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Varicose veins

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V A R I C O S E V E I N S

By

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INTRODUCTION.

Varicose veins are of relatively common occurrence and with or without the various complications present a condition which may be quite a distressing and disabling problem for the patient, while in its more serious aspects has been the cause of death in not a few instances.

In view of the present economic condition, it behooves the physician to have at his comman an efficient, yet safe treatment for varicose veins which will entail the least possible financial loss for the patient from both cost of medical care and loss of time from a remunerative occupation.

With these remarks in mind the author of this paper will attempt to present a general review of recent literature on this subject with special reference to the injection treatment, and if by this work he has learned to treat the condition with somewhat more than average skill, one purpose of the paper will have been accomplished.

DEFINITION.

A varicose vein (varix, phlebectasia) is a permanent dilatation of one or more veins, usually with elongation, tortuority, and thickening of the walls. The great and small saphenous veins of the legs, the hemorrhoidal veins (hemorrhoids), the spermatic vein (varicocele), and those of the pampiniform plexus (varicocele of the round ligament) are most frequently affected, however they may occur in any portion of the body when favorable circum-

stances for their formation arise. This paper will be confined to those varicosities occurring in the leg.

ANATOMY.

The venous system of the lower leg consists of the superficial and deep portions. The deep veins of the lower leg are those situated deeply among the muscles and bones and collect blood from the deep structures about the foot and ankle, carrying it upward and then becomes the popliteal vein at the lower edge of the popliteal space. It continues thus until it enters Hunter's canal and is then designated as the femoral. From these it passes up and under Poupart's ligament and at this point becomes the external iliac and later joins the internal iliac at the brim of the pelvis to form the common iliac vein.

The venous system which lies superficially consists of the long and short saphenous with a very extensive collateral circulation between themselves and with the deep veins.

The long saphenous arises at the inner side of the foot and ankle, passes upward just internal to the edge of the tibia, past the internal cendyle of the femur, then along the inner side of the lower thigh and on upward joining the femoral vein of the deep system through the osteat window, two inches below Poupart's ligament.

The short saphenous collects the blood from the back and external border of the foot and back of the calf. It joins the poplitial vein in the upper edge of the pop-

liteal space, both systems of long and short saphenous veins with anastomosing veins form an extensive net work over the whole lower leg, resting in the superficial fascia.

The superficial veins are in turn connected with the deep veins both in the lower leg and thigh by communicating veins. In most cadaver specimens investigated by McPheeter there were two communicating branches in the middle and lower thigh, though in some there were none. In the lower leg, however, the communicating branches are supplied with valvis with the cusps facing upward and inward which tend to prevent the reflex of blood and to maintain the blood column above them. As a rule the valves in the vein are supplied and placed in relation to the opening of a tributary vein and are distal to it.

The valves are usually of the bicuspid type, though many unicuspid and occasional tricuspid valves are met with.

Along the main trunk of the long saphenous both in the thigh and lower leg there are often found small normal veins lying close to and often parallel with a varicosed vein.

MICROSCOPIC ANATOMY OF THE NORMAL VEIN.

The walls of a vein consist of three coats.

(1) An inner coat, the intima.

(2) A middle coat, the media.

(3) An outer coat, the adventitia.

The intima consists of a single layer of endothelial

cells, the middle coat consists mainly of smooth muscle, the outer of connective tissue; these coats are not distinctly differentiated from one another. Unlike an artery the thickness of the walls of a vein are not directly proportionate to the size of the vessel, but depend, also, upon other factors such as the position of the vein and the support given to its walls by surrounding structures.

The intima is composed of cuboidal epithelium with the elastic interna just beneath it. Below this is the media with large amounts of muscle tissue interpersed with fibrous tissue. The media forms the large part of the vein wall. Elastic fibers are also scattered through out these layers. Beneath this is seen the adventitia which consists almost entirely of fibrous elements and only a small amount of muscle tissue. The muscle fibers run longitudinally, circularly, and obliquely. Through the media and adventitia may be seen the vasa vasorum.

The walls of the vessels are supplied with both medullated and non-medullated fibers. The latter are axones of the sympathetic neurones; as these nerves control the calibre of the vessels they are known as vasomotor nerves. They form plexuses in the adventitia, from which are given off branches which penetrate the media and terminate in muscle cells. The medullated fibers are the peripheral neurones of spinal or cranial ganglion. The larger fibers run in the connective tis-

sues outside the adventitia. From these are given off branches which enter the media, divide repeatedly, lose their medullary sheaths and terminate mainly in the media, although many can be traced to their termination in the intima. It is apparent that there is considerable variation in the normal histology of veins. This variation in structure is probably due to variations in function and in location with reference to surrounding structures. In addition, different portions of a single vein, such as the saphenous, may show great variations in the proportions of its constituent structures. These facts must be borne in mind when endeavoring to form a picture of pathological changes.

EMBRYOLOGY.

The discussion on this subject is based on the work of Dr. Kampmeier and Arey's Developmental Anatomy.

Dr. Kampmeier's work was done mostly on the human embryo and part of it on the fetus at full term in addition to the dissection of the venous system in the adult cadaver.

The valves are first seen in the human embryo at the period of three and a half months development. They developed first in the upper long saphenous, so that by the fifth month all the valves are supposed to have been established. They begin as a thickening of the endothelium with a ridge-like formation on the vein wall. At first they form a mere circular ridge in the wall of the vein. This ridge is composed solely of endothelial cells at first

but soon mesenchyme just beneath the ridge seems to push out almost as fast as do the endothelial cell layers. This seems to cause a thinning of the vein wall at the base of the ridge. The base of the ridge of the biscuspid then begins to form downward as though the pressure of the fluid from above forced the attachment to the vein wall while the ends of the ridge or ledge were formed. This might account for the formation of the cusps of the valves. The pressure of the fluid from above the valve cusps would clearly cause the two valves to bring their ends into opposition; thus closing the lumen of the vessel.

The tunica media above the valve flap is only one fifth as wide as elsewhere, and circular muscle fibers seem markedly deficient. This may be an explanation of the varices, saccular in type, which Kampmeier found in cadaver specimens.

At times there are found remnants of valves which seem to be only vestigial structures located near a tributary vein. This would seem logical as protection against a reflux at the vein opening.

Valves are usually located at the entrance of the saphenous into the femoral and into the popliteal. They are usually to be found distal to or below the opening of a tributary.

McPheeters work on cadavers did not show that valves at the function of the short saphenous and popliteal to be as constant a finding as would be expected. Often

there were no signs of valves at all. At times the valves seemed to bear no relation whatsoever to the entrance of a tributary vein. Some of the tributary veins have no valves at all. There seems to be no regularity whatsoever in their location.

According to Kampmeier, Von K. Bardeleben did an enormous amount of work on the valves in the veins and their development and that he states that many more valves are laid down during fetal life than survive to adult growth. This view would agree with the theory of Klotz, that a degeneration of the valves in adult life with a loss of tone and a secondary gradual atrophy is one of the chief causes in the development of varicose veins.

PHYSIOLOGY OF VEINOUS FLOW IN THE LEGS.

Howell has devised a simple apparatus for determining venous pressure, the degree of pressure necessary to obliterate a given vein in the arm or leg can be readily determined and measured in columns of water, but it is obvious that for any given vein this pressure will vary with the position of the vein and thickness of its wall. When the hand hangs pendant at the side the pressure within its veins will be greater than when it is raised to heart level. The pressure actually measured for any given position of hand or foot must, therefore, be corrected for the heart-level by determing the vertical distance between the vein and the heart, and subtracting this distance, expressed in centimeters, from

the pressure, also expressed in centimeters, which was found necessary to obliterate the vein.

When venous pressure is measured in the legs at a low level in a person while standing we should suppose that after a reduction to the heart-level it would be about the same as that noted for veins of the arm, since the vessels are of about the same order with reference to their distance from the capillary bed. In a series of observations of this kind, reported by Von Recklinghausen, it was found on the contrary, that after subtracting the distance between the foot and the heart, the pressure within the veins was negative by as much as 40 cm. Howell explains this unexpected result by supposing that the flow from below got up only enough pressure in the veins to lift the blood above the level of the pelvis and that the complete closure of venous valves at this level protected the veins from the full pressure of the volume of blood above them. Eventually, the pressure in the veins would have risen sufficiently to lift the blood to the heart level, but it seems probable that under ordinary conditions of life this result is affected by cooperation of the muscles of the legs and respiratory movements of the thorax. Howell,in his book, believes the most important accessory factor in venous circulation to be the respiratory movements and contractions of muscles of the limbs and viscera. In brief, it may be said that the main effect of the respiratory movements is to force or suck blood from the large veins of the abdomen to the

heart, this in turn causes the large veins such as the iliacs to exert an aspiratory effect on the smaller veins below it, such as the popliteal, thus furnishing stimulus to central flow of venous blood.

PATHOLOGICAL PHYSIOLOGY OF VARICOSE VEINS.

As reference to the trendelenberg states of varicose veins will be referred to from time to time during the completion of this paper, I will endeavor to explain them at this time in order that clarity of meaning shall not be sacrificed.

The patient's leg is elevated and held in that position until the varicose veins are empty, next the proximal end of the long saphenous vein below Poupart's ligament is compressed, and the patient is allowed to stand up. If the vein fills up with a gush of blood from above when compression is released the test is said to be a positive Trendelenburg, for valvular incompetence of the long saphenous. If, however, the veins fill up suddenly on standing before compression is released and the veins become more distended the test is said to be a double positive Trendelenburg, and indicates incompetence of valves of the long saphenous and anastomatic branches. If after elevation and compression the veins fill up slowly on standing and do not dilate more after relieving pressure, the test is negative and the valves are known to be competent.

As before described the anostomotic veins of the superficial and deep systems have valves which direct

the flow of blood. Thus in a normal individual it is possible for the blood to pass from the superficial veins to the deep system but not in the reverse direction. If the Frendelenburg state is negative or double this reverse flow from deep to superficial veins will be possible. According to the McPheeter all varicose veins and particularly in those in which the valve action has become deficient, either through a primary destructive injury to the valve or secondary to a dilatation of the vein walls, the venous blood is stagnant or flows in the reverse direction. He also states that "The very thought of injecting directly into the blood stream a destructive solution with the intention of getting a thrombus formation, which is always considered the parent of an embolus, seems unscientific and certainly non-surgical. This, however, is what is done in the injection treatment of varicose veins by sclerosing solutions." With this thought in mind he conducted a series of X-ray experiments to prove that the direction of venous flow in varicose veins tended to prevent embolus formation rather than produce it. Thus for the following discussion on X-ray evidence the author is indebted to H. O. McPheeter.

Lipiodal was injected directly into varicose veins of the thigh and the results observed under the fluoroscope; and it very clearly confirmed the opinion that the venous flow in varicose veins was toward the periphery, returning to the general circulation through the

communicating veins and the deep system.

The case described was of a woman, age 40, who gave a Frendelenburg positive, the patient was placed on the fluroscope table in sitting position and ½ c.c. of lipiodol injected and the following facts noted:

(1) As long as the patient remained quiet the lipiodol remained in a solid mass at the site of injection.

(2) When asked to strain as at stool the mass passed downward about six inches. Relaxation caused no reflux.

(3) Muscular activity of the foot without force caused the lipiodol to pass downward into the communicating veins.

(4) Forceful exercise of the calf muscles simulating walking caused the particles to pass into the deep system, where they advanced toward the heart with each pump-like action of the legs.

(5) During inspiration globules of lipiodol in superficial varicose veins were forced peripheral-ward about one inch, those in the deep system remained stationary. This illustrates the effect of intra abdominal pressure on blood flow in the valveless saphenous.

(6) Expiration with negative intra abdominal pressure produced no change in the superficial varicosed saphenous, but due to the aspiratory effect, tended to draw particles central-ward from the deep system of veins.

This explains clearly how valvular incompetency in the great saphenous (Frendelenburg positive) plus valvular

deficiency in the communicating veins (Frendelenburg negative) gives the described Trendelenburg double. In this condition we get a reverse flow from both the superficial and deep system of veins, causing a stagnation of blood in the dependent extremity.

GROSS PATHOLOGY.

Bernstien classifies the varicose veins according to the pathological formation present or the types of varices as:

(1) The isolated or saccular varix. It is usually present on the main trunk of the long saphenous in the thigh.

(2) The serpentine or sinuous varix. These two forms are encountered at the same time on the principal trunk of the long saphenous and the collaterals.

(3) The varix of uniform dilatation. One may call it the normal vein interposed between two varicosed parts of a vein, yet where the wall is hypertrophied on account of the abnormal pressure due to the true varice on both sides. This is seen on all parts of the thigh and lower leg.

(4) Fine cutaneous dilatations. These are commonly seen on the inner thigh of fleshy individuals and are called "stars", "brushes", "skyrocket" or "spider bursts."

MICROSCOPIC PATHOLOGY

As indicated by a definition of varicose veins in the early stages of varicosities there is a general hy-

pertrophy of all contractile elements. As dilatation continues there is a gradual progressive atrophy of these same elements, so that in the fully developed varix both elastic tissue and muscle tissue show evidences of extreme atrophy. The wall of the vessel becomes thinner and fibrosed. Changes in the intima occur in the form of proliferation which produces nodular elevations similar to those seen in arteriosclerosis. Calcification may occur in varicose veins of long standing and ossification may occur rarely. If inflammation is present with the various inflammatory products it is generally regarded as a complicating factor and not a direct part of the process of varix formation.

ETIOLOGY OF VARICOSE VEINS.

In discussing the etiology of varicose veins very few authors seem to be at agreement as to the more common etiological factors involved in the production of them and until the development of sclerosing methods of injection treatment has been a rather discouraging proposition, and because of the number and wide difference in opinion as to the etiology it was impossible to treat the condition by removal of the cause. However, there are a number of generally accepted conditions which are known to predispose to varicose veins and are as follows:

(1) Heredity and congenital factor.

McPheeters, Merkat, Lundblad and other place this factor at more than 70% of all causes. This means that the patient is born with weak vein walls, so that when he is subjected to the strains of adult life there is increasing congestion in the veins of the extremities and the vein walls give way and dilate causing incomplete closure of the valves and venous stasis. Such strains occur in pregnancy and in occupations demanding long hours of standing or walking on hard floors with poor shoes, however, there is not a single case recorded where varicosities of the arm have resulted, and while there is a wide difference in position and use of these extremities as compared with the legs it seems that if 70% can be attributed to this factor that an occasional occupation would lead to varix formation in them.

Hesse and Schaak, with an immense amount of experimental material and work, found that the normal valves in the long saphenous stand the back pressure of 180 millimeters of mercury. They explain the formation of varicose veins on the basis of accepting the normal back pressure in the venous system due to intra abdominal pressure acting on valves which are congenitally weak or weakened by disease, trauma or age.

Bier and Lehman explain varices on general connective tissue weakness of the entire body which include ptotic tendencies towards varices, varicocele, pes planus, enteroptosis, hemorrhoids, etc. The walls of the vein and

their accompanying valves would be sufficient to maintain the normal pressure without difficulty, yet they would give way to the increased pressure which would be associated with heavy work, severe contractions of the abdominal muscles, coughing as in pneumonias and chronic bronchial conditions, etc.

As told by McPheeters, Kashimura, a Japanese surgeon, offers the explanation that it may not be entirely a congenital proposition, but that during life there develops a loss of nerve and muscular tone of the vein wall which allows the dilatation to occur. Lending weight to his theory, he states that varicose veins are very rare in Japanese in their own country. This he attributes to the fact that they do their work in the sitting position. While in America the Japanese suffer as much or more than the Americans when they do long hours of work in the standing position. He offers the explanation that the standing position first causes over stimulation of vein walls with compensatory hypertrophy and secondary degeneration and relaxation. It is well known that people who work with long hours of standing often develope varicose veins, yet to see a mail clerk, laundress or other person who has been on the job for years does not mean that one is also viewing a sufferer of varicose veins.

(3) Endocrine theory of varix formation.

This factor is no doubt important, but this again could act on congenitally weakened walls. This endocrine factor is most active and its results are most

often seen associated with three periods of menstrual function an exhibition of heightened endocrine activity, puberty, pregnancy and the menopause. As to varicose veins of legs and vulva in pregnancy, Delee and Williams treat the matter of etiology rather lightly and assume that because the veins dilate with pregnancy and usually recede post partum that the weight of the pregnant uterous is the sole cause.

Gaugier believes that under ordinary conditions certain hormones secreted by the endocrine glands maintain the tonicity of the walls of the veins through the sympathetic system which acts upon the smooth muscle fibers. If some of these secretions are lacking, there is a lack of tonicity of walls of veins and valves and that this constitutes varicose disease. He further points out as proof of his theory that these congestive attacks are always more marked at the time of the menopause and in many cases varicose veins appear at that time. In cases of removal of the ovaries, varicose veins often occur within two to three months. He further notes that during the first months of pregnancy when the uterous is small and relatively light that varices are frequently developed.

These facts seem to indicate that varices develop when there is a disorder in ovarian secretion. But Gaugier and others either do not mention or fail to reconcile these views with the fact that varicose veins are fairly frequent in men.

Millet does not consider the before mentioned con-

ditions as etiological factors, because of their almost universal commonness, he believes the origin of varices should be searched for in a syndrome which is common to all cases and not to heterogenous and variable cases, but ends by rather weakly declaring that he believes the liver to be the sole cause and advises treatment in the form of a rest cure at a mineral water springs, making his paper appear too much like an advertisement for a nostrum.

(4) Age and sex.

In Bernstein's series of cases 75 per cent of varicose veins occurred before the thirtieth year. In both sexes they were approximately equal up to the twentieth year; between twenty and thirty years, four women to one man, from thirty to forty years, three women to one man and between forty and fifty years, four women to one man.

McPheeter's work shows the same ratio. This unequal relation between men and women bears direct evidence to substantiate Gaugier's theory as to the association of ovarian and endocrine system with the development of varicose veins, but a fallacy as to statistics is evident because more women than men present themselves for treatment for cosmetic reasons and several writers go so far as to state that the varicose incidence in men is equal to that in women.

(5) The infection theory.

Often a patient dates the onsets of his varicose veins from an attach of pneumonia, influenza, typhoid, diphtheria, pelvic infections, etc. This lends strength to the theory that infection is an etiological factor. As stated by McPheeters in his text, Thorel believes that this condition would start with an endophlebitis, later extending to the media of the vessel wall. Others believe that it would come directly through the vasa vasorum and directly involve the media. Still others think that it might be either embolic or hematogenous in origin or by direct extension from localized infection in a neighboring field, such as occurs in injuries and traumas. This would be explained by the development of a low grade phlebitis and even periphlebitis, but of such a low grade type as to give no clinical symptoms whatsoever at the time, yet suffer to initiate destructive processes in the vein wall, which later go on through a pathological course to a destruction of the muscle layer of the media and a fibrous tissue formation, this, tending to dilatation without subsequent constriction and the formation of varicosities.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS.

Under the diagnosis of varicose veins not only the apparent dilatation of veins, but also veins which cause pain in the leg, must be considered and with these any other subject or disease which will cause pain in the lower leg. Of these rheumatism is the most common, with

rheumatic pains about the knee and ankle. As is the case with any other disease and a point often forgotten by the student a patient may have two or more diseases at the same time which may or may not be associated, thus because of the commonness of these two conditions, rheumatism and varicose veins often occur together.

By the abnormal tension on the terminal nerve filaments underlying the skin of the lower leg, the patient can have pains which simulate most any condition of the lower leg, thus if every dilated vein on the lower extremity is regarded as a varicose vein and treated as such, grave mistakes may occur. A group of rare but well defined cases of multiple arterio venous communications may give rise to a mistake in diagnosis characteristic of this group is, (1) there is no visible pulsation as the communications are small. (2) it is congenital and becomes manifest in early life, progressing continuously, (3) the affected limb is warm and may be larger than its fellow, (4) the blood in the dilated veins is arterial in character.

"Buergers" disease, which affects arteries as well as veins, not infrequently starts with a spontaneous phlebitis, which subsides and occurs again. These recurring attacks may result in dilated veins with valvular insufficiency. Unless attention is paid to absence of pulse, the dependent rubor and the characteristic intermittent claudication, the mistake is made and has been made of injecting such veins with sclerosing solutions.

The same is true, though to a less extent, of venous dilatations occurring in patients with obliterated arterie sclerotic vessels.

Another error which is said to be quite frequent is to treat a patient's veins when his complaints originate in another source. The frequent occurrence of flat foot with varicose veins has been emphasized. "Ache in the calf, the knee and hip joints, with less emphasis on the characteristic site of pain at the arch of the good and the calluses may mislead the practitioner to interpret the patient's symptoms to be partly or solely due to varicose veins. Any orthopedic difficulty, such as genu valgum, sacro-iliac pain or spondylolisthesis if they radiate to the extremities, should be investigated.

Probably the chief differential diagnosis to be made is between a simple varix and a compensatory varicosity due to a thrombosis of the deep circulation. The patient should be questioned carefully about previous inflammation of the leg and especially phlebitis. The type said to be most frequently met with is the phlegmasia alba dolens of the puerperium. If the patient has had phlebitis there should be no attempt made to obliterate the superficial veins until the deep veins have been proved competent. Ferguson's practice is to test this by applying a snug elastic bandage to the extremity, if there is an incompetent deep circulation the patient usually experiences no benefit from the bandage and on the

contrary complains of more discomfort and disability. Kern and Angle state that there is no absolute test for determining obstruction of the deeper veins, and they depend more on the patient's history of a post-operative or post partum phlegmasia alba dolens than on any test. As suggested by Herbert Davis of Omaha a good clinical test is to bind the lower extremity with an elastic bandage from the toes to knee so that it collapses the superficial veins, but exerts less than systolic pressure on the leg, the patient is then sent for a ten block walk, if deep circulation is good the patient completes the walk and returns usually stating that there is much less pain and discomfort; on the other hand, if there is no deep circulation, the patient can walk but a few blocks and returns begging to have the bandage removed because of increased pain and disability.

De Takats uses Perthes test for patent deep circulation. A blood prssure cuff is thrown around the thigh in the upright position and is inflated just enough to compress the saphenous vein. The patient is then asked to walk to and fro or to flex and extend his knees about ten times. During these activities, the calf muscles contract and squeeze the blood out of the deep veins and aspirate the blood from the varices. The dilated veins must diminish in size if the deep circulation is patent. To demonstrate better the loss of blood following this sucking action the blood pressure cuff is deflated and

the blood rushes into the saphenous vein and fills up the varix to its former size. If there is no appreciable diminution in the size of the dilated veins when the patient walks, an increased venous pressure must be present in the deep veins, a fact which signifies that obstruction is present somewhere between the veins of the calf and the vena cava.

In those cases where the veins are small and the chief symptom is pain the differential must be made from thrombo angiitis obliterans, intermittent claudication and Raynaud's disease. The history of superficial vascular changes, and the application of tests for the arterial circulation by palpation of the pulse of the dorsalis pedis tibica postica or the popliteal arteries, and X-ray pictures will help in diagnosis.

A careful general physical examination should always be made before institution of treatment, the thoroughness and carefulness being dependent on the experience of the physician. McPheeters believes that the importance of a general physical examination in each and every individual case is exaggerated.

The various laboratory tests such as Urinalysis, blood count and wassermann often yield useful diagnostic information.

COMPLICATIONS OF VARICOSE VEINS.

Complications include rupture of the dilated vein through the thin over-lying skin with profuse hemorrhage, infectious thrombo-phlebitis, local infections, derma-

titis, eczema, ulcer cruris and rarely embolism.

The most common complications in the development of infectious thrombo-phlebitis of the superficial group of veins and deep veins of the lower leg. As before stated, the blood is stagnant and poorly oxygenated and is thus more susceptible to infection, thus violent acute, inflammatory conditions develope. The condition is very painful and tender. The vein becomes filled with a hard clot or thrombus.

Following the marked inflammatory condition of the leg associated with thrombo-phlebitis, there is marked injury and destruction to the lymphatic circulation which causes a varying degree of edema.

The continued congestion of the skin associated with varices at times causes an intense dermatitis and later on an eczema which may be of the moist and oozing type. Fungus infections of the feet are often associated with this.

The condition called Hemorrhagic varice is the condition in which the varix wall is very thin and followed by light trauma or spontaneously will actually rupture and give much diffusion of blood into the superficial fascia.

The most severe and extreme condition which develops as a complication associated with varicose veins is the varicose ulcer.

TREATMENT OF VARICOSE VEINS.

In general the treatment resolves itself into actual treatment which may be surgical or by injection with

associated general treatment, prophylactic and palliative treatment.

Prophylaxis. Occording to Grelety and Bosviel rhythmic walking is the best prophylactic measure. Individuals who are obliged to remain standing for long periods during working hours should be encouraged to walk before and after work. Walking is preferable to violent exercises which many individuals take on Sunday.

Shoes should be well-fitted and of good quality. High heels are to be forbidden because it is noted that the heel is immobile, the step is reduced in length and the muscles of the calf are said to atrophy.

Lying down frequently with the feet elevated is often helpful. The object of gymnastics is to increase the venous circulation by respiratory movements and develop the muscles of the legs. Horse-back riding is said to be apt to increase varicose veins, but tennis and golf may be allowed: The weight of the individual should be carefully watched, under weight persons often predispose to varicose veins because the veins are deprived of support by fat. Constipation should be checked and other conditions which cause increased abdominal pressure, such as chronic cough should be cleared up.

Delbet says that garters may be of value in case of severe varicose veins if they are sufficiently tight to compress the veins and to diminish the weight of the column of blood; while McPheeters says that tight garters are to be absolutely forbidden.

All genital affections in women should be carefully treated. Diseases of the uterous and ovary may not only cause stasis in the venous plexuses, but may compress the iliac veins directly.

In view of the endocrine theory of varicose vein formation, the administration of various glandular products are sometimes of benefit.

PALLIATIVE TREATMENT.

Attempts to remove etiological factors involved in the production of the varicose veins and the wearing of elastic stockings or elastic bandages of some type is the usual palliative treatment prescribed. The purpose of the stocking or bandage is to give mechanical support to varix. Often in pregnancy this treatment alone will keep the patient comfortable and help to prevent the occurrence of permanent varix formation.

OPERATIVE TREATMENT.

As stated by Douthwaite, Matas has outlined the principles upon which the effectiveness of the operation depends as follows:

(1) To arrest the hemodynamic reflux of the column of venous blood in the superficial vein when the valves of these veins are incompetent and the varicosities accompany or depend upon progressive intravenous tension.

(2) To force the more superficial venous circulation from the less supported subcutaneous veins into the deeper more supported trunks.

(4) To make impossible the entrance into incompetent superficial veins of blood from deeper intramuscular veins by obliterating enlarged parts of the communicating branches while removing or obliterating the superficial trunks.

SURGICAL TREATMENT -- is composed of ligation, excision, and ligation and injection combined.

BABCOCK'S VENECTOMY.

A pliable probe is introduced into the vein for some distance, the distal end of the vein is tied to the acorn-tipped end of the probe and by a series of quick jerks the vein is stripped out. Collateral veins are said to bleed but little into the subcutaneous tissue. A firm supporting bandage is applied from the toes to the thigh and the patient remains in bed for seven to ten days.

Mayo has modified the operation somewhat by merely tying the vein to the tip of the probe introduced into the vein and the vein is pulled out inverted on itself.

Schede's operation consists of a circular incision of the skin and subcutaneous tissues to the muscular sheaths at the junction of the middle and upper third of the leg. The divided veins are tied and the wound sutured. As an undesirable paraplegia or circulatory deficiency occasionally follows from the division of sensory nerves and superficial veins the operation has been modified.

Powell uses an interrupted incision. To make the division more complete, Friedel employs a long spiral incision, encircling the leg a number of times from the root to the knee.

Where the veins are very tortuous the turning back of skin flaps and the careful excision of veins is used by some men, but the vitality of the skin is poor and secondary necrosis and sloughing may occur.

COMBINED LIGATION AND INJECTION TREATMENT.

Wright uses the combined ligation and injection method of treatment for varicose veins which allows the patient to remain ambulatory. The vein he selects for treatment he speaks of as the parent vein, usually a portion of the saphenous and the most prominent, rather than the highest portion is selected for ligation.

"The skin is sterilized and then anesthetized with novocain. An incision half an inch long is then made across the line of the vein, and when the subcutaneous tissue is reached a small retracter is inserted. The vein is then picked up and freed from connective tissue, the retractor removed turned around and the prongs inserted under the vein and separated. Owing to the self-retaining nature of the retractor which is a modification of Irwin Moore's laryngo-fissure retractor, the vein is kept on stretch and elevated out of the wound, two c. cm. of 5% sodium morrhuate are injected into the lumen of the vein. The object of the injection is to fix the thrombus which will form after the ligation, above and below it. Two

ligatures of cat gut are now passed around the vein, at least an inch apart and the vein divided between them.

The advantages of this type of procedure over injection alone are said to be that it hastens the treatment because a much smaller number of injections are needed to produce results and that sclerosis is more certain.

THE INJECTION TREATMENT OF VARICOSE VEINS.-- HISTORY.

The history of the injection treatment of varicose veins dates back to the invention of the hypodermic syringe by Pravaz in 1851. Coagulating substances such as alcohol, ferric chloride, tincture of iodine, Lugol's solution, and carbolic acid were used, but later were replaced by the hypertonic solutions of sodium salicylate, sodium chloride and sugar. The bulk of the credit for the establishing of the method in more recent years seems to be due to the efforts of the French investigators. Tavel, 1904, Sicard and Gaugier, Genevrier, Forestier, Dilater and Troisier, may be mentioned as important contributors to the subject. Linser in Germany, in 1911, while treating a syphylitic patient with mercuric chloride, observed after repeated injections that the veins became thrombosed. This suggested to him the possibilities of mercuric chloride in the treatment of varicose veins, and he used it until 1923. At that time he abandoned the use of solutions of mercuric chloride because of the occasional toxic effects and resorted to a solution of sodium chloride, from which he obtained good results. In this country

McPheeters took an early interest in the method. The general trend of the English, French, German and American opinion is shown in the recent publications of Douthwaite, Forestier, Kausch, Bobl, and McPheeters. Equally interesting references are those of De Takats, Tunick, Kilbourne and Kern and Angle, and many others.

CONTRA INDICATIONS TO INJECTION TREATMENT.

Deep thrombo-phlebitis produces a dilatation of the superficial veins which is of a compensatory nature and must be preserved. Obliteration of the varices is, therefore, contra indicated. Recent cases of thrombo-phlebitis in the deep system are a positive and definite indication and must remain so until time has shown the extent of damage to the deep circulation, and until the infectious process has subsided entirely. Kern and Angle consider that in addition to active or latent phlebitis and obstruction of the deep veins, arterial disease of the extremities (Raynaud's disease and thromboangitis obliteranc) and cardiac diseases are contra indications. They say that pregnancy in itself is not a contra indication, but that since varices are greatly improved after delivery as a rule, they prefer to wait. McPheeters, on the other hand, does not think that the varices of pregnancy, where they are painful or distressing because of their size should be looked upon as interdicting injection treatment. The field of pregnancy and varicose veins seems to be in need of further investigation because of the great diversity of opinion as to its cause and indications for treatment.

Elderly patients and patients enfeebled by acute or chronic disease are generally considered as contra indicative to injection treatment, and arterio venous fistula previously described is also considered as such.

INDICATIONS FOR INJECTION TREATMENT.

The indications for the injection treatment of varicose veins seems to vary with the conservatism of the physician and his experience. Sicard considers that only those cases should be treated which present definite disabling pathology due to the varices. McPheeters believes that all cases of varicose veins should be treated by the injection method, unless a definite contra indication exists.

The conditions generally accepted as indications for treatment are:

(1) Varices which are so large and painful as to partially or wholly disable the patient.

(2) Varices which have developed complications such as ulcer, eczema or pruritus.

(3) Painful large varices of pregnancy before the end of the sixth month.

(4) Varices causing rheumatic pains in joints.

(5) From the patient's stand-point and probably often bringing the patient to the physician is cosmetic effect.

SOLUTIONS USED.

The physician has at his command a variety of solutions that have been used with success.

Siebert and Wreszynski have grouped them pharmacologically as follows:

Group 1. The salts which absorb water: Sodium chloride, calcium chloride, sodium salicylate, and sodium citrate.

Group 2. The hologens: Tincture of iodine, Lugol's solution, Pregl's iodine solution.

Group 3. The alkalies, which have very cauterizing effects: sodium carbonate solution.

Group 4. The heavy metals: Corrosive sublimate, iron perchloride, mercuric iodide.

Group 5. The organic cauterizing agents: Alcohol, dextrose, glucose, invert sugar, quinine and urethane.

The most important of these are : Sodium salicylate, 20, 30, and 40 per cent solutions as used by Sicard, Parat, and Pennoyer. 30 per cent by Heineck, 40 per cent by Forestier, Douthwaite, Schussler, 50 per cent by Perry and Edmunds. Quinine and urethane, Geneirrier, 1921, Sicard and Gaugier, and given second choice by McPheeters, Smith and Payne, Douthwaite, Goldsmith and Dixon. 50 per cent glucose, De Takats, Douthwaite, Ferguson and Dixon. 15 to 30 percent sodium chloride, Linser, Schmier, Ferguson. Invert sugar 50, 60, 75 per cent solutions, Logefeil and Dahlstrom, McPheeters first choice, De Takats, Carter. Dextrose 50 per cent and sodium chloride 30 per cent, Kern and Angle, De Takats, Gile, Ferguson. Sodium morrhuate, Smith of Rochester.

Each of the above solutions has its exponents and

opponents. The ideal aimed at is to use a solution which will produce a minimum amount of reaction, will be effective in the majority of cases, and will not cause sloughing or pervascular infiltration.

Concentrated sodium chloride solutions and sodium salicylate solutions have the distinct disadvantage of causing a severe cramp whortly after injection, which lasts for several minutes, at times there occurs a very marked perivenitis with infiltration, redness and tenderness of the skin and subcutaneous tissues surrounding the vein. This may persist for a week or ten days despite hot applications. Faulty injections will cause a slough of the tissues if either of these solutions get out side the vein wall in any considerable amount. They both produce a good firm sclerosis for considerable distance even in large varices. Obliteration is firm positive and fairly permanent. With quinine and urethane solution a moderate cramping is observed (De Takats). McPheeters and others state that it does not cause any cramping at the time of injection. Following its use in a subject with idiocyncrasy for quinine systemic symptoms will be observed.

Hypertonic sugar solutions have been extensively used and are very popular at present. These solutions seem to be fairly innocuous, the cramp produced is milder than that which follows sodium chloride solution. They are said not to cause sloughing when accidentally introduced extravasularly. When this occurs, there is a sharp, lo-

calized and burning pain. De Takats says that the cramping pain (which after correct injection) takes place is evidently at a time when the hypertonic solution reaches the nerve fibers in the adventitia, either through the wall of the vein or vasa vasorum. At the same time, because of the stimulation of the sympathetic perivenous fibers an active contraction of the vein occurs. The sclerosing effect of the sugar solutions is probably not so great as that of the sodium salts.

The combined glucose and sodium chloride solution is said by Angle and Kern to result in endophlebitis equal to that produced by the sodium chloride solution and to cause an exceedingly firm thrombosis.

TECHNIC OF INJECTION TREATMENT AND CAUTIONS.

The technic of the treatment has been described by Linsar, Sicard, McPheeters, De Takats, Kern and Angle, Dixon and a great many others. The procedure varies with the clinician and the solution used, but in general there is of course a great similarity, the following technic is fairly typical and with slight modification can by used for any solution.

Needles. The needles should be of short length, sharp and have a short bevel. A long bevel point predisposes to leakage of fluid into the tissues. The gauge will depend on the preparation.

A 10 c.c. syringe, the solution selected for the injection, tourniquets, pads, adhesive tape and elastic web bandage usually complete the equipment. McPheeters

prefers a syringe with finger and thumb grips so that fluid may be injected or withdrawn with one hand, the other hand left free for other procedure.

POSITION OF PATIENT DURING THE INJECTION.

Considerable discussion has been devoted to the question of the position of the patient during injection. Most agree that the horizontal position is best of all, but may not be possible in all cases. The exact position of the leg at the time of injection will vary with the technician. It must be left to the individual operator to use his own judgment as to how best to collapse a vein and how to keep it collapsed if so desired.

SITE OF INITIAL INJECTION.

Most authors prefer to begin injection in the lower segments of the dilated vein and then proceed upward one segment at a time. According to Payne, varicosities involving the ankle should be left until last. The preliminary precautions of intravenous therapy with regard to asepsis should be observed. The patient is asked to stand bare-legged, and while the varices are well distended the sites of injection are marked with iodine or some other colored solution. The patient is then placed in the recumbent position and the needle inserted.

One must be certain that the needle is in the vein, the solution should be injected toward the trunk. As soon as blood can be aspirated into the syringe, the second and third fingers of the left hand should be used to strip the

vein proximally and distally from the insertion point, and to maintain compression on the segment about to be injected, thus the vein is made as empty as possible. The delivery of the solution should be made very slowly, and the injection will be painless as long as the solution is going into the vein and the needle is free in the lumen of the vein. Blood should be aspirated several times during the injection. For assurance on this point, just enough fluid is injected to make the vein distended. Cellan and Jones consider that the temperature of the injected solution is important and recommend warming it to 105° F.

The injection should be stopped immediately if any stinging or burning is complained of by the patient, as this indicates that some of the solution has been injected outside the vein. After all the solution is injected the needle is allowed to remain in position for a few minutes and the leg kept quiet; no pressure should be made on the vein for fear of forcing the solution back alongside the needle and into the subcutaneous tissues.

McPheeters uses a proximal and distal tourniquet, applied with just sufficient tension to obstruct the circulation in the superficial veins, but not enough to cause a constricting effect on the veins of deep system, to localize the solution in the injected segment. Some other men do not use a touniquet at all.

Pressure should be applied over the puncture in the vein after the needle is withdrawn to prevent extravasa-

tion into subcutaneous tissues, a sterile pad may be strapped in place over the site of entry. The leg may then be bandaged with an elastic bandage of sufficient size. Kern and Angle apply a firm pressure bandage taking in the entire leg and foot. This is worn during the treatment and for three weeks thereafter in order to support the veins until complete organization has taken place.

After the injection is completed and the bandage applied, the patient is usually allowed to get up and go about his usual business.

The amount of sclerosing solution used and the number of injections made at a sitting vary with the extent and number of varices. Treatment may by some men be repeated every other day or twice a week. The number of injections required to obliterate individual varicosities varies too widely to allow for a definite statement. It will depend on the site and extent of the varices, on the intensity of back pressure, on the presence of reflux from deep veins, on the type of solution used and conditions of the walls of the veins undergoing treatment.

As a rule a cure is usually effected in from three to five weeks, but a much longer time may be necessary. Final functional and cosmetic results are not seen until at least three months after treatment has ceased.

IMMEDIATE RESULTS OF INJECTION TREATMENT.

Usually in twenty-four to forty-eight hours after an injection one of the following results will occur:

(1) No sclerosis.

(2) Only thickening of the vein wall without obliteration of the lumen.

(3) Complete sclerosis and obliteration of the lumen, resulting in a tender fibrous cord.

(4) The same as number three with perivenitis.

THE COMPLICATIONS THAT OCCUR WITH THE INJECTION TREATMENT must be constantly kept in mind. These can be divided into local and general effects as follows:

(1) Immediate local reaction.

(2) Immediate general reaction.

(3) Latent general reaction.

(4) Latent local reaction.

a. Marked inflammation.

b. Ascending perivenitis.

c. Sloughs and ulcers.

(1) The immediate local reaction is rarely of serious importance. This usually consists of a burning sensation at the injection site. At times it becomes a severe cramp with pain radiating through the calf and over the extensor or plantor surface of the foot. The distribution of the pain seems to indicate nerve stimulation since it does not follow the course of the veins, according to Cattell. Others think that reflex stimulation of nerve fibers to smooth muscle in the vein walls is the cause of the cramp.

(2) The immediate general reaction depends on the type of patient and type of solution used. Such symptoms

as thirst, sweating, anxiety, vertigo, palpitation, tinitus and so forth are reported, these seem to be most prominent in nervous women and can probably be best explained on that basis. However, it is unwise to attribute all the reactions to an emotional factor, because persons sensitive to quinine may very properly have tinnitus, vertigo, nausea, etc.

(3) Latent general reaction. Headache and fatigue with a feeling of lassitude may follow an injection. Vomiting may occur. Thses general symptoms are explained as to be due to too large a quanity of the solution being used, but are often seen with the use of small amounts and are probably then due to a lessened tolerance by the patient. The presence of any of the symptoms at the time if the next injection should be an indication for delaying it until the symptoms have cleared up; the physician remembering that a different solution may be better tolerated by the patient.

(4) Latent local reaction.

(a) Marked inflammation. This is a frequently noticed reaction in the region of a vein which has been correctly injected that may be evidenced by a firm, slightly red, swollen and tender area. Such inflammation will subside within two or three days. At times, however, a marked inflammatory reaction takes place causing considerable discomfort and may incapacitate the patient. Most authorities agree that this reaction is due to solution in the perivenous tissue either by faulty injection, or leakage.

(b) Ascending perivenitis. The local inflammatory reaction may rarely involve all of the internal saphenous in the thigh even though the injection be confined to a point as low as the knee. This has been reported in undilated as well as dilated veins and may become quite an alarming symptom, but as yet, no cases of fatality from thrombosis and embolism from the iliac veins has followed. De Takats considers that the anatomic arrangement of the fossa ovale, the stagnation in the superficial system and the large volume of moving blood in the femoral veins probably gaurd against this possibility.

(c) Sloughs and ulcers. Any appreciable amount of especially the saline or salicylate solutions injected outside of the veins will lead to sloughing and formation of a chronic ulcer, at times attempts to inject the small "spider bust" or telangiectatic veins which are very superficial will, also, result in sloughing.

If local burning, cramps and pain persist for more than three or four minutes perivenous injection should be suspected, and it will show as a rule a local rapidly swelling area, particularly with concentrated solutions.

An ulcer is said to be prevented by attempts to aspirate as much of the solution as possible from the tissues followed by the injection of normal saline, distilled water or patient's whole blood into the involved area. The sloughs begin with marked local inflammatory

reaction and later develop into deep punched-out areas with necrotic centers. These should be kept clean and guarded from infection; various ointments and pastes have been recommended. They require weeks and even months to granulate and heal.

HISTO PATHOLOGY FOLLOWING INJECTION.

Histologic study of veins following injection of sclerosing solutions reveals a destruction of the intima together with a varying degree of thrombosis. There is first cloudy swelling of the endothelium; later proliferation occurs. From these proliferated cells fibrous tissue arises, in the mass of which are lodged blood cells. The walls of the vein and the thrombus quickly agglutinate, resulting in the formation of a fibrous cord which may in some cases remain palpable and in others may become difficult if not impossible to feel. The clot is reported to be firmly attached and is nearly an intregal part of the vein wall itself; therefore it appears that the danger of embolism should be slight. There is said to be no coagulation of blood in the vein.

CLINICAL RESULTS OF THE INJECTION TREATMENT OF VARICOSE VEINS WITH VARIOUS SOLUTIONS.

McPheeters has treated approximately one thousand cases with results that he considers far better than surgery. Nideroe treated one hundred forty cases with 25 or 30% sodium salicylate or with quinine and urethane with excellent effect. Schussler, since 1922 has treated very

satisfactorily more than one hundred fifty cases. He feels that 95% of varicosities can receive the benefit of the method, but he emphasizes the need for complete mastery of the technic. Schmier has treated about three thousand cases with more than ten thousand injections, and reports enthusiastically as to results. De Takats has reported on five hundred cases and says that the injection treatment has proved a valuable addition to specific therapeutic armamentarium. Kern and Angle's report on one hundred four cases with six hundred fifty-one injections, indicates the value of the method from the stand-point of efficacy, safety and economy of time.

RECURRENCE OF VARICOSE VEINS AFTER INJECTION TREATMENT.

The most commonly discussed short-coming of the injection treatment is the percentage of recurrences. When a vein is removed by surgery, it is generally granted that it will not recur. However, in the experience of McPheeters, Merkert, Lundblad and others, recurrences after surgical removal are more common than after injection treatment. They think that it is probably due in some degree to new varicose vein formation, so the problem at hand when a patient presents himself with a new set of varicose veins is whether it is a true recurrence or a new development. When it is a new formation a more thorough search for etiological factors must be made. When it is a true recurrence, improvement on technic is advised, along with various other explanations, the most popular being the recanalization theory. However, it is noted that certain

veins are more resistant to sclerosing solutions, often too weak a solution is used, or not enough and terminal compression until good organization has occurred may be neglected by the patient or the clinician.

If the great saphenous is patent at the saphenofemoral opening downward with a defective valve at that point, which allows the venous blood column to continue its downward pressure against a thrombosed segment of varicose veins at the knee and lower leg, it is reasonable to assume that this pressure will ultimately force open the old channel and that the main trunk will open collateral vessels and form more varicose veins as in the beginning. Failure to recognize this point is said by DeTakats to be responsible for a great majority of failures when technic was otherwise perfect.

PULMONARY EMBOLUS.

After a review of the literature, McPheeters found only four cases in which pulmonary embolus was found to be the cause of death, fifty-three thousand cases from European and American clinicians. However, I believe, and with some proof, that cases of pulmonary embolus and death following injection treatment are more numerous than this as an occasional sporadic case among the patients of physicians who are not in the habit of reporting such cases, or who willfully do not report such cases, are bound to occur, probably the most common factor in their production is a period of inactivity by the patient either in the belief of the patient himself or the physician that following

treatment it is the proper procedure.

As is usual the embolus is formed from a preformed thrombus intentionally produced by the sclerosing fluid, and if a reverse flow in varicose veins is usual as described under pathological physiology, then the danger from embolus should be nil. However, McPheeter is of the belief that when some other inter-current condition develops, such as a complicating acute infectious thrombo-phlebitis associated with the injection treatment, that there is a possibility of embolus formation.

If the segment of thrombus broken loose is large, then it will block the opening of the pulmonary artery and cause instant death, while if it be smaller, it may pass this point and occlude a smaller area of lung tisue.

The seriousness of this complication is, of course, dependent on the size of the embolus, a very small one causing no symptoms if lodged in the lung, while a very large one always causes instant death. When smaller portions of lung are involved the patient will have the symptoms of coughing, pain in the chest, dippnea and hemoptysis.

If the patient is instructed to remain active following injection treatment and the limb properly bandaged, provided the technic is correct there is almost no danger of embolus formation.

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