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SURGICAL TREATMENT OF CHRONIC LYMPHOEDEMA OF THE LOWER LIMB

WITH PRELIMINARY REPORT OF NEW OPERATION

BY

NOEL THOMPSON, M.B., F.R.C.S.

*Consultant Plastic Surgeon, Stoke Mandeville Hospital,
Aylesbury, Bucks*

The accumulation of excessive amounts of lymph in the subcutaneous tissues of the lower limb may occur from two quite distinct groups of causes. Secondary ("obstructive") lymphoedema results from the mechanical blocking of proximal lymphatics previously anatomically normal following trauma, surgical excision of inguinal lymph nodes often in association with post-operative infection or deep x-ray irradiation, the lymphatic spread of malignant metastases or (in the tropics) the filarial parasite. Primary ("idiopathic") lymphoedema, whether inherited, congenital, or presenting clinically in later life, is now regarded as the consequence of a structural, developmental defect of the regional lymphatics resulting in functional derangement and lymph stasis (Kinmonth *et al.*, 1957). Radiological lymphangiography following the direct injection of diodone into the peripheral limb lymphatics, in the way described by Kinmonth *et al.* (1955), demonstrates that the defect may take one of three forms: aplasia with absence of lymph vessels, hypoplasia with poorly developed lymphatics in diminished numbers, or hyperplasia with dilated varicose and incompetent lymphatics (Kinmonth *et al.*, 1957).

Such limbs are prone to recurrent attacks of infection in the form of cellulitis and lymphangitis, now considered merely secondary to the pre-existing lymphatic abnormality (Kinmonth *et al.*, 1957; Taylor, 1959). In essentially all cases, however, whether primary or secondary in type, the stagnation and accumulation of lymph is limited to those subcutaneous tissues of the limb lying superficial to deep fascia, the muscles being unaffected. Early surgical treatment was directed, there-

fore, towards establishing drainage of the oedematous subcutaneous tissues of the limb into either the normal subcutaneous tissues of the trunk or the normal deep muscles of the limb itself.

Historical Survey of Operative Treatment

Handley (1909) inserted multiple silk threads subcutaneously throughout the length of the lower limb in the hope that the lymph would ascend by capillary attraction to the level of the iliacus muscle, in which the upper ends of the threads were buried, but confessed to failure a year later (Handley, 1910). No long-term successes have followed the substitution for the silk threads of strips of fascia (Lexer, 1919), or buried tubes whether of rubber (Walther, 1918), "polythene" (Hogeman, 1955), or "portex" (Jantet *et al.*, 1961). Failure was usually attributable to infection, extrusion of the implanted foreign material, and the impossibility of obtaining drainage against the force of gravity by the provision of valveless and inert channels. Gillies and Fraser (1935) introduced the more rational and physiological concept of transferring normal lymphatic vessels in a full-thickness flap of skin and subcutaneous fat taken from the arm to act as a lymphatic bridge across the postulated lymphatic block at the groin and so join the oedematous thigh to the normal tissues of the flank on the same side. Despite ingenious modification (Mowlem, 1948) this remains a procedure of some magnitude which has never repeated the success obtained in the first-reported single case. It has little relevance in cases of primary lymphoedema where the lymphatic maldevelopment is widespread (Mowlem, 1958; Taylor and Kinmonth, 1949), any response being more likely to be due to the local implantation of new lymphatics with competent valves than to the successful bridging of a local obstruction (Kinmonth and Taylor, 1954).

The superficial lymphatics draining the skin and subcutaneous tissues communicate so very rarely with the deep lymphatics draining the subfascial compartment of the limb that, as a general proposition, it remains true that the superficial and deep lymphatics are independent of each other until they reach the inguinal region (Poirier *et al.*, 1903; Clark, 1958). This view, traditional among anatomists, has received confirmation from modern methods of lymphangiography in human subjects (Blocker *et al.*, 1960). On the assumption that the lymph drainage of deep tissues was unaffected in cases of lower-limb lymphoedema, many surgical efforts have in the past sought to establish drainage of lymph from the oedematous superficial into the normal deep tissues by removing the deep fascia separating superficial from deep lymphatic systems. Lanz (1911) devised a means of communication between the superficial and deep tissues of the lateral thigh by turning pedicled strips of deep fascia into the underlying muscle layer, even inserting them through trephine holes in the femur into the marrow cavity. Kondoléon (1912) later simplified the procedure and extended it to the lower leg by excising in two stages long strips of deep fascia through long medial and lateral incisions. In a late follow-up of his cases Kondoléon (1924) stressed that the greatest improvement in the size and function of the limb occurred where a more radical excision of fascia had been employed in early cases without appreciable subcutaneous fibrosis. Although restoration to

normal did not occur, the majority of cases improved in function as a result of diminished oedema.

The Kondoléon operation was radically modified by Sistrunk (1918, 1927), who advised that the widest possible removal of deep fascia should be accompanied by excision of some overlying skin and diseased subcutaneous fat, to reduce the bulk of the limb. Many published accounts attest the usefulness of the Kondoléon-Sistrunk procedure in arresting progress and producing remission from attacks of cellulitis after lengthy follow-up periods of up to 20 years (Weinstein and Roberts, 1950; Mackmull and Weeder, 1957). Ghormley and Overton (1935) found that of 64 patients so treated "satisfactory" improvement was maintained in 42%, and only 12.5% were wholly unimproved, while cellulitic attacks were abolished or improved in 77% of those affected. Jantet *et al.* (1961) conclude that the operation maintains its usefulness in the treatment of moderate lymphoedema.

Because of their frequent failure to reduce the affected limb to normal dimensions and their limited capacity to cure, the "physiological" operations detailed above have currently become increasingly supplanted by "excisional" operations aiming at total ablation of all lymphoedematous tissue (Kinmonth, 1952). Believing that any benefit ensuing from Sistrunk's operation derived exclusively from the excision of diseased tissue, and that both deep and superficial lymph drainage from the limb was equally impaired, Homans (1936) advocated the removal of all deep fascia and almost all subcutaneous fat from the lower leg in four operations staged over many months; at each stage long thin skin flaps carrying only the minimum of subcutaneous fat necessary to ensure a blood supply to the flap were replaced as sole cover to the deep muscles, tendons, and bones.

It is noteworthy that although Homan's professed aim was a radical excision of all oedematous tissue, yet by excising the deep fascia of the entire circumference of the limb the Kondoléon principle of deep drainage of lymph was not excluded.

The occasional recurrence of lymphoedema in the small amount of subcutaneous fat left beneath Homan's skin flaps indicated the logical ultimate stage in the evolution of the excisional operation: the removal of the entire catchment area served by the superficial lymphatics by radical excision of all superficial tissues of the lower leg down to deep fascia or muscle, followed by re-surfacing of the limb with free split-skin grafts taken from the affected limb or elsewhere. This concept, initially advocated by Charles (1912) as a treatment for filarial elephantiasis, was independently rediscovered by Macey (1940, 1948), who applied his split-skin grafts in stages, and by Poth *et al.* (1947), who in a one-stage procedure left an intact strip of skin overlying the tibia anteriorly. With minor variations in technique such a radical excisional approach has been advocated by many surgeons, including Mowlem (1948), Blocker (1949), McIndoe (1950), Farina (1951), Watson (1953), Pratt (1953), and Gibson and Tough (1954). The excisional operation is by no means without disadvantages, quite apart from the unpleasingly attenuated contours presented by the flayed limb which are accentuated by the redundant outlines of the untreated thigh. Thus many reports stress the occurrence of severe papillomatosis in the skin grafts, surface weeping of lymph, local breakdown and ulceration, eczema of skin grafts, recurrent

cellulitis, keloid and wart formation, and the recurrence of oedema in incompletely removed subcutaneous fat (Watson, 1955; McKee and Egerton, 1959; Jantet *et al.*, 1961). A recent survey discovered that while the main complaint was relieved in 69% and improved in a further 24%, no less than 60% suffered some complication listed above (Jantet *et al.*, 1961). The excisional operation is palliative and not curative, and can only maintain its popularity in cases of uncomplicated lymphoedema in the absence of any simple method for successfully improving the intrinsic drainage of lymph from the affected tissues.

Factors Relevant to an Evaluation of the Kondoléon Operation

In patients suffering from primary lymphoedema it is now known that the lymphatic structural abnormality is not certainly restricted to the superficial lymphatic vessels, but may affect also the deep lymph trunks, which are then greatly dilated and show retarded lymph flow in association with valvular incompetence (Kinmonth and Taylor, 1954). Since there is no clinically evident oedema of the deep tissues in such patients, it must be presumed that the deep lymph drainage is nevertheless adequate. The flow of lymph in normal lymphatic trunks of human limbs is determined in its direction by the anatomical disposition of the valves, but is itself chiefly the result of extrinsic forces: muscle contraction in raising tissue-tension (White *et al.*, 1933), and the pulsation of blood-vessels by their massaging effect on adjacent lymph vessels (Parsons and McMaster, 1938). It is conceivable that muscle action and arterial pulsation are able to produce an adequate return of lymph from the deep compartment of the limb even in the presence of incompetent valves.

Kondoléon's conception that removal of deep fascia would promote an anastomosis of superficial to deep lymphatics has long been criticized on the grounds that in many cases of filarial and post-operative lymphoedema responding favourably to operation the pelvic lymphatics draining both superficial and deep lymph zones must often have been also occluded. It therefore appears likely that following the excision of deep fascia the superficial lymph swamp is absorbed by the blood-vessels of the muscles (Henry, 1921; Peer, 1955).

It has been repeatedly observed that regeneration of deep fascia occurs rapidly, even within a few months, following the Kondoléon operation and thereby re-establishes the initial barrier between superficial and deep lymph zones (Bertwistle and Gregg, 1928; Peer *et al.*, 1954).

Lymphatic Transposition using "Shaved" Subcutaneous Skin Flaps

Certain possible causes of failure following the Kondoléon procedure may be eliminated or reduced by effecting a transposition of superficial lymphatics into the deep compartment of the limb through the medium of the "shaved" skin flap. If the surface epidermis is first thinly shaved from skin, the residual dermis with its contained epithelial elements may safely be buried in the tissues, as Hynes (1956, 1959) has clinically confirmed. Histological examination of buried dermis grafts (Thompson, 1960a, 1960b) and of skin grafts

applied to "shaved" skin surfaces (Thompson, 1960c) confirms that ultimately surviving epidermal appendages are few and largely free of late complications.

The principle involved (Fig. 1) is applied by raising a long lateral skin flap as thinly as possible from the

FIG. 1.—Principle of the operation. (a) Cross-section of lymphoedematous limb. (b) Thin lateral skin flap raised, and underlying fat and fascia excised. (c) Flap replaced, its redundant free margin of "shaved" epidermis then buried into muscle layer. Arrows indicate direction of lymph flow in lower limb.

full length of the lymphoedematous limb and excising the whole of the underlying subcutaneous fat and deep fascia. The flap is then reappplied to the exposed deep structures, the redundant free margin of the flap being "shaved" of its epidermis—which is removed as a Thiersch graft—and then furled into the deep compartment at the site of a convenient intermuscular crevice presenting itself along the course of the main vessels. By these means the following objectives may be achieved:

1. If anastomosis of superficial to deep lymphatics is at all possible, then by bringing the superficial lymphatics in the buried free border of the flap into close proximity with the deep lymphatics accompanying the main vessels optimum conditions are established for this to occur. In addition, the superficial lymphatics in the buried periphery of the flap are exposed to the propulsive effects of muscle action and arterial pulsation, both calculated to assist lymph flow.

FIG. 2.—Stages in operation to medial aspect of limb. Thigh is completed (b to e) before lower leg is treated (f to i). (a) Shows line of incision. Shaded area is "shaved" of epidermis by removing from it a medium-thickness split-skin graft. (b) Thin posterior skin flap raised as far back as mid-thigh posteriorly. (c) Subcutaneous fat and deep fascia excised deep to the flap, exposing muscles. (d) "Shaved" margins of skin flap advanced beneath deep fascia into femoral canal. (e) Burial of "shaved" area completed. (f) Thin posterior skin flap raised from lower leg. (g) Underlying fat and deep fascia excised to expose soleus and gastrocnemius muscles. (h) "Shaved" margin of skin flap advanced to lie alongside posterior tibial vessels. (i) Final suturing to completely bury "shaved" margin of flap.

2. Vascular absorption of superficial lymph by muscle venules, if it occurs, would be facilitated by draining the superficial lymph swamp into the extensive intermuscular cleft.

3. Such drainage of superficial lymph into deep tissues should be well maintained, since regeneration of deep fascia cannot now re-segregate superficial from deep lymphatic territories, the interface between the two being transgressed by a permanent lymphatic-bearing band of dermis and subcutaneous fat throughout the length of the limb.

The Operation

By burying long "shaved" skin flaps on both medial and lateral aspects of the limb, at operations separated by an interval of three to six months, maximum application of the principle stated should result. Each flap should be based on the mid-posterior axis of the limb as being a negative zone of lymph drainage.

Before each stage the patient is submitted to three to five days' pre-operative bed rest, with carefully maintained elevation of the limb and firm compression bandaging reapplied twice daily, to reduce the limb to its least dimensions. Tetracycline is begun pre-operatively; blood transfusion is desirable at operation.

Operation to Medial Aspect of Limb (Fig. 2)

The limb is suspended at a convenient level from a hook in the operating-theatre ceiling by transfixing the calcaneum with a Böhler pin to which a rotating stirrup is attached.

The line of the incision (Fig. 3) is planned to lie $1\frac{1}{2}$ in. (3.8 cm.) posterior to the course of the femoral vessels in the thigh, and 1 in. (2.5 cm.) behind the posterior margin of the subcutaneous surface of the tibia in the lower leg, the two being joined by an incision curved posteriorly, traversing the mid-medial aspect of the knee-joint. The whole incision extends from a point about a handbreadth below the inguinal ligament to a position at the ankle below and behind the medial malleolus. From its upper end a further short incision passes upwards and backwards to a point rather behind the mid-medial axis of the limb, to define the upper margin of the thigh flap.

The surface epidermis is "shaved" from the upper and anterior free margins of the flap by removing from the area shown (Fig. 2 a) a medium-thickness split-skin graft using a free-hand skin-grafting knife. The width of the "shaved" band is usually about 2-3 in. (5-7.5 cm.) in the thigh and $1\frac{1}{2}$ in. (3.8 cm.) in the lower leg, but must vary with the degree of enlargement present. It is a simple matter to re-apply a portion of the removed skin graft to any "shaved" surface left unburied at the end of the operation. All skin ("shaved" and unshaved) posterior to the incision is undermined as far as the mid-posterior axis of the limb, and raised as a thin skin flap. The operation is conducted in two phases, the thigh being completed

and sutured before the lower-leg flap is raised. In the thigh (Fig. 2 b) the skin flap is raised with about $\frac{1}{4}$ - $\frac{1}{2}$ in. (3-6 mm.) of subcutaneous fat adhering to its deep surface, and is slightly thickened towards its base. The remaining subcutaneous fat, together with all underlying deep fascia, is then excised from beneath the whole extent of the flap (Fig. 2 c) to expose the muscles of the thigh behind the sartorius. The infrapatellar branch of the saphenous nerve is preserved.

Mattressed sutures of heavy silk, transfixing the skin and deep fascia of the anterior thigh, as well as the "shaved" area of the posterior skin flap well away from its free margin (Fig. 2 d), are inserted and held long in forceps to guide the shaved flap into position beneath the deep fascia of the anterior thigh. Buried catgut sutures tack the free margins of the flap to the adductor muscles of the thigh above, and into the femoral canal itself anteriorly in close proximity to the femoral vessels. The transfixing mattress sutures are then tied over small bolsters of tulle gras. By finally suturing the free margin of the anterior thigh skin to the posterior skin flap at the posterior limit of the shaved area (Fig. 2 e), the whole of the latter is buried and advanced without tension into the deep muscular compartment of the limb.

The raising of a long medial skin flap having its shaved anterior margin continuous with that in the thigh is extended to the full length of the lower leg (Fig. 2 f). The subjacent subcutaneous fat and deep fascia having been excised (Fig. 2 g), the shaved free margin of the flap is buried in close proximity to the posterior tibial vessels (Fig. 2 h); in the upper calf this involves detaching the medial fibres of origin of the soleus muscle from the lower part of the soleal line of the tibia before the free margin of the flap can be sutured to the muscular belly of flexor digitorum longus. Closure of the wound by interrupted sutures (Fig. 2 i) results in complete burying of the "shaved" surface of the flap.

The entire limb is then given a firm bulky compression dressing. Post-operatively, elevation of the limb is maintained until drains are removed on the fifth day; ambulation begins on the fourteenth day, with elastic-bandage support, later to be replaced by a permanent heavy-duty one-way stretch-elastic stocking. Maximum response to the operation does not occur for some months.

Operation to Lateral Aspect of Limb

The operation proceeds in principle as for the medial aspect of the limb and may with advantage precede it when the lower leg and dorsum of foot are chiefly involved, since the immediate reduction in bulk obtained is greater and the operation may more easily be extended to include the dorsum of the foot.

The incision (Fig. 4) is designed to lie $1\frac{1}{2}$ in. (3.8 cm.) postero-lateral to the line of the femoral vessels in the thigh, curve posteriorly to traverse the mid-lateral aspect of

FIG. 4.—Line of incision on lateral aspect of limb, in relation to superficial lymphatics. Direction of lymph flow is towards free margins of flap.

FIG. 3.—Line of incision on medial aspect of limb in relation to superficial lymphatics. Direction of lymph flow is towards free margins of flap.

the knee, and then descend the lower leg 1 in. (2.5 cm.) posterior to the line of the anterior tibial vessels, ending below and anterior to the lateral malleolus. Where the foot is affected it may be prolonged (Fig. 9 c) across the anterior aspect of the ankle-joint and along the medial border of the foot to raise a skin flap from the dorsum of the foot. The upper margin of the thigh skin flap is directed at an obtuse angle towards the gluteal fold and need not exceed one-third of the circumference. The superior and anterior margins of the skin flap are "shaved" of surface epidermis, the flap is raised as thinly as is feasible back to the mid-posterior axis of the limb, the underlying subcutaneous fat and deep fascia are excised, and the shaved free margins of the flap are advanced in the thigh beneath the lateral free border of sartorius to be sutured to the lateral muscular wall of the femoral canal alongside the femoral vessels, and in the lower leg into the intermuscular crevice between tibialis anterior medially and the extensores digitorum longus and hallucis longus laterally, in close proximity to the anterior tibial vessels. The musculo-cutaneous nerve is preserved.

Only patients who have exceeded one year's post-operative follow-up are reported.

Case 1

The patient, a woman of 45, developed in 1945 a secondary (obstructive) lymphoedema of the entire left leg, following a severe crush injury to the left lower abdomen and groin when trapped by a reversing lorry. The swelling persisted thereafter without pain or ulceration and progressively

FIG. 5.—Case 1. Obstructive lymphoedema of left leg. (a) Pre-operative: two years after first operation (to lateral aspect of limb). (b) Post-operative: just prior to second operation. (c) Post-operative: six months after second operation (to medial aspect of limb).

increased in size. In 1959 recurrent cellulitis became established in the lower leg, five severe attacks occurring, always at the same site, over a period of nine months. The chief complaint was of heaviness and clumsiness of the left leg, with great limitation of physical activity from the need to spend many hours a day with the limb raised.

On examination (Fig. 5 a) the left lower limb showed massive enlargement from groin to toes, with soft pitting oedema of the dorsum of foot and lower leg except over the middle third of the shin anteriorly, which was indurated and dusky red at the site of repeated cellulitic attacks. The limb was increased in circumference by 6 in. (15 cm.) at mid-thigh and 4 in. (10 cm.) at mid-calf, when compared with the right leg.

A deep-vein phlebogram showed no abnormality in the iliac and femoral vessels.

Treatment consisted of two operations, the first to the lateral and the second to the medial aspect of the limb.

First Operation.—On October 20, 1959, a long mid-lateral incision was made from the level of the greater trochanter

FIG. 6.—Case 1. Obstructive lymphoedema of left leg. (a) two years after first operation (to lateral limb) and just before second operation (to medial limb). There is improvement in lower leg, but complete relapse in thigh. (b) six months after second operation (to medial limb). Entire limb is improved, except at knee-level, where no tissue was excised and no "shaved" skin buried.

above to the lateral malleolus below. In this initial operation on the first patient treated, the operation differed from that described above in that the buried skin flap was reversed in direction, the skin surface being "shaved" anterior to the incision and the thinned anterior flap advanced posteriorly beneath the posterior deep fascia, to be sutured to the vastus lateralis and gastrocnemius muscles in the thigh and lower leg respectively.

Post-operative progress was uneventful except for a lateral popliteal-nerve palsy due to overfirm bandaging of the limb, which recovered completely. The lower leg was reduced in circumference by 1½ in. (3.8 cm.) and became much less oedematous; this improvement was maintained over a period of two years (Fig. 5 b). The thigh, however, though initially reduced by 3 in. (7.5 cm.), relapsed to its pre-operative dimensions within six months (Fig. 6 a), and the attacks of cellulitis, having vanished from the lower leg, then reappeared in the medial thigh within two months of operation, to recur with steadily increasing frequency and severity thereafter.

It seemed clear that the direction of lymph flow in the buried skin flap had not been taken into sufficient account. This flap having been buried in a posterior direction, those subcutaneous lymphatics of the lower leg normally draining along the line of the short saphenous vein into the popliteal lymph nodes were able to drain into the deep tissue; in the thigh, however, no such normal direction of flow was possible and the buried flap merely superimposed a further obstructive element on that already existing at a higher level. It seemed difficult to explain the relapse in size of the thigh, and the transfer of cellulitic attacks from below to above the knee, in any alternative fashion.

Second Operation.—On September 25, 1961, a full-length medial flap was raised in the formal manner described above (Fig. 2). The sole deviation in technique was that no excision of subcutaneous tissue or skin "shaving" was carried out at the level of the knee.

Post-operative progress was satisfactory when last seen, six months after the second operation (Figs. 5 c and 6 b). Attacks of cellulitis in the thigh ceased within a few weeks of the operation and have not recurred. The thigh circumference had become reduced by 5 in. (12.5 cm.) and the calf by a further 1 in. (2.5 cm.). Pitting oedema of the lower leg was minimal and altogether absent from the foot, which had not been included in either operation. The patient was restored to full normal physical activity, though continuing to wear a light elastic stocking.

Case 2

The patient, a man aged 42, was treated in 1941 for a seminoma of the left testis, receiving left orchidectomy with block dissection of the iliac and para-aortic lymph nodes followed by deep x-ray irradiation. In 1944 signs of secondary (obstructive) lymphoedema appeared in the form of swelling of the ankle, spreading progressively during the next three years to involve the whole lower leg, and thereafter remaining relatively unaltered. The chief complaint was of aching discomfort in the limb, which became severe towards the end of the day, resulting in increasing limitation of physical activity.

On examination the left leg presented an advanced degree of oedema from knee to ankle, moderate swelling of the thigh, but only slight involvement of the dorsum of the foot

(Fig. 7 a). Well-marked pitting was obtainable in the lower leg in most areas though slightly limited by early fibrosis, but was entirely absent at the sites of occasional plaques of subcutaneous fibrous tissue. The calf measurements were increased 7 in. (18 cm.) and the thigh 1½ in. (3.8 cm.), by comparison with the normal right leg.

On investigation a radiological lymphangiogram of the left leg disclosed the presence of dilated and very tortuous lymphatic vessels in the lower leg in normal numbers (Fig. 8), confirming the diagnosis of obstructive lymphoedema.

On September 9, 1960, a full-length lateral skin flap was raised from groin to ankle, and its "shaved" anterior border was buried into the femoral canal above and alongside the anterior tibial vessels below, exactly as described above.

Post-operative progress was uneventful, the patient walking within two weeks. When last seen, 18 months after operation, the left lower limb had decreased by 5 in. (12.5 cm.) at the calf but was unaltered in the thigh (Fig. 7 b). The hard fibrous subcutaneous plaques had disappeared from the lower leg and only slight oedema persisted. The patient had lost all aching discomfort in the limb, and was restored to normal physical activity. He continues to wear an elastic stocking, but in the circumstances has refused a further similar operation to the medial aspect of the limb as unnecessary.

FIG. 8.—Case 2. Lymphangiogram of lower left leg, showing marked obstructive lymphoedema.

FIG. 7.—Case 2. Obstructive lymphoedema of left leg. (a) Pre-operative. (b) Post-operative, 18 months after operation to lateral limb only.

Case 3

The patient, a man aged 52, presented with primary lymphoedema of the right lower leg, associated with varicose veins. In 1947 he developed swelling of both ankles, much more marked on the right, attributed to varicose veins and treated by venous ligation. In 1953 failure to maintain elastic support resulted in a sudden marked increase in size of the right lower leg and dorsum of foot, which persisted. In 1960 a brief attack of cellulitis occurred in the right lower leg. The chief complaint was of heaviness of the limb, with appreciable limitation of physical activity; the walking distance was limited to 1 mile (1.6 km.).

On examination (Fig. 9 a) the right lower limb showed a moderate degree of swelling extending from below the knee to the base of the toes and especially marked over the lower leg and dorsum of the foot. All superficial veins were very varicose. The oedema was soft and easily compressible. Circumferential measurements showed that the right leg was increased 4 in. (10 cm.) at mid-calf and 1 in. (2.5 cm.) over the dorsum of the foot, when compared with the left limb, which itself showed very slight pitting oedema over the shin.

On investigation deep-vein venography of the right leg disclosed no abnormality, but a radiographic lymphangiogram (Fig. 10) demonstrated a marked degree of hypoplasia of lymphatic vessels; these were very few in number, normal bifunction was absent, but valves were present.

On April 14, 1960, the varicose veins were stripped and the ankle perforating veins ligated, but five months after operation the swelling was not decreased in size.

On September 13, 1960, a lateral skin flap was raised (Fig. 9 c), limited to the lower leg and extending from the level of the tibial tuberosity to the ankle and then on to the dorsum of the foot; its anterior shaved margin was buried alongside the anterior tibial vessels in the leg, and below that level beneath the deep fascia of the medial border of the foot.

Post-operative progress was marked by a decrease in the amount of oedema present over a period of several months, and this improvement was maintained. One year after the operation the limb subjectively felt much lighter, and physical activity was greatly improved, the patient walking distances of 5 miles (8 km.) with ease. The calf was now only 1½ in. (3 cm.), and the foot ¼ in. (6 mm.) larger than the contralateral limb (Fig. 9 b); firm elastic support to the limb was still necessary to control residual oedema.

At a period of abnormal physical stress the pre-operative degree of swelling temporarily recurred, but it rapidly subsided to its former dimensions after a few days' rest and elevation. In the circumstances, however, a medial flap operation is planned to reinforce the improvement so far obtained.

Discussion

The natural history of lymphoedema of the limbs consists of a gradual but inexorable progress from the initial state of reversible pitting oedema, which is abolished by adequate elevation of the limb, through a phase of increasing subcutaneous fibrosis of the lymph-sodden tissues, to end in a brawny non-pitting oedema on which elevation has no effect.

The "physiological" operation described above can register its maximum effect best, in limbs of appreciable bulk in which the oedema is soft and compressible, by establishing drainage of that fluid element in the swollen limb which is capable of responding to elevation.

FIG. 9.—Case 3. Primary lymphoedema of right leg, associated with varicose veins. (a) Pre-operative. (b) Post-operative, one year after limited lateral skin-flap operation to lower leg and dorsum of foot. (c) Diagram showing line of incision in relation to subcutaneous lymphatics of a normal limb. It would have been better had the upper transverse incision just below knee level been replaced by the dotted extension up into the thigh. Such an extension would have avoided transection of the rare hypoplastic lymphatics ascending into the thigh on the lateral aspect of the knee.

Although in Case 2, reported above, areas of localized subcutaneous fibrosis resolved after a buried-flap operation, it must remain true that advanced subcutaneous fibrosis and superficial hyperkeratosis constitute strong indications for a purely excisional operation. Where subcutaneous fibrosis is present in limited amount it seems possible that a buried-flap operation may arrest progress of the condition, and diminish if not abolish attacks of cellulitis.

The procedure described has produced satisfactory results, over the observation period available, in the two cases of obstructive lymphoedema. After periods of two and a half and one and a half years respectively both have been restored to normal physical activity, with limb measurements not greatly increased over those of the unaffected limb. It is most probable, however, that in these two cases the superficial lymphatics are normal in number and distribution, and valved though incompetent from dilatation. It is conceivable that with the establishment of adequate internal lymph drainage these vessels may again become competent.

No such claim can yet be made in the case of primary lymphoedema. The response to operation in a patient with marked lymphatic hypoplasia (Case 3), though encouraging, has been less dramatic and complete than in the obstructive cases. The drainage of lymph obtained by the operation may prove to be dependent on the number and valvular competence of the subcutaneous lymphatic vessels present. Experience gained in the two operations on Case 1 clearly indicated that in cases of secondary (obstructive) lymphoedema the skin flaps should be buried in the direction of cutaneous lymph flow. Further experience may indicate that in cases of primary lymphoedema (and especially in the hyperplastic variety) the buried skin flaps may need to be increased in number or altered in direction, or both, in accordance with the number, distribution, and state of the existing subcutaneous lymphatic vessels as disclosed by lymphangiography.

The favourable response obtained in cases of obstructive lymphoedema of the lower limb has indicated the possible usefulness of the operation in cases of obstructive lymphoedema of the upper

FIG. 10.—Case 3. Lymphangiogram of lower right leg, showing marked hypoplasia of lymphatics.

limb following radical mastectomy: two such patients have been treated in this way with initial improvement, but too recently for inclusion in this report.

Summary

A new "physiological" operation for the treatment of chronic lymphoedema of the lower limb is reported which involves the transposition of subcutaneous lymphatics into the deep (subfascial) compartment of the limb by means of a buried "shaved" skin-flap. In this way the internal drainage of lymph from the lymphoedematous subcutaneous compartment into the deep lymphatics—or, more probably, the muscle venules—is attempted.

Three illustrative case reports are submitted after follow-up for periods of from one to two and a half years. Two patients with obstructive lymphoedema have yielded good results, with considerable reduction in size of the limb and restoration to normal activity. One patient with primary lymphoedema due to lymphatic hypoplasia has been improved.

The operation would appear to have its principal indication in the treatment of limbs presenting appreciable enlargement from readily pitting lymphoedema, in the presence of valved superficial lymphatics. There is evidence, however, that subcutaneous fibrosis may undergo resolution after the operation.

In the patient with obstructive lymphoedema first treated the clinical response to burying the "shaved" skin-flaps in varying directions at separate operations demonstrated the advisability of burying the flaps in the direction of superficial lymph flow. Further experience is necessary fully to assess the value of the method in treating cases of primary lymphoedema; particularly in the presence of the hyperplastic type of developmental abnormality, re-orientation of the flaps may prove necessary to drain the dilated and valveless subcutaneous lymphatic channels, often associated with dermal back-flow, demonstrable by radiographic lymphangiography.

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EFFECT OF DESFERRIOXAMINE AND D.T.P.A. IN IRON OVERLOAD

BY

R. M. BANNERMAN, D.M., M.R.C.P.
Medical Tutor

SHEILA T. CALLENDER, M.D., F.R.C.P.
Consultant Physician

AND

D. L. WILLIAMS, B.A.
Graduate Assistant

From the Nuffield Department of Clinical Medicine,
the Radcliffe Infirmary, Oxford

Accumulation of excess iron in the body is associated with such complications as cirrhosis of the liver, diabetes mellitus, and heart failure. Patients suffering from idiopathic haemochromatosis may be improved by repeated venesections, which remove the excess iron (Finch and Finch, 1955), but in patients with haemosiderosis following repeated transfusions for various types of refractory anaemia venesection is obviously not feasible, and such subjects—for example, children with thalassaemia major—may be kept alive by transfusion, only to die later from intractable cardiac failure associated with iron deposition in the heart muscle (Smith *et al.*, 1960).

The therapeutic use of chelating agents led to the hope that one might be found which would have a high specificity for iron. Although the earlier developed agents dimercaprol and ethylenediamine-tetra-acetate (E.D.T.A.) will both remove some iron from the body (Ohlsson *et al.*, 1953; Seven *et al.*, 1954) neither is quantitatively very effective. Diethylenetriamine-penta-acetate (D.T.P.A.), another substance related to E.D.T.A., has been shown to remove significant quantities of iron in iron-storage disease (Fahey *et al.*, 1961). Bickel *et al.* (1960) have described a different type