisable to interrupt this retrograde flow by a separate ligation of the external saphenous vein at the upper end. There are several possible ways of stopping the leaks through the communicating veins. These are: (1) Ligation of each communicating vein individually; (2) extirpation of the internal saphenous and ligation of communicating veins and collaterals; and (3) ligation and transection of the saphenous below the level of all the communicating veins with incompetent valves.

It is not feasible to ligate each communicating vein individually, because it would necessitate exposing the entire length of the internal saphenous vein in the thigh and ligating and sectioning each tributary. Such an operation would become, therefore, a major procedure of as much magnitude as extirpation of the internal saphenous vein by the Madelung method. When a thrombus forms in the internal saphenous vein, which we have described as occurring in the majority of cases after distal injection of sclerosing solution, there is less retrograde flow through this vein from incompetent communicating channels. There is, however, a tendency for this obstruction to disappear, especially when the blood in the venous system is under high pressure. The most feasible remaining procedure, therefore, seems to be an additional transection and ligation of the saphenous vein below all the communicating veins which have incompetent valves. This is done some two weeks after the high ligation of the saphenous on the same side and again 2 cc. of sodium morrhuate are injected into the distal stem of the vein. Apparently it is more important here to resect a sleeve of the saphenous about 2 cm. in length because of the danger of recurrence through the scar.

It is to be recognized, in employing this procedure, that recurrences can take place around the site of ligation through the collateral channels in the superficial system of veins and also that recurrences can take place through the scar. While appreciating this, it is also to be remembered that no method of treating varicose veins insures definitely against recurrence. It seems that the method detailed above will give better permanent results than any of the other methods.

Furthermore, no matter what the treatment is for varicose veins, no attempt is made to reestablish the normal physiology, nor can this be accomplished. In the injection treatment alone, obstruction to the flow is produced by initiating thrombosis in the vessel. With ligation and injection a more definite obstruction is brought about. Excision attempts to remove the pathologic vessels, but it does not reestablish normal physiology.

In those cases which show recurrences the patients must be treated, again selecting the method most applicable to the conditions which they present at the time they apply for treatment of the varicosities. To forestall any concern the patient may have relative to recurrences, they are told that there is no way of predicting in which patients varicosities will again occur, but that there is

such a tendency, and that at least 10 per cent will recur after such treatment. They are assured that varicosities can be corrected again, and that if they never neglect varicose veins they will not develop complications such as ulcer and hemorrhage.

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DISCUSSION.—DR. WM. D. HAGGARD (Nashville, Tenn.).—After this perfect exposition and compelling confirmation, I believe that it is like carrying sugar to New Orleans to add anything. This definite demonstration of what has been happening to us without our knowledge is going to be extremely helpful. Like many of you, I have gone through with all the forms of treatment. We began with circumcision of the veins through the skin (Schede's operation), with ligation of the severed superficial veins with only fair results. Then we employed the extensive vein stripping operation, which was fairly satisfactory. The demonstrations of Doctor Mahorner convince us that our source of error was that we ligated the long saphenous vein too low. In addition to ligation of the vein at the saphenofemoral junction, ligation of the tributary veins is necessary, particularly the superficial epigastric, the circumflex iliac, and the external pudendal vein. The immediate grade injection of sodium morrhuate, and then a few subsequent injections below the knee is curative in practically all cases. If one fails to ligate those veins one is likely to have recurrence. We are all familiar with the disappointing results, by and large, of injection of sclerosing solutions above. I think most surgeons now feel that this simple procedure of ligating not only the long saphenous but those three tributaries, offers the best results. We have used it in a number of cases that have recurred after vein injections, vein stripping and ligation of the saphenous below the junction.