THE POST-PHLEBITIC LEG: FURTHER EXPERIENCES

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This paper presents further experiences gained from over 200 cases of strip grafting, an operation which I described in 1950.[1] A review of 100 cases so treated was published in 1955.[2]

The principles of Operation are as follows:

1. The lower medial aspect of the leg in man is ill equipped for complications of varicose veins, viz. thrombophlebitis, post-phlebitic congestion, 'blow-outs', infection, induration and ulceration. Essential differences exist between the medial and lateral aspects of the lower leg (Fig. 3).

2. The case must be assessed as a whole with regard to age, occupation, walking ability, adiposity, cleanliness, varicosities, blow-outs, induration of the 'isolated cuff' and ulceration, and arterial state.

3. Excision of the virtually irreparable tissue (with the potentialities of further recurrences of ulceration and infection, oedema and thrombosis, dermatitis, pain, and even carcinoma) is needed in order to replace it by healthy skin graft on muscle.

4. As the major pathological lesions and symptoms are in the area of the medial side of the lower leg, the operation is a direct attack on the 'focus of interest',[1] and excises the 'isolated cuff', deals with the varicose veins feeding it and 'blow-outs' (only attacked by the local operation), and excises deep scar tissue, which is occasionally extensive.

STRIP GRAFTING IN INDURATED MEDIAL LEG ULCERS

In operating on these cases it has been found that the best results ensued when a large area of skin was removed, including all the area of induration and ulceration on the medial side of the leg. A relatively large area of skin graft on muscle must lie adjacent to dangerous situations such as over bone and malleolus. It is essential to excise fascia so as to expose soft subfascial tissues. All varicose veins are removed, especially incompetent communicating veins (in this article called 'blow outs'). Thi spart of the operation, which was used extensively even before strip grafting was started in 1942, and was recorded in 23 cases of strip grafting in 1950, had been meticulously described by Linton[3] 10 years previously. Cockett and Edgar Jones,[4] in 1953, recorded two cases of eradication of supramalleolar perforator veins ('blow outs') as if this were a new procedure, without reference to Linton's classic work on the problem.

It has been assumed by some that the treatment by strip grafting is just a graft to the ulcer area. This concept is entirely erroneous. The problems of the post-phlebitic leg are many, and neither an immediate or permanent result can be achieved by a mere skin graft to the ulcer region. Every aspect of the pathology must be considered and treatment directed to all the aspects contributing to the disease. Attention is called to Figs. 1 and 10 in my 1955 article[2] where these aspects are set out in graphic form.

Pre-operative Selection

There are certain types of patients in whom operation is contra-indicated.

1. *The elephantoid leg* (Fig. 1). This worst type of post-phlebitic leg, where all the vicious cycles have existed, is complicated by osteitis, gross infection and ulceration (often with *Bacillus proteus* present), gross congestion of the limb on standing, a fixed ankle, and furry skin thickening of the foot, presumably from chronic lymphatic obstruction and skin stricture at the ulcer region.

2. Neglectful patients who cannot see below their knees or bend to attend to their limbs, or do not trouble to attend to minor injuries or maintain a minimum degree of cleanliness of their legs or anywhere else. This does not exclude the very adipose as long as care can be and is given to general cleanliness.

3. Unless a patient is prepared to remain at bed rest until there is complete healing, dependent granulation tissue will develop and infection and chronicity in a small unhealed area of the graft will lead to disappointment.

4. Systemic conditions may present contra-indications, e.g. diabetes, arterial blockage and syphilis.

5. Lateral ulcers (Fig. 2) require special consideration. A supramalleolar ulcer may be associated with varicosity of the small saphenous tree, or it may be fed by a 'blow-out' on

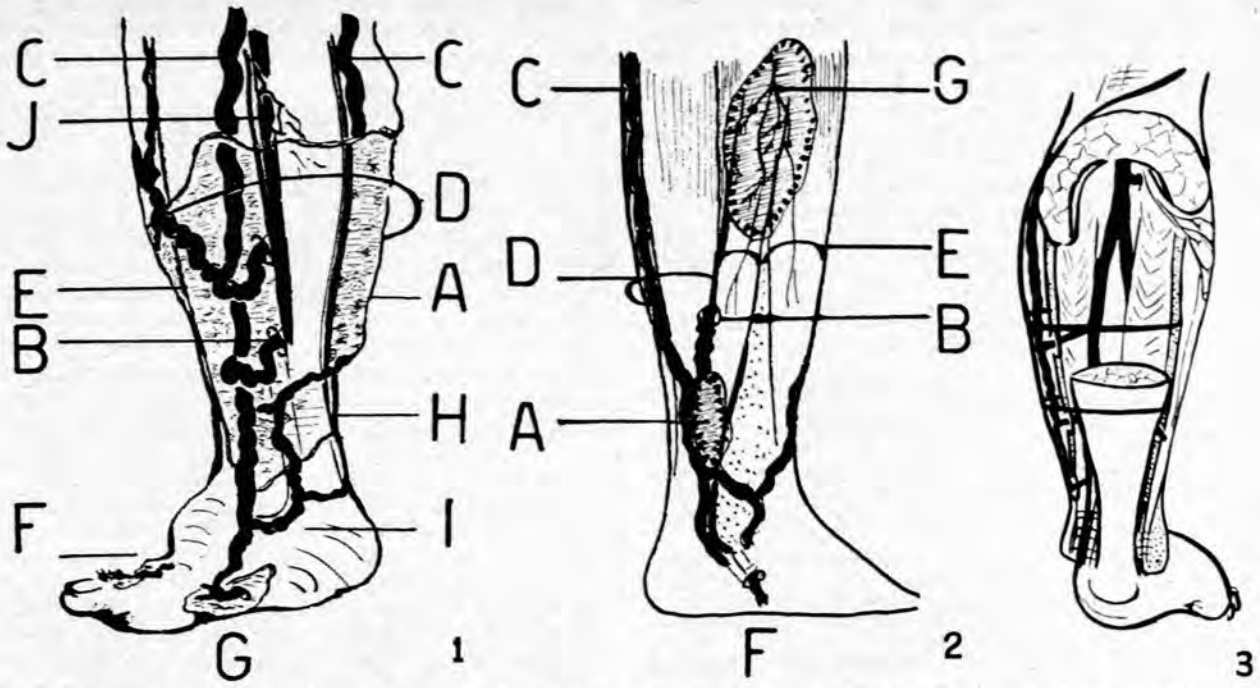

Fig. 1. Advanced incurable 'elephantoid' case. A=Large ulcer and indurated tissues. B=Large supramalleolar medial 'blow-outs'. C=Superficial feeder varicose veins. D=Extent of 'isolated cuff' of induration. E=Ulcer on tibia, with periostitis. F=Furry base of toes, ulcers at base of toes. G=Foot 'blow-out' and lateral foot ulcers. H=Skin stricture. I=Stiff ankle. J=Deep veins straight and incompetent, muscle fibrosed and avascular.

Fig. 2. Lateral ulcers. A=Supramalleolar lateral ulcer with underlying venous pool. B='Blow-out' feeding ulcer in post-phlebitic. C=Lesser saphenous varicosity feeding ulcer in varicose ulcer. D='Isolated cuff' lateral extent. E=Fascia over lateral muscles attached to them and intervening septa. F=Lateral foot 'blow-out'. G=Multiple arterial perforators. These supply overlying skin as well as muscle. Note area of high lateral ulcer.

Fig. 3. Illustrating medial and lateral sides of leg (see text).

the lateral side, when it is likely to be post-phlebitic. Lateral ulcers do not become indurated as on the medial side of the leg. When down to tendons they may be chronic, and the base is then avascular from the bloodless tendon base. However, when the ulcer is in the middle of the lateral side, or higher, syphilis and arterial blockage, usually from atherosclerosis, with obstruction of the lateral popliteal artery must be foremost in the mind. Beware of lateral ulcers, expecially when there is osteitis with periosteal thickening on X-ray.

Technical Improvements

Experience shows that even in the hands of excellent surgeons the details of strip-grafting technique have not always been followed as described. The posterior part of the incision is made first, cutting through to subfascial tissue, and a finger is directed below fascia and scissors used, cutting through this plane and continuing right into the ankle. In some of the worst cases in the region of the retinaculum of the ankle it is wiser to do the subfascial dissection as a separate procedure, until the soft base is widely exposed throughout. Deep penetrating septa of scar tissue may be present at the ankle, sometimes becoming indistinguishable from the tendo achillis and, on rare occasions, even extending right through to the lateral side, where there may be lateral ulceration as well. Under fascia all the fascia and subcutaneous tissues lift off in one and include the ulcer and indurated tissues inseparable from the fascia, and as the incision is turned anteriorly the great saphenous vein is reached, and when it is dilated and varicose and thickened it is divided and stripped to the groin. As the incision extends distally there may or may not be 'blow-outs' with definite holes in the fascia through which the veins pass, usually large and dilated, even in the lying position. Usually two or three are found, sometimes only one large one, and sometimes none.

There is no contra-indication to excision and grafting well over the malleolus and tibia. In the latter case, if the extension of ulceration is well over the tibia, it is wise to graft laterally as well, to obtain as much grafting on muscle as possible in the neighbourhood of suspect areas.

I have called the area of excision the 'Isolated Cuff'. This describes the tissue superficial to the hand passed under fascia, over the calf muscles, and extending from the fibula laterally to the tibia medially. It becomes grossly congested on standing when there are varicose veins of the great and lesser saphenous trees, and even more so when there are underlying 'blow-outs'. The size of the induration will depend to some extent on the presence of a double varicose system, and whether these thrombose or not, but the subcutaneous tissues of the 'isolated cuff' are subject to induration whenever thrombosis, infection, ulceration, haemorrhage, trauma, necrosis, widespread skin eruptions, or dependent granulation tissue occur. Induration is peculiar to the medial side because of the relative isolation of this 'cuff'. On squeezing this tissue

after excision, a white lymph escapes, presumably collected from poor drainage of lymph from the 'isolated cuff'. Oedema is the rule, and intolerable tissue tension is presumed to occur in the sudden attacks of diffuse erysipeloid infections, blistering necrosis, and suddenly developing massive ulcerations.

I consider the medial side of the leg to be the venous side as compared with the lateral 'arterial side' (Fig. 3). The differences between the medial and lateral sides of the lower leg are as follows (they are discussed later):

MEDIAL

Fascia is isolated from muscle.
Tissues superficial to fascia form an isolated cuff.
Medial side is venous side, containing the long saphenous vein, communicating veins, post-phlebitic 'blow-outs', and varicose and post-phlebitic ulcers.
Venous flow is through long saphenous or poorly supported intermuscular channels on exercise.
Induration is common, and may progress to skin stricture.
Lymphatic obstruction in 'isolated cuff'. The medial side drains deep haematomata (e.g. 'ruptured plantaris', and deep inflammatory exudate (e.g. calf abscess after septic thrombosis).

LATERAL

Fascia is attached to muscle.
Tissues superficial to fascia intimately related to muscles.
Lateral side is arterial side. Lateral popliteal artery obstruction causes skin and muscle necrosis in upper half. Lateral tendons form an avascular base in lateral ulcers.
Venous flow is through short saphenous or well supported intermuscular and usually intramuscular channels.
Induration is not present.
'Blow-outs' unusual.

Size. In the early grafts the extent of the excision of the ulcer and indurated tissue and fascia was too small, and in several cases induration persisted and ulceration recurred; when a large excision and graft was done, permanent healing resulted. It is a feature of large strip grafting on muscle that surrounding indurated tissues soften; the healthiest portion of the leg is now in the centre of the graft.

Even when the area of excision appears relatively large, considerable contraction occurs later. The degree of take is important, for scar in the region of the graft, especially if near bone, is to be avoided.

Bevelling. By cutting the edge of the skin obliquely the appearance is considerably improved. This is important in the adipose, but in thin patients the surface of the graft is level with surrounding skin.

Two-stage Procedures. In occasional cases, especially in bilateral grafts, the excision of scar is done under a bloodless field. Tulle gras is placed on the raw area and pressure applied with tie-overs of silk. At the end of a week a red healthy granulation tissue has formed evenly on the base and the skin graft can be applied without further preparation.

A bloodless field and grafting at the same time has not been entirely satisfactory in the few cases in which it has been used. The thin areolar covering to tendons, especially on the lateral side of the leg, seems to withstand the period of vascular obstruction poorly, expecially when a graft with pressure is added to the bloodless stage of excision. Tendon slough has occurred, and this has taken longer to heal than the usual period of graft healing.

Dressing and Immobilization. By encasing the leg below the knee in plaster of Paris, the nursing and the post-operative handling is greatly simplified. The plaster is left undisturbed for about 4 weeks if the patient is comfortable and there is no strong odour after 4-6 days. This makes dressings unnecessary until after the plaster is removed, and then there is often little to be done when the graft has taken well. When an odour is apparent after a week the plaster can be removed, but this is unusual.

Meticulous Attention to prevent 'Dependent Granulation Tissue'. The patient must be treated with the leg elevated until there is complete healing. The usual period is 6 weeks, but an extra period until the graft and incision lines are strongly healed is always worth while. Hurrying over the last little bit of healing and allowing the patient up and about is likely to lead to persistent oedema and congestion, an encouragement of an unhealed area and perpetration of a chronic ulcer.

Pressure Dressings. These may be of a variety. The usual method is to apply gauze, cotton wool or liquid paraffin soaked cotton wool over the grafted area and then to apply crepe bandages very evenly from the base of the toes to just below the knee. Three bandages are used, according to the size of the leg, and over these bandages elastoplast is rolled. Pressure dressings are kept on for 3-4 weeks at a time and the patient allowed to do increasingly more walking. An alternative method of pressure dressing is a double stockinette with foam spong rubber over the graft between the two layers of stockinette and sewn into place and, over this, further crepe bandages. Occasionally plaster of Paris well padded is used when there is a linear pull on any area of the graft, with still poorly healed skin over this area. Immobilization ensures strong healing. Sometimes patients are sensitive to bandaging or heat and, with a well healed graft, occasionally a patient can be allowed graded rising, walking and exercising, without any temporary period of compression bandaging.

Sensitivities have occasionally been prominent complications. This has happened with the use of Cetavlon in cleansing, and considerable extra bed-rest dressings may result from this type of sensitivity.

THE RESULTS

These are essentially similar to those published in September 1955. The follow-up period now dates back to 1942, i.e. 16 years.

1. Recurrent ulcers may be due to:

(*a*) Technical errors such as untreated feeder varicosities, 'blow-outs' or deep-vein incompetence, or to a poor take in an area related to tendons or bone, or to too early rising. If massive ulceration occurs over bone after strip grafting, a cross leg, thigh to ankle, skin flap has proved satisfactory.

(*b*) Small sores may develop into large ulcers in patients who cannot obtain leave of absence for bed rest, or in whom neglect, uncleanliness, or obscured visibility is present so that *B. proteus* complicates the ulcer. Bed rest and dressings will result in healing more rapidly after strip grafting than before.

(*c*) Ulceration away from the graft, usually on the other side of the ankle (lateral), is not uncommon. Here a perforation 'blow-out' or a missed short saphenous varicosity must be considered. Grafting is only done when there is extensive skin involvement, and extensive subcutaneous venous pooling.

With selection of cases, the recurrence rate is not frequent, and excluding technical errors and ulceration on other parts of the leg, it is now no more than 16%.

2. *Pain is relieved* in all cases, and cases strip-grafted on one side and incised and sutured on the other consistently

prefer the grafted side, and return for strip-grafting of the other leg in later years if this other leg develops pain, induration and ulceration.

3. *Sensitivities* generally disappear. The immediate results are good. There appears to be a focus in the indurated tissue which acts as a trigger to generalized allergic skin reactions.

4. *Oedema disappears* as the patient walks more and exercises the calf and ankle. A period of oedema after removal of the compression bandages is usual in the elderly, adipose and inactive, but this improves.

Occasionally a painful limb with or without persistent minor ulceration may occur with femoral thrombosis, which requires anti-coagulants and bed rest, followed by graded activities and walking with support for relief.

5. *Foot Deformities.* As has been pointed out, claw toes, shortening of the tendo achillis, and aggravation of congenital deformities, are a common feature in chronic leg ulceration and induration, and walking without pain must be established to get good final results (Fig. 4).

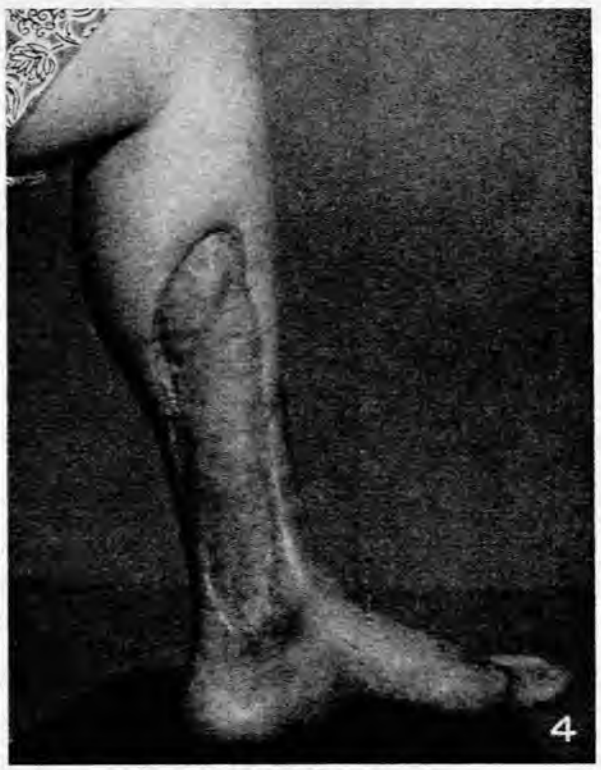

Fig. 4. Strip grafting: good final result.

It is apparent that the *focus of interest*[1] is in the region of the lower leg medially, mainly in the area of the 'isolated cuff',[2] which is the name given to the tissues in this region, so prone in man to suffer from induration and ulceration. Here, there may be distended varicosities and 'blow-outs'; lymph accumulates; inflammation results in slough, thrombosis, intolerable tissue fluid tension and diffuse skin reactions; necrosis, including endothelial and fat necrosis, is poorly resolved; scar and chronic ulceration persist; and skin stricture, circular induration and ulceration may follow. With pure varicose veins, the most dependent part of these varicosities is in this area, and when both systems are varicose there is a tendency for greater induration than when only one system is affected.

When there has been a deep-vein thrombosis re-vascularization may be satisfactory,[1] with re-formed muscle veins and resultant absence of varicosities, oedema and cyanosis or incompetent deep veins. The re-vascularization, however, is commonly unsatisfactory.

The result of the development of collateral veins, which are dilated normal veins and therefore incompetent, and the re-canalization of thrombosed veins, is invariably an increased volume of blood in the standing position, with incompetence of affected veins.

Calf Muscle Pump. With systole and diastole of the calf muscle pump[2] under normal conditions the blood in the superficial tissues is sucked into the deep veins and carried upwards by reason of the adequacy of the valves of the deep vein. Pumping as a factor in venous return can only take place when there are favourable conditions, namely, no 'blow-outs' and normal non-distended receiving veins with functioning valves (Figs. 5 and 6).

Clinical Test. A useful clinical test[2] consists of making the patient stand and examining the area of varicosities in the lower leg. The patient is asked to exercise by raising and lowering the heels, and the alterations in pressure are estimated by the palpating finger. The feeder vein (great saphenous and/or lesser saphenous) is compressed at knee level and exercises continued. Alterations in pressure are again estimated by the palpating finger. When a noticeable reduction in pressure can be felt on eliminating the feeder vein, then the calf muscle pump must be working, and a significant 'blow-out' cannot be present. When no significant reduction takes place the case may be called complicated, i.e. complicated by major 'blow-outs'. A positive reduction in pressure indicates the perfect case for eradication of the affected varicose vein tree feeding the area. A negative pressure test indicates a necessity for effective attack on the areas of the 'blow-outs'.

It can be appreciated that neither ligation of deep veins or grafting of deep veins can have the slightest effect on the efficiency of the calf muscle pump as long as the locally incompetent 'blow-outs' are still present. The relatively poor support against incompetence above the knee even in the normal, and the relative ease by which obstruction is overcome by recanalization and collaterals, makes attempts to introduce artificial valves and ligate deep veins almost ludicrous.

The veins from behind the lateral malleolus drain through intramuscular channels mostly (Fig. 5), whereas on the medial side the blood flows through intermuscular channels and is less well supported. On venous obstruction or high pressure above, the muscles will force the flow of blood into the intermuscular channels, and in a reverse manner through the communicating veins, establishing 'blow-outs' on the medial side in the region of the isolated cuff (Fig. 6).

In the presence of a greatly increased volume of blood in superficial varicose veins, it is conceivable that distension of communicating veins might follow, and subsequently too even of the deep veins. In either case 'blow-outs' would be established, with loss of effective pumping action of the calf pump. As the late stages of varicosities are indistinguishable from post-phlebitis in this respect, such a course is quite

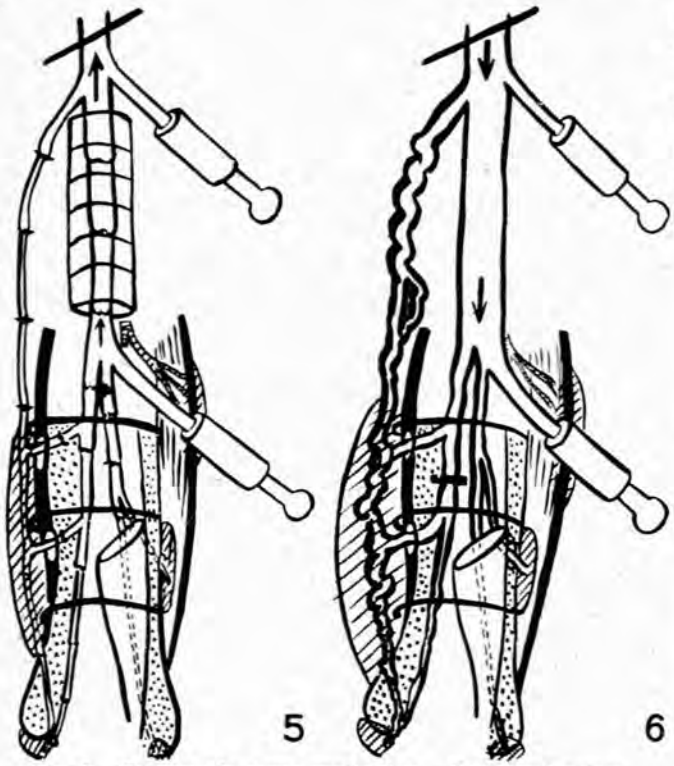

Fig. 5. Calf muscle pump mechanism. Competent valves above. Flow on exercise through competent communicating veins by reason of diastole of pump.
Fig. 6. 'Blow-outs' in obstruction. Deep-vein incompetence. Dilatation of deep venous tree.

possible although it is in the post-phlebitic that 'blow-outs' are commonly, and even early, established.

THE ARTERIAL CIRCULATION

It is quite apparent that in the post-phlebitic leg muscle pumping does not effectively assist venous return, and furthermore there is gross venous incompetence with dilatation of veins, so that a greatly increased amount of blood surges into the legs from the venous side when the standing position is assumed. The flow obviously goes on in this position. This inevitability of venous return brings into consideration the part played by the arterial circulation in limbs in the standing position, and especially in varicose and post-phlebitic legs.

It has been established that the blood in varicose and post-phlebitic and ulcerated legs is by no means in a state of stasis. The oxygen content in a vein from such a leg is actually increased.[2] Further, the arterial pulses on standing are greater than on lying, the oscillometric pressure and blood pressure are higher, ulcers may bleed on standing (and not dark deoxygenated blood) and stop bleeding on elevation, and a cut vein bleeds copiously in a strong pink oxygenated flow from the distal cut end.

Duffield and Harris[5] showed how, with venous obstruction, the capillary pressure invariably rises immediately to higher levels than the venous obstruction, within the bounds of systolic pressure.

There is an inevitability of venous return contingent on arteries capable of delivering the pressure, and it is redundant to suppose the arteries more fully occupied in this regard in the standing than in the lying position, and in the venously engorged varicose and post-phlebitic leg than in the normal.

The small arteries show peculiarities characteristic for this service. In excised areas it is common to find hypertrophy of small vessels (Fig. 7). When extensive incisions and excisions are performed considerable bleeding is the rule, but within seconds of applying pressure on a large swab the bleeding will cease, except for the distal ends of large veins that have been cut. This shows considerable tone in small vessels in the post-phlebitic leg, a tone vitally necessary to cope with the pressure in the standing position and the emptiness of veins in the elevated state. With an indurated and inflamed 'isolated cuff', this hypertrophy of small vessels may be complicated by inflammatory cellular infiltration with endarteritis and periarteritis, and these changes may be important in the tendency in this area to get occasional stasis, thrombosis and necrosis.

Fig. 7. Thickened vessels in indurated cuff (excised)

Selective arterial responses are present, as is well shown in the response of the capillaries of the toes when the hands are heated, and the almost negative response of the ulcer region. This must mean either absence of capillaries here, or a shunting past the capillaries in the ulcer region through larger vessels. It is also a feature of this patient that although grossly increased circulation may occur through areas where there are dilated vessels, the feet are often cold and sweaty, and even on standing there may be no evidence of the greatly increased flow in the visible portions of the feet and toes.

If such arterial response does occur it must apply where pressure most calls for such a response, where venous pressures are highest, that is in varicose trees or 'blow-outs', and even in deep and superficial distended systems, but consistently

in the area of the 'isolated cuff'. The well supported ankle veins may protect the feet except in the worst cases, when on standing even capillaries dilate under pressure and under the influence of metabolites ('the flush syndrome').[1]

This local arterio-venous response is applicable to states such as local varicose veins, capillary and cavernous haemangioma, traumatized varicose veins, and dependent granulation tissue.[2]

DISCUSSION

The presence in a late post-phlebitic of a large patent femoral vein above an apparent obstruction is intriguing. This may be seen in venographic studies or at operation. Cramps and venous congestion on standing have often been relieved by division of this vein. The only likely explanation is that venous obstruction had resulted in distension of the venous tree below; dilatation of collaterals and late venous incompetence; increased volume and increased flow; and distension of the venous tree above.

Gibbs,[6] in a recent publication, has stressed the importance of the calf veins. He states: 'During the greater part of life a progressive increase of body weight occurs and thus the muscles of the calf contract against a steadily increasing load. The greater metabolic requirements of the muscles are met by an increase of blood flow through them. The veins therefore increase in diameter, and further anastomoses are opened up to accommodate the augmented venous return. The intramuscular veins particularly of the soleus muscle become very large and may exceed the diameter of 1 cm.' And he speaks of 'blood pools in the inert reservoir of venous blood in the soleus muscle'.

Such a concept of a tendency in increased age for blood to accumulate in the veins of the legs cannot go unchallenged. Rather may it be stated that with age, as the veins lose their tone, and there is increasing abdominal pressure and stretching of supporting structures, venous incompetence occurs. Veins dilate, valves become incompetent, and veins are filled from heart to feet on standing. This is the whole story of the dilated venous bunches in the soleus; and of course age alone is not the whole story. It is when there are varicose veins, or post-phlebitic venous incompetence with distension of veins, that the leg veins will dilate—mostly where the veins are least supported (i.e. in the intermuscular veins and superficial veins) rather than in the well supported intramuscular venous pools, if these still exist after extensive thrombosis.

A greater comprehension of the problem now becomes possible. The eradication of dilated venous trees will reduce the flow and congestion. Rest will restore tone in veins. Isolated divisions of deep veins may play a part temporarily. Supported deep channels must be kept patent and when the volume of blood is diminished by eradication of varicosities distally, rest may restore a dilated deep tree to normal. Nature abhors venous obstruction, so that if the wrong vein is ligated collaterals will restore flow as long as the arterial circulation is normal. Division of a dilated incompetent deep venous tree will only act temporarily in reducing venous inflow to the leg, and the volume of blood will still remain if varicosities are untreated, and new dilated collaterals will inevitably form; the result will be a return to the state as before the deep-vein ligation.

In the area of the 'isolated cuff' a consistently increased flow of blood without complications is unusual. Oedema diapedesis, tissue fluid tension, haemorrhage, thrombosis, inflammation, necrosis and irreparable changes are the rule. The inflammatory changes affect the arteries too, and this may be important in the presence of intense congestion, oedema, exudates, and necrosis.

In a leg afflicted with late varicosities, or the post-phlebitic state, in which a labile artereolar adjustment has become established and in the standing position an increased vascular flow is present, arterial blockage may produce little clinical effect. The development of collaterals during the period of adjustment to the venous disturbances serves well later. The term 'masked arterial disease'[4, 5] has been used to describe this state.

Having accepted the phenomenon of increased venous pressures causing a corresponding increase in arterial pressures, and noting the inevitable increased oscillometric pulsations in post-phlebitics with or without ulcers and complicated varicose veins, it has been natural specially to observe patients with different types of venous disease who are known to have arterial disease.

A case may present with post-phlebitic or late varicose ulcers on the medial side of the leg, and by mere accident the popliteal artery may be found to be blocked. A case may be instanced where there had been no symptoms of arterial disease, no intermittent claudication, no distal pallor or rest pain, and only on treatment of the gross varicose veins, with enforced lying in bed, did this patient develop gross sloughing and gangrene—necessitating amputation.

Several cases have been observed with varicose veins and blockage of the popliteal artery without any form of arterial symptoms. In another case, in which amputation was necessary in one leg (arteriosclerotic with atheroma), and arterial studies demonstrated arterial disease in the other, with partial blockage, a subsequent clinical venous thrombosis of the leg passed through a phase of cold oedema but shortly became warm and healthy, without clinical foot pulses or oscillometric pulsations below the knee.

It is contended that in venous disease (varicosities and post-phlebitics) a maximum veno-arterial dilatation is present in standing and walking, and this stimulus to the arterial circulation through its branches and collaterals may mask underlying arterial blockage in the main vessel and may even be a protective influence against gangrene. In patients who are elderly, and therefore may have vascular obstruction, eradication of varicose veins should not be viewed with any degree of confidence in its safety.

SUMMARY

The author's previous communications on the syndrome of the post-phlebitic leg are mentioned.

The differences existing between the medial and lateral aspects of the lower leg are outlined.

The significance of 'blow-outs', and a clinical test, are discussed.

The arterial response is considered in connection with the inevitability of venous return.

The further experiences in 200 cases of the operation of strip grafting, which the author introduced, are presented.

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