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Strategies for Free Flap Transfer and Revascularisation with Long-term Outcome in the Treatment of Large Diabetic Foot Lesions

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WHAT THIS PAPER ADDS

A major proportion of large chronic tissue defects in the foot treated with free flap transfer are of diabetic origin with either neuro-ischaemic or predominantly neuropathic aetiology. Revascularisation in conjunction with free flap transfer may be necessary. This paper describes for the first time, the strategies for free flap transfer in both neuro-ischaemic and predominantly neuropathic large diabetic foot defects, as well as the long-term outcome in different treatment groups.

Objective/Background: To analyse the impact of ischaemia and revascularisation strategies on the long-term outcome of patients undergoing free flap transfer (FFT) for large diabetic foot lesions penetrating to the tendon, bone, or joint.
Methods: Foot lesions of 63 patients with diabetes (median age 56 years; 70% male) were covered with a FTT in 1991—2003. Three groups were formed and followed until 2009: patients with a native in line artery to the ulcer area ($n = 19$; group A), patients with correctable ischaemia requiring vascular bypass ($n = 32$; group B), and patients with uncorrectable ischaemia lacking a recipient vessel in the ulcer area ($n = 12$; group C).
Results: The respective 1, 5, and 10 year amputation free survival rates were 90%, 79%, and 63% in group A; 66%, 25%, and 18% in group B; and 50%, 42%, and 17%, in group C. The respective 1, 5, and 10 year leg salvage rates were 94%, 94%, and 87% in group A; 71%, 65%, and 65% in group B; and 50%, 50%, and 50% in group C. In 1 year, 43%, 45%, and 18% of the patients in groups A, B, and C, respectively, achieved stable epithelisation for at least 6 months. The overall amputation rate was associated with smoking (relative risk [RR] 3.09, 95% confidence interval [CI] 1.8—5.3), heel ulceration (RR 2.25, 95% CI 1.1—4.7), nephropathy (RR 2.24, 95% CI 1.04—4.82), and an ulcer diameter of >10 cm (RR 2.08, 95% CI 1.03—4.48).
Conclusion: Despite diabetic comorbidities, complicated foot defects may be covered by means of an FFT with excellent long-term amputation free survival, provided that a patent native artery feeds the ulcer area. Ischaemic limbs may also be salvaged with combined FFT and vascular reconstruction in non-smokers and in the absence of very extensive heel ulcers. Occasionally, amputation is avoidable with FFT, even without the possibility of direct revascularisation.

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INTRODUCTION

The influence of chronic ischaemia on outcome after free flap transfer (FFT) in large diabetic foot lesions is a largely un-investigated issue.[1] In general, neuro-ischaemic diabetic foot lesions fare much worse than the purely neuropathic ones.[2,3] In the absence of peripheral arterial disease (PAD), the free flap may be anastomosed to local vessels; however, when the local arterial circulation is insufficient, a preliminary vascular bypass for inflow is necessary. Previous series have mostly involved patients with combined FFT and vascular bypass in mixed series with diabetic and non-diabetic patients. Series including only patients with diabetes are available but a comparison of outcomes in patients with and without vascular reconstruction has not been performed.[1,4]

Therefore, this study analysed the long-term outcome of FFT in patients with diabetes with large chronic foot defects in three patient groups. Group A had predominantly neuropathic lesions with an in line native artery to the ulcer

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area; group B had lesions with critical ischaemia treated with vascular bypass; and group C had lesions with uncorrectable critical ischaemia.

MATERIALS AND METHODS

Between 1991 and 2003, large tissue defects of the foot were debrided and covered with FFT in 63 patients with diabetes. According to the University of Texas wound classification system, 57 were 3A—D and six were 2A—D lesions.[5] The ulcer diameter exceeded 10 cm in 44% of the patients, whereas the smallest area was 5 × 3 cm. In most patients, the ulcer extended to two or more angiosome regions.[6] The patients had undergone multiple revisions and many unsuccessful attempts at covering the tissue defect with skin grafting or local flaps in the past. Without proper wound excision and FFT, all patients would have faced major amputation.

Free flap surgery was considered if the tarsal bones and the body of the calcaneus could be saved, taking into account the general condition of the patient. The ability to walk or move a wheelchair independently had to be retained, and life expectancy had to be reasonable. The decision tree used is available in a previously published article.[7] A multidisciplinary team, consisting of a plastic and a vascular surgeon, specialists in internal medicine and in infectious diseases, and an anaesthesiologist, evaluated each candidate for FFT. An infection unresponsive to antibiotics and debridement, as well as a progressive gangrene of the foot despite revisions after proper revascularisation, were beyond the reach of even this kind of treatment.

A stressful peri-operative period and recovery time necessitated careful pre-operative evaluation of the general condition and cooperation of the patient. Uraemia was mostly considered as a contraindication. Two uraemic patients were operated on in 1995 and 1997. Suitability for general anaesthesia, prolonged operation time, and major bleeding were weighed carefully.

Procedure

The ulcers were first excised, along with all diseased bone, creating a fresh wound bed. The free flap was selected on the basis of the size, depth, and location of the defect. Furthermore, comorbidities related to flap raising and potential atherosclerosis in the flap vessels were evaluated. The 38 latissimus dorsi (LD), 11 rectus abdominis (RA), and eight forearm flaps (FA) were the most frequently used. LD and RA flaps were mainly covered with skin grafting, whereas FA flaps were fascio-cutaneous. The serratus muscle was used twice, and the gracilis, adductor, vastus lateralis, and parascapularis flaps once each, using a surgical technique described previously.[8]

With vascular reconstruction, an in line arterial supply to the foot or ankle according to the ulcer location was created whenever possible. Of the 48 concomitant vascular reconstructions, 36 were performed simultaneously with the FFT. In staged operations, the FFT was performed if the ulcer showed no healing within 1—8 weeks, and in one case 1 year after the vascular reconstruction.

In vascular bypass operations, heparin was infused perioperatively before clamping the artery. In separate flap transfer operations with microvascular anastomosis only, no intravenous heparin was given. Post-operatively, low molecular weight heparin was administered in the surgical unit. Acetylsalicylic acid with daily dosage of 100 mg was introduced permanently except in patients on warfarin.

Design

The patients were divided retrospectively into three groups according to the presence and severity of PAD, based on the findings at angiography and at operation (Fig. 1). This division was congruent with available non-invasive measurements (Table 1). All patients, except five in group A, underwent a conventional pre-operative angiogram or digital subtraction angiogram. In these five patients the microvascular anastomosis was performed to a pedal vessel with a palpable pulse.

In group A ($n = 19$), a patent native arterial line supplied the ulcer area. Patients were included in group A if the anterior tibial (ATA) or the posterior tibial artery (PTA) continued below malleolar level, supplying arterial circulation to the ulcer area in the foot, or if the ATA, PTA, or fibular artery reached the malleolar level and fed the ulcer area in the ankle and Achilles tendon region. These large lesions covered several angiosomes, and the angiosome concept as such could therefore not be used.

A local native artery served as the inflow vessel in 14 of 19 patients in group A. The remaining five patients had patent but calcified leg arteries, not suitable for microvascular anastomosis, and an end to end anastomosis was performed between an inflow conduit and the flap artery. The toe pressures in four of these five legs were 78, 64, 55 and 34 mmHg, respectively; in one patient, toe pressure measurements were not available. In the latter two patients, however, an arterial line was patent down to the foot on angiography. Three patients in group A underwent a preceding percutaneous transluminal angioplasty of a short stenosis in the superficial femoral artery or crural vessels. Their toe pressure values were between 56 and 69 mmHg before the angioplasties, which were performed to achieve the best possible circulation prior to major surgery.

Patients in group B ($n = 32$) had correctable ischaemia. All patients underwent bypass of an occluded arterial line to an outflow vessel reaching the foot. The flap inflow was taken either end to side from the vascular graft ($n = 28$) or from a native outflow artery ($n = 4$).

Twenty-one patients had a simultaneous FFT and vascular reconstruction, whereas 11 had a staged operation. The simultaneous operation was done when the tissue defect already necessitated FFT pre-operatively. If the nearby tissues or skin grafting were not sufficient to cover the tissue defect, the staged operation was performed after a vascular reconstruction and subsequent revisions.