THE BLOOD SUPPLY OF THE OSTEOCUTANEOUS FREE FIBULAR GRAFT

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The use of an osteocutaneous free fibular graft as a single-stage reconstructive procedure for composite tissue loss is increasingly common. Detailed anatomical study in cadavers of the blood supply to the graft demonstrates cutaneous arteries arising from the peroneal artery and then passing along the posterior surface of the lateral intermuscular septum. These vessels pierce the crural fascia and then ramify to supply the skin. Knowledge of the vascular anatomy of the skin overlying the fibula is essential to the success of the graft.

Vascularised fibular grafts have proved more successful in the management of extensive bone loss from long bones than traditional methods of non-vascularised grafting (Taylor, Miller and Ham 1975). The fibula has the advantage of being a compact long bone and is suitable for early weight-bearing. The peroneal artery, which provides the nutrient vessels to the fibula, is of sufficient calibre to be used for microvascular anastomosis. A free fibular graft can be combined with a fasciocutaneous flap which is also supplied by the peroneal artery (Chen and Yan 1983; Harrison 1986). The incorporation of a skin flap allows treatment of cases with a simultaneous skin defect.

The blood supply to the skin consists of two main types of artery: first, those which are terminal branches of arteries supplying other tissues such as muscle; secondly, direct cutaneous arteries which pass between individual muscles, often along fascial planes, to reach the skin, as described by Manchot in the nineteenth century (Ristic and Morain 1983) and by Salmon (1936). It is the direct branches of the peroneal artery which must be included in the osteocutaneous fibular flap if the skin is to remain viable (Carriquiry, Costa and Vasconez 1985). These vessels were originally observed in studies of the communicating veins of the legs although their potential significance was not realised at that time (Linton 1938). It was recognised by Pontén (1981) that long skin flaps could be raised in the lower leg provided the deep fascia was included. The direct cutaneous vessels pierce the deep fascia and then ramify in the subcutaneous layer, establishing a surgical plane in the leg deep to the fascia (Haertsch 1981).

MATERIALS AND METHODS

This study was carried out on 16 fresh cadavers, aged 59 to 72 years (mean 63 years) and excluded all those with diabetes or evidence of peripheral vascular disease. The popliteal artery was exposed through a longitudinal posterior incision. It was cannulated and flushed at 100 to 150 mmHg with one litre of normal saline at 37°C for two to three hours. The origin of the peroneal artery was then tied proximally and cannulated. In eight cadavers 30 ml of 100% w/v barium sulphate and 10% gelatin at 37°C were injected and in the remaining eight cadavers 30 ml of indian ink were injected, both at a pressure of 100 to 150 mmHg. Radiographs were taken of the leg using Kodak Industrex C film. Exposures were made in the post-mortem room from a mobile unit at 150 mA and 50 kV for 1.0 second and the films processed by hand. In the ink-injected leg a flap of skin, approximately 10 × 15 cm, was raised on the lateral aspect of the leg, including the deep fascia. The lateral intermuscular septum was dissected free, the peroneal artery and its cutaneous branches identified and their position and size recorded.

FINDINGS

The peroneal artery arises from the posterior tibial artery approximately 2 to 3 cm below the lower border of the popliteus muscle, it passes towards the fibula and descends along its medial border, between tibialis posterior and flexor hallucis longus and divides into calcaneal branches which ramify on the lateral and posterior surfaces of the calcaneum. These vessels anastomose with the anterior and posterior tibial arteries.

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Fig. 1

Cadaver leg injected with indian ink to show perforating cutaneous vessels of the peroneal artery running along the posterior surface of the lateral intermuscular septum.

The peroneal artery supplies the nutrient vessels to the fibula which enter on the posteromedial surface of the bone. At approximately 2 to 5 cm intervals throughout its length septocutaneous vessels arise which pass laterally, sometimes through the edge of soleus, onto the posterior surface of the lateral intermuscular septum (Fig. 1). These vary in number, from four to eight, and have a diameter of 0.4 to 1.5 mm. They are accompanied by venae comitantes which provide a communication between the superficial and deep venous systems. The uppermost posterolateral vessel often originated from the posterior tibial artery in half of the cadavers studied; it corresponds to the circumflex fibular artery described in *Gray's Anatomy* (Warwick and Williams 1973). Having pierced the deep fascia of the leg, the vessels divide to form a plexus of vessels in the subcutaneous layer and supply the skin (Fig. 2). The region of skin supplied by the peroneal artery includes a consistent area on the posterolateral aspect of the leg (Fig. 3).

Fig. 2

Radiograph of a cadaver leg in which the peroneal artery has been injected with barium sulphate. The perforating vessels (thin arrow) can be seen running out to the skin from the peroneal artery (thick arrow); these must be included in the osteocutaneous fibular graft. Reflux of contrast into the anterior tibial artery can also be seen.

DISCUSSION

The skin flap should be designed with its long axis in the line of the fibula. The deep fascia of the leg must be included with the skin to preserve the plexus of vessels lying within the subcutaneous fat. These vessels may be damaged by excessive movement of skin upon fascia. The cutaneous vessels of the peroneal artery pass onto the posterior surface of the lateral intermuscular septum, either directly or through the edge of soleus. The vessels may pierce the lateral intermuscular septum and run for a short distance on its anterior surface. In order to preserve these vessels a strip of soleus should be contained within the fascial pedicle; it is unnecessary to include a great bulk of muscle between the skin flap and the fibula. The nutrient vessels of the fibula pass into the posteromedial surface of the bone and the cuff of muscle included in the fibular graft should always be thickest at this point (Fig. 4). At the origin of the peroneal artery a large

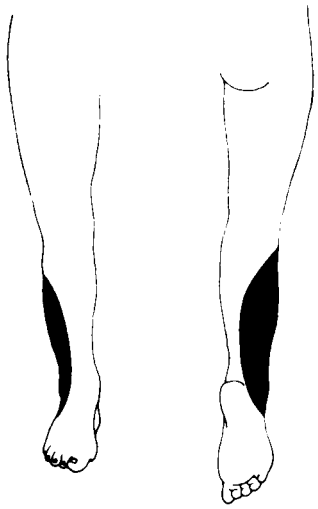

Fig. 3

Shaded area represents the cutaneous distribution of the peroneal artery.

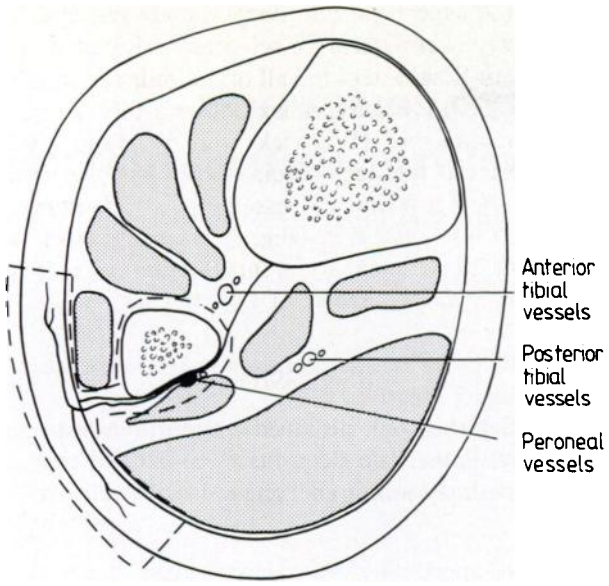

Fig. 4

Cross-section of the lower leg showing the cutaneous branches of the peroneal artery (the dotted line represents the limits of the osteocutaneous fibular graft).

cutaneous vessel arises, the circumflex peroneal artery. This may branch from the posterior tibial artery and be impossible to include in the flap.

It is hoped that this study clarifies the surgical anatomy of the osteocutaneous fibular graft and will encourage its use as a single-stage reconstruction procedure in the management of extensive bone and soft-tissue loss. The use of a skin flap has the additional advantage of allowing monitoring of the circulation to the composite graft.

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