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THE DORSALIS PEDIS FLAP FOR LOWER LEG RECONSTRUCTION

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The dorsalis pedis pedicled island flap was used in 13 cases of soft tissue reconstruction of the distal third of the lower leg and heel. The intended purpose was achieved in 12 cases. Donor site morbidity was insignificant. The operative procedure is described with emphasis on the dissection of the flaps and the identification of important vessels. Meticulous donor site coverage is stressed. The indications for this flap procedure are outlined.

Key words: leg injuries; tibial fractures; wound and injuries; reconstructive surgery

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Soft tissue defects in the distal third of the lower leg have always constituted difficult reconstructive problems. In the past decade various new methods, which are better than the classic cross-leg flap, have emerged. Milestones in this development have been the definition, on an anatomical and a hemodynamic basis, of three different flap types:

1. the random/cutaneous flap,
2. the axial/arterial flap,
3. the myocutaneous flap

(McGregor & Morgan 1973, Daniel & Williams 1973, McCraw et al. 1977) (Figure 1A, B, D). Through this development a number of new donor sites for axial/arterial and myocutaneous flaps have been described. As a consequence, the use of the island flap principle (Figure 1C, E) for single stage reconstructions has been revived.

With the recognition of the dorsalis pedis flap (McCraw & Furlow 1975), which is a hybrid axial/arterial/myocutaneous flap (Robinson 1976), the island flap principle was made available for the treatment of defects in the distal part of the lower leg and heel region (Figure 3).

This paper illustrates the versatility of the dorsalis pedis island flap with emphasis on operative technique and evaluates the short-term donor site morbidity.

PATIENTS AND METHODS

Thirteen patients, 10 men and 3 women, were treated at the Department of Plastic Surgery, Rigshospitalet, in the period 1979–1981, with a *dorsalis pedis island flap*. The follow-up period was 3–20 months. The mean age was 42 years (range 30–65 years).

The indication for a pedicled flap was soft tissue defects unsuitable for split-skin grafting in the distal third of the lower leg or the heel region (Table 1). The duration of the ailments ranged from 1 month to 10 years. The cause of the skin defect was postoperative infection in 3 cases, complicated malleolar or tibial fractures in 7 cases and unstable scarring or hyperkeratosis in 3 cases.

Eight patients have been examined personally and 5 by an interviewing letter.

Preoperative assessment

Preoperatively the vascular status of the foot and leg has to be confirmed by careful physical examination or, if necessary, by arteriography. A non-palpable pulse in the posterior tibial artery and/or the dorsalis pedis artery has been considered as an indication for arteriog-

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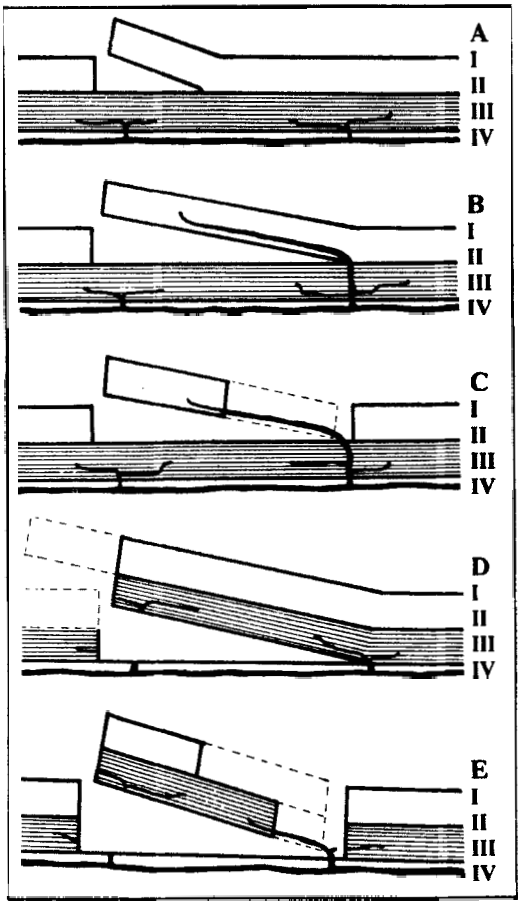

Figure 1. Schematic drawings of different flap types and the relations between skin (I), fascia (II), muscle (III), and segmental vessels (IV).*

A. Random cutaneous flap. The dermal plexus is supplied from musculo-cutaneous perforating vessels and/or other unspecified cutaneous arteries. (Surviving length: X)

B. Axial/arterial flap. The dermal plexus is supplied from a direct cutaneous (named) artery within the flap. (Surviving length: arterial pedicle + X)

C. Island flap. The dermal plexus of the flap is supplied from a direct cutaneous artery. The flap is connected to the body only by the (neuro-) vascular pedicle.

D. Myocutaneous flap. The dermal plexus is supplied from musculo-cutaneous perforating vessels. The muscle is supplied from a segmental vessel. (Surviving length: muscle pedicle (+ X?))

E. Myocutaneous island flap. The dermal plexus is supplied solely from the musculo-cutaneous perforating vessels. The flap is isolated on the dominant vascular pedicle of the muscle.

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Table 1. Dorsalis pedis island flap transfers

Pedicled island flap		13
Achilles region	1	
Lateral malleolus	2	
Medial malleolus	2	
Distal 1/3 lower leg	6	
Heel region	2	

raphy. Impaired or absent flow in the posterior tibial artery as visualized by arteriography has been considered as a contraindication for the dorsalis pedis island flap procedure on the ipsilateral foot.

Cadaver dissections of the donor region before undertaking clinical cases are recommended.

Operative procedure

The operation is performed in a bloodless field under general anesthesia.

The required flap is marked out on the dorsum of the foot as symmetrically as possible in relation to the course of the dorsalis pedis artery. The venous arcade should be incorporated in the flap, and the proximal border of the flap should be distal to the extensor retinaculum. In an average adult foot a flap measuring approximately 12 × 9 cm can be raised (Figure 2A, B).

The flap may be raised from whichever direction is preferred, but the critical part of the dissection is the identification of the dorsalis pedis artery, the first dorsal metatarsal artery and the plantar branch of the dorsalis pedis artery in the first interspace.

Usually, we do a medial approach carrying the dissection laterally in a plane just superficial to the periosteum and the tenosynovium of the extensor hallucis longus tendon. At the fibular margin of the tendon an incision parallel to the tendon is made down to the periosteum. The dissection is now kept close to the periosteum of the cuneiform bones until the dorsalis pedis vessels are identified in the flap tissue. At this point it is very easy to enter the wrong plane, superficial to the vessels, especially if the dissection is started from the fibular side. When the terminal branching pattern of the dorsalis pedis artery has been identified the ramus plantaris is divided between ligatures distally to the branching off of the first metatarsal artery.

Having completed this stage, the flap elevation is a matter of routine dissection. Care is taken not to expose bare tendon and to leave sufficient amounts of vascularized tissue to accept a split skin graft. The tendon of the extensor hallucis brevis is severed distally and proximally and may be left in the flap or extracted.

To increase the mobility of the flap the extensor retinaculum may be divided and the anterior tibial vessels dissected further proximally.

When raising the flap the superficial peroneal nerve supply may be incorporated in the flap or left intact to supply the fibular toes when not needed in the flap

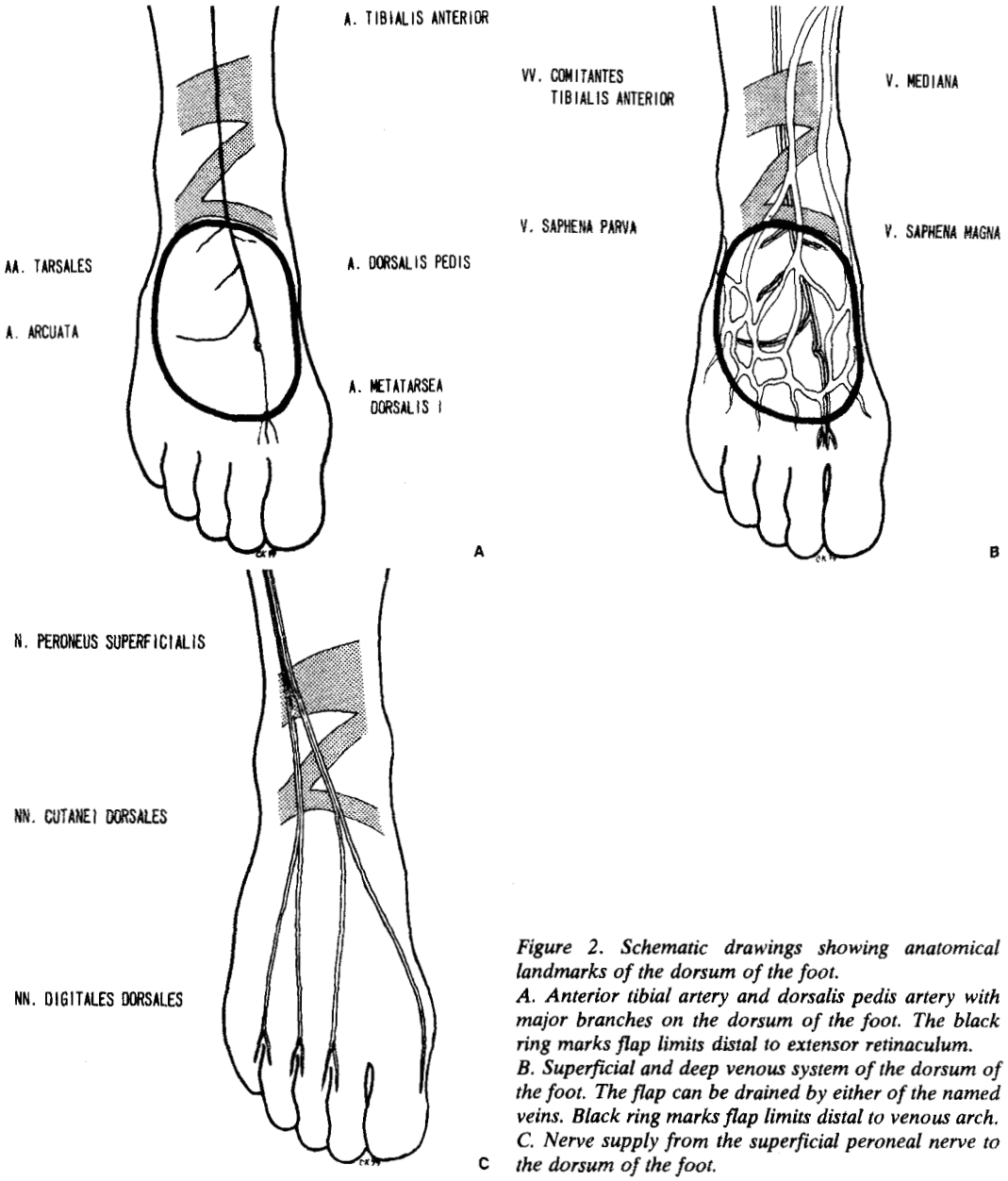

Figure 2. Schematic drawings showing anatomical landmarks of the dorsum of the foot.
A. Anterior tibial artery and dorsalis pedis artery with major branches on the dorsum of the foot. The black ring marks flap limits distal to extensor retinaculum.
B. Superficial and deep venous system of the dorsum of the foot. The flap can be drained by either of the named veins. Black ring marks flap limits distal to venous arch.
C. Nerve supply from the superficial peroneal nerve to the dorsum of the foot.

(Figure 2C). When severance is decided upon this should be done at a high level above the ankle joint to avoid possible disability from neuroma formation.

The deep peroneal nerve is severed at the distal border of the flap. The motor branch to the extensor brevis muscle may be preserved when preparing a long vascular pedicle using the anterior tibial vessels, but the deficit following severance of that nerve branch is negligible.

If the flap has to be transferred via a subcutaneous tunnel to cover the defect, it is of course important to avoid sharp bony ridges, i.e. margo anterior tibiae and margo lateralis fibulae, which have to be flattened. It is helpful to make the tunnel oversized with ample space for two fingers.

The extensor retinaculum is repaired to avoid bowstringing of the tendons. When closing the wound care

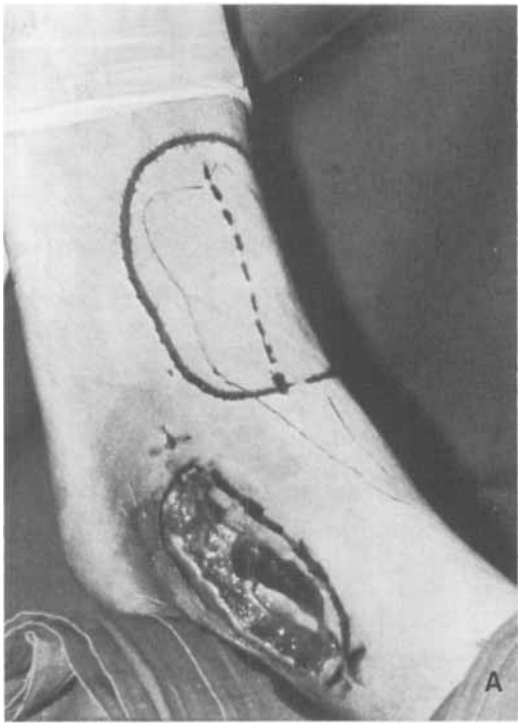

Figure 3. A. Defect of the lateral malleolar region due to postoperative wound-infection after osteosynthesis of a malleolar fracture. Dorsalis pedis flap marked out in relation to venous arch and palpable pulse.
B. The dorsalis pedis flap has been raised on its neurovascular pedicle and a superficial vein.
C. Healed flap and donor site 4 months later.

is taken not to compress or kink the vascular pedicle. If direct closure creates too much tension the defect should be covered with a split thickness skin graft. We usually insert a rubber drain below the flap and a subfascial suction drain in the leg wound.

The donor defect on the dorsum of the foot must be closed with great attention to details (Figure 4). After meticulous hemostasis the bared extensor hallucis longus tendon is covered by suture of the tenosynovium, possibly reinforced by the muscle belly of the extensor hallucis brevis in the proximal part of the defect. A medium thickness split-skin graft is applied unmeshed and sutured in place taking care to provide enough tissue for the depths of the first interspace. A slightly compressive bandage using vaseline gauze, wet cotton and dry gauze combined with a dorsal plaster slab, allowing inspection of the flap, is applied.

Postoperative care

The patient is confined to bed with the lower leg elevated until the dressings are changed, usually on the

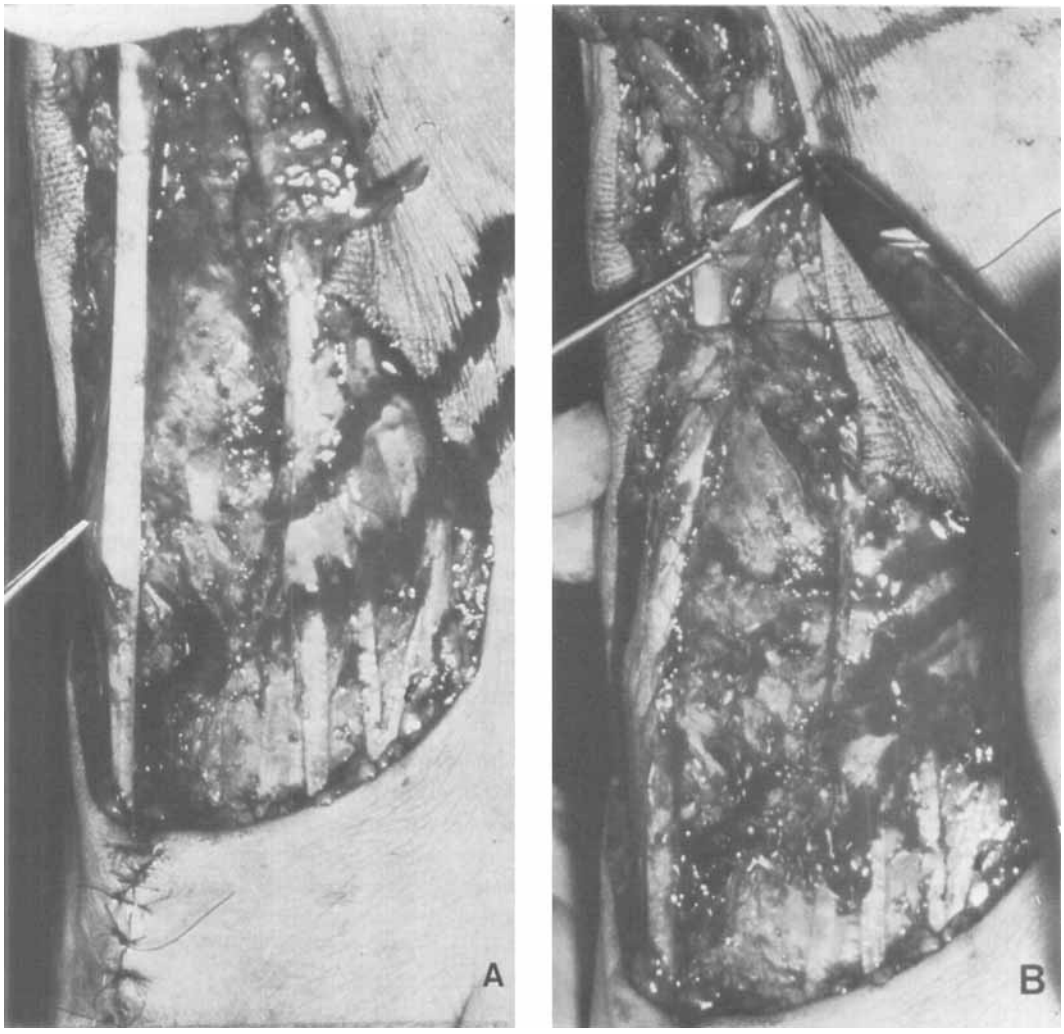

Figure 4. Donor site repair showing: (A) The bared extensor hallucis longus tendon and the possibility for suturing the paratenon tissue which has been completed (B) together with repair of the extensor retinaculum.

fourth day, from which time the grafted area is left exposed. The color, capillary refill, and turgor of the flap are checked regularly to detect possible vascular compromise. When the grafts have taken, the patients are allowed up in a chair with continued elevation of the leg for another week. The third postoperative week the patient is allowed up for increasing periods of time with reduced weight-bearing on the operated leg.

In uncomplicated cases, patients can be discharged after 3 weeks and are recommended to wear thick stockings in normal footwear. In cases of fractures or tendon ruptures the period of non-weight-bearing and hospitalization is regulated according to these injuries.

RESULTS

Flap survival (Table 2). Twelve out of thirteen pedicled island flaps survived, and the reconstructive purpose was fulfilled. One flap failed, probably following proximal vascular spasm with arterial thrombosis. Five flaps had minor marginal necroses that healed by secondary intention or after skin grafting. The mean healing time was 17 days (range 11–60 days). The mean stay in hospital was 30 days (range 16–65 days).

Table 2. Survival statistics for pedicled dorsalis pedis island flaps

Success	7
Partial success	5
Failure	1
Total	13

Table 3. Donor site morbidity following a dorsalis pedis island flap transfer

Ulceration	3
Pain	0
Dysesthesia	13
Need for special footwear	2
Clogs inapplicable	13

Donor site (Table 3). Eleven out of thirteen donor sites healed uneventfully. Two donor sites required secondary grafting procedures of small areas. In no cases did tendon necrosis or ostitis occur. As seen from Table 3, most patients use normal footwear. Three patients developed minor transient ulcerations along the extensor hallucis longus tendon when protection of the grafted area was neglected. These ulcerations healed when the pressure area was relieved.

DISCUSSION

Operative technique. Using careful preoperative planning and following the presented guidelines a dorsalis pedis island flap can be raised, transferred to the recipient site and its donor site repaired with a skin graft within 3 hours. Special circumstances, of course, may prolong the operation time. There is no room for slovenliness, neither in the flap dissection nor in the repair of the donor site. Delay as discussed by May (1977) has not been used in the present series, but none of the flaps have reached dimensions that would have warranted such a procedure. The first dorsal metatarsal artery was present in sizable dimensions in all the cases although it had a deep course in the interosseous muscles on a few occasions.

The vascular compromise of the single flap that failed could not be related to any technical error. Although never proved, it was believed that proximal spasm precipitating an arterial thrombosis was the cause of flap failure. This might be a parallel to the observations of Godina (1979), who found that proximal spasms following distal microvascular surgery played a role in free flap failures, especially when operating distal to zones of previous injury.

Flap characteristics. The dorsalis pedis flap is very thin and supple and usually fits in the recipient site very well without bulk. The flap conveys a permanent blood supply to the recipient area and when intended, a nerve supply that enhances the durability of the skin coverage. At times, this nerve supply is preserved *per occasionem* without any complaints from the patients. Whether or not to sacrifice the superficial peroneal nerve when it is not needed in the flap seems to be a matter of insignificant importance as long as the nerve is cut at a high level above the ankle.

Donor site. Is the dorsum of the foot an expendable donor site? Under special circumstances, this donor site would be ill advised. Patients with heavy outdoor work with the possible need for wearing clogs should not have the durable sensitive skin from the dorsum of their feet removed. Preferably another flap type should be used, possibly the best alternative being a free flap. However, in most cases patients do not have special needs. In the presented series only a few patients have had problems related to the donor site and the feared complications of tendon necrosis and possibly ostitis have been avoided.

Indications. We have found the dorsalis pedis island flap well suited for repair of soft tissue defects of moderate size in the *distal third* of the lower leg and heel region. We find the skin quality of this type of repair far superior to what has been achieved with combined muscle flaps and split-skin grafts. The dorsalis pedis island flap procedure is reliable and expedient, providing solid soft tissue repair usually within 3 to 4 weeks.

Defects in the proximal two-thirds of the lower leg can easily be reached by the dorsalis pedis

island flap as shown by Kamal et al. (1979) and it may be used for such defects when local flaps are unavailable or have not succeeded, as a simple and probably safer alternative to a free flap. In these cases the patients will benefit from sound surgical judgment, i.e. a combined evaluation of the risks of flap failure, donor site morbidity, cosmetic appearance and overall costs.

CONCLUSIONS

In a small series, the dorsalis pedis island flap was found to be versatile, reliable and expedient for repair of soft tissue defects in the distal third of the lower leg. Donor site morbidity was minimal.

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