British Journal of Plastic Surgery (1987), **40**, 230–235

Anterior tibial artery flap: anatomy and case report

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Summary—A simple, large fasciocutaneous flap based on the perforating branches of the proximal anterior tibial artery and venae comitantes can be raised which is particularly suitable as an inferiorly based island pedicle flap to cover cutaneous defects of the lower third of the lower leg, an area notoriously difficult to cover with local flaps. The flap has an extremely wide arc of rotation and can reach from the knee superiorly to the sole inferiorly. It can be transferred as a fascial flap or as a free flap. The secondary donor site defect overlies muscle bellies, lies well away from bone and readily accepts split skin grafts.

The need still exists for a simple reliable flap of appropriate thickness to cover the distal one-third of the lower leg, especially in such circumstances as acute compound wounds or chronic skin instability and ulceration.

This area remains the traditional province of the microsurgical free flap transfer because of the limitation of local flap tissue both from the standpoint of quantity and of circulatory reliability. However, free flap transfer to the lower leg, especially in post-traumatic circumstances, has significantly high failure rates.

An island flap with ideal attributes can be elevated on the anterior tibial artery and its venae comitantes and when based inferiorly can resurface the distal third of the lower leg. As it is taken from the proximal one-third of the leg lateral to the tibia and overlying the extensor and peroneal compartments, a large area of skin is available. The secondary defect overlies muscle bellies and readily accepts split skin grafts. The length of vessel pedicle when based inferiorly allows for an extremely wide arc of rotation to virtually any point of the lower leg, ankle, foot or even sole (Fig. 1). It is easy to raise and it has a reliable blood supply. It may be transferred as a free flap if desired. The fascia in this area is very thick and a fascial flap alone may be utilised to minimise the donor defect. Tibial bone grafts may also be raised as pedicled or free flaps on this same vascular system either alone or in combination with skin.

Anatomy

In a series of 13 fresh cadaver dissections, the flap was supplied by perforating vessels arising from the anterior tibial artery in its proximal one quarter. The longest and largest branch which was present in 11 out of 13 legs arises 2 to 4 cm below the origin of the anterior tibial artery after it perforates the interosseous membrane into the anterior compartment (Fig. 2). This large fasciocutaneous vessel, 1.5 mm or more in diameter, descends as it becomes superficial in the fascioseptal space between the peroneal and extensor muscle groups and comes to lie alongside the superficial peroneal nerve which it accompanies to approximately the mid point of the lower leg overlying the fibula. Muscle branches are given to the adjacent peroneus longus and extensor digitorum longus muscles immediately after its origin from the anterior tibial artery. The anterior tibial artery generally supplies the peroneal compartment by two pedicles, a superior and an inferior, and it is the superior pedicle which gives off the fasciocutaneous branch which comes to run with the superficial peroneal nerve.

The vessel accompanying the superficial peroneal nerve is referred to in the older anatomical literature as the *arteria nervi peronei superficialis* and instances are recorded of it arising from the peroneal artery and winding superficially around the fibula. However, this pattern was not seen in these dissections. Presumably fasciocutaneous branches of the anterior tibial artery would still be passing along the peroneal septum in such a case. Various degrees of development of this vessel have been described, but it is generally small and does not go beyond the mid lower leg. Breidenbach has studied its potential for supporting the superficial peroneal nerve as a free vascularised nerve graft (Breidenbach and Terzis 1984). This large fasciocutaneous branch of the anterior tibial artery usually remains on the

Fig. 1

Figure 1—Cadaver dissection of anterior tibial artery flap based inferiorly showing long flexible pedicle allowing a wide arc of rotation.

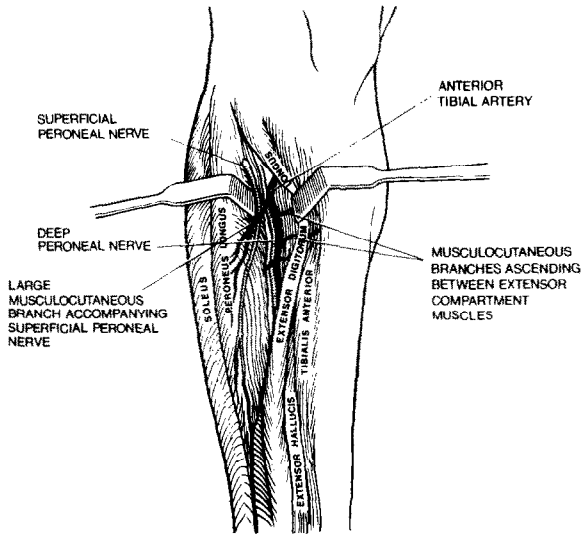

Fig. 2

Figure 2—Anatomy of anterior tibial artery flap.

tibial side of the superficial peroneal nerve, but in one case it passed deep to it to enter the skin on the fibular side. In this latter circumstance a flap based on the anterior tibial artery via this vessel cannot be pedicled distally until it is threaded underneath the superficial peroneal nerve in order to preserve the nerve. Other fasciocutaneous perforating branches arise from the anterior tibial artery in its upper third and emerge between the individual extensor muscles rather than between the extensor and peroneal compartments. These are variable in number and size, but will also usually be sufficient to supply a large flap and may be the dominant supply.

Indian ink injections studies into the anterior tibial artery from below, after proximal ligation at its point of perforation through the interosseus membrane, regularly stained an area of skin overlying the proximal antero-lateral aspect of the leg measuring at least 15 cm in length and 10 cm in width.

The anterior tibial artery proper lies deep on the interosseous membrane accompanying the deep peroneal nerve and is at least 5 cm distant from the skin flap. This long septal attachment effectively lengthens the pedicle of the flap beyond the length of the anterior tibial artery proper and increases the arc of rotation allowing the flap to reach the knee.

Dissection

The flap is outlined over the upper one third of the extensor muscle bellies with its vertical axis along the junction line between the extensor and peroneal muscle compartments. The size of the flap can be as long as the upper half of the lower leg and its width can extend from the anterior border of the tibia anteriorly to the midline posteriorly. The flap is incised circumferentially through skin and deep fascia to the muscle substance. A vertical incision extending downwards from the lower border of the flap along the line of junction between the extensor and peroneal compartments is made to expose the anterior tibial artery and venae comitantes inferiorly, accompanied by the deep peroneal nerve. These vessels lie deep on the interosseous membrane and are a considerable distance from the plane of the flap.

The posterior half of the flap is raised first in a subfascial manner from posterior to anterior until the anterior border of peroneus longus muscle is seen. Here the dissection passes deeply taking care to sweep all the peroneal muscle fascia anteriorly. Within this fascia will be seen the large fasciocutaneous branch of the anterior tibial artery. It is best identified first at the inferior limit of the flap where it is easily located in close association with the superficial peroneal nerve. This vessel must be retained in the septal sheet but the nerve can be easily separated as it lies lateral to the vessel and is left in the leg.

The whole flap is now raised keeping this vessel within it. Proximal muscle branches of the vessel require ligating before its origin from the anterior tibial artery proper is identified.

If any concern remains as to the vascularisation of the flap from this major vessel branch, then the other musculocutaneous perforators should be identified before the anterior half of the flap is elevated from the extensor muscles because these latter perforators ascend between the extensor muscles and not between the peroneal and extensor compartments. If both sets of perforators are felt necessary for viability then the origin of the extensor digitorum longus muscle may need division and distraction distally to allow both branches to remain attached to the anterior tibial artery proper. In other words, two fascioseptal sheaths will be required both leading down to the anterior tibial artery, the extensor digitorum longus muscle having to be filleted out from between them.

The anterior tibial artery is ligated above the origin of the fascio-cutaneous branches along with its venae comitantes and they are then freed from the accompanying deep peroneal nerve and muscles sufficiently to allow the flap to sit easily in its elected position. Care must be taken not to damage the proximal muscle branches of the deep peroneal nerve.

The secondary defect overlies well vascularised muscle bellies and readily accepts the split skin graft.

Case report

A 46-year-old male had sustained an injury to the right lateral malleolar region 15 years previously (Fig. 3). Despite periodic rest and split skin grafting it had not healed for periods longer than 3 months. Biopsy demonstrated this to be a histiocytoid haemangioma which is a tumour of low grade malignancy with little tendency to metastasise but which has a reputation for local recurrence. He had required daily dressings and bandaging for several years. All pulses were present in the leg and he was not diabetic.

The ulcer was excised widely including scarred deep

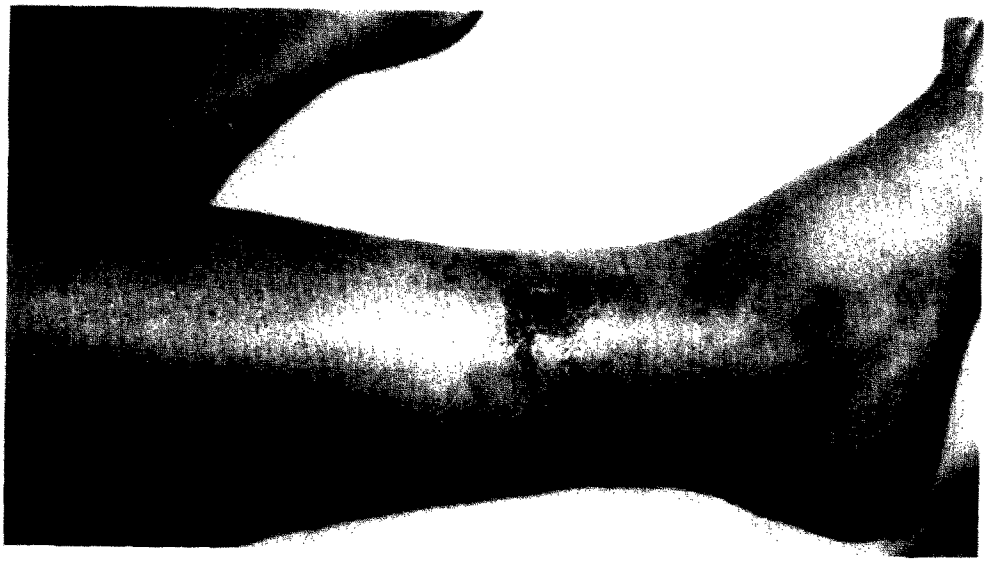

Fig. 3

Fig. 4

Fig. 5

Figure 3—Preoperative defect—histiocytoid haemangioma of 15 years' duration. Figure 4—Immediate postoperative resu
Figure 5—Twelve months postopcratively.

fascia exposing tendon and fibula bone. An anterior tibial artery flap, as previously described, was elevated and pedicled into the defect (Fig. 4). There was no suggestion of venous engorgement of the flap despite its retrograde drainage through the venae comitantes. A delayed open split skin graft was applied to the donor site.

The wounds healed uneventfully although the leg had persistent swelling for three months, which then settled completely. At 12 months postoperatively he has a well contoured healed ankle without evidence of breakdown (Fig. 5).

Discussion

For the management of defects of the lower third of the lower leg, superiorly based muscle (Ger, 1968; Pers and Medgyesi, 1973) and fasciocutaneous (Pontén, 1981(Barclay et al., 1982) flaps are appropriate for small defects only and complications are high (Neale *et al.*, 1983) while inferiorly based muscle flaps (Townsend, 1978) are also precarious. The dorsalis pedis island flap traced back to the anterior tibial artery (Kamal *et al.* 1979) is also limited in size and the secondary defect is prone to complications both immediate and long term.

The peroneal artery flap originally described in combination with the fibula by Chen and Yan in 1983 has been raised purely as a fasciocutaneous flap inferiorly based by Donski and Fogdestam (1983) and as an island or free flap by Yoshimura *et al.* (1984). This flap has many attributes for cover of the lower third of the lower leg without the need for microsurgical transfer. Skin thickness if appropriate, it is locally available and the secondary defect is most acceptable. However, as the greatest concentration of skin perforators from the peroneal artery arise from the middle or lower third of the lower leg the defect may encroach on this area limiting the amount of flap skin available. The circumference of the leg at this level is small even in an intact leg, so that only small flaps will be available unless perforators are found in the upper half of the lower leg. Furthermore the status of the peroneal artery cannot be evaluated clinically by palpation, unlike the anterior and posterior tibial vessels. This is particularly relevant when the flap is indicated for post-traumatic sequelae when the peroneal artery may have been injured. Also, access to the peroneal vessels is technically difficult in the presence of an intact fibular bone.

By contrast the anterior tibial artery flap offers a larger area of skin with a longer pedicle. The flap can reach from the knee superiorly to the tip of the toe inferiorly. It may also be used as a free flap. The secondary defect readily accepts split skin grafts with minimal contour disturbance.

On the negative side the flap does necessitate division and stripping of the proximal half of the anterior tibial artery and it would be contraindicated if either the anterior or posterior tibial arteries were not palpable at the ankle. When flap cover is required following traumatic loss, damage to one of these vessels is frequent and under such circumstances this flap cannot be used. The most suitable indications for its use would be following tumour resections around the distal one-third of the leg or ankle region.

If there has been a history of trauma in the upper third of the lower leg, the continuity of the anterior tibial artery in the region of origin of the perforating vessel may be in some doubt without angiography. However, in most circumstances forward flow palpable in the anterior tibial artery at the anterior ankle confirmed by simultaneous occlusion of the posterior tibial artery will mean a patent anterior tibial system.

Some devascularisation of the proximal bellies of the extensor muscles must occur although this appears well tolerated. Damage to the proximal motor nerve branches of the deep peroneal nerve must also be guarded against during flap dissection.

Retrograde venous drainage of flaps remains an anathema to plastic surgeons, but the adequacy of drainage of the radial artery and peroneal flaps have been well documented and likewise this clinical case showed no signs of embarrassment.

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First received 20th August 1985.
Revised 3rd June 1986.
Accepted 25th August 1986.

Editorial Note

The preceding paper by Morrison and Shen was first received on 20 August 1985, within 3 weeks of Dr Wee's paper (*British Journal of Plastic Surgery*, **39**, 327) which described a very similar, though not identical, flap. It was provisionally accepted but returned to the authors for minor revision on 7 October 1985. The revised version was received on 3 June 1986 and after further correspondence it was accepted on 25 August 1986.

The following paper by Torii *et al.* was also received before the publication of Wee's paper and describes a very similar flap to that of Morrison and Shen, without lengthening of the pedicle by division of the anterior tibial vessels. The Editor believes that it represents original and independent work and is therefore worthy of publication.