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A 15-Year Experience with Combined Vascular Reconstruction and Free Flap Transfer for Limb-Salvage☆

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Abstract *Objectives:* To evaluate the results and complications of combined simultaneous arterial re-vascularisation and free flap transfer in patients with critical limb ischaemia and large soft-tissue defects that would otherwise have required major amputation.
Design: Retrospective analysis of all combined procedures performed between 1993 and 2007 with regard to complications and outcome.
Materials and methods: Seventy-eight procedures were performed in 76 patients with a mean age of 60 years (range: 18–80 years). The majority had diabetes (70.5%). Follow-up was obtained from hospital charts and telephone contacts with patients or GPs.
Results: The limb-salvage rate was 93% after 1 year, 80% after 3 years and 71% after 5 years. Perioperative complications occurred in 50% of the patients; six out of 78 (7.7%) arterial reconstructions and 13 out of 78 (16.7%) flaps had to be revised during the early postoperative period. However, most flaps could be saved by a secondary procedure resulting in an early failure (amputation) rate of 6%.

In-hospital mortality was 3.8%. End-stage renal disease was the only factor predicting limb loss. In total, 65% of the patients survived and were able to walk on their reconstructed limb at 1-year follow-up. Combined survival and limb-salvage rates were 85%, 66% and 51% after 1, 3 and 5 years.
Conclusions: Combined arterial re-vascularisation and free flap transfer can be performed safely with acceptable morbidity and mortality and should be considered for every mobile patient with large soft-tissue deficit (>10 cm^2) without end-stage renal disease prior to major amputation.

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Introduction

The increasing prevalence of diabetes and continuing tobacco consumption still lead to a rise in the number of patients with critical limb ischaemia and large soft-tissue defects. Despite the increasing possibilities of distal (endovascular) re-vascularisation and new wound-healing techniques, wound healing and limb salvage can often not be obtained when bones and/or tendons are exposed (TASC II).[1] Major amputation, although sometimes unavoidable, seldom leads to independent ambulation, is more expensive than a successful re-vascularisation and negatively influences life expectancy.[2] Combined lower limb re-vascularisation and free-tissue transfer to cover a large and deep defect immediately provides adequate blood supply and coverage of the wound with living tissue, leading to expedient healing and full-length limb salvage.

Despite this technique being first described more than 20 years ago, it has not obtained widespread acceptance, probably due to the presumed technical difficulties of the procedure and the fear for morbidities or complications.

Therefore, we retrospectively evaluated our 15 years of experience with special interest for the results with regard to limb salvage, ambulation and the risks and complications of the procedure.

Material and Methods

Patient selection

All the records of simultaneous combined re-vascularisation and free-tissue transfer procedures (76 consecutive patients with a total of 78 combined procedures) performed between 1993 and 2007 were reviewed. This combined procedure was the last attempt to avoid a major below- or above-knee amputation, consequently patients excluded for co-morbidities or unreconstructable ischaemia were generally amputated. All patients had a large soft-tissue deficit (exposed bone and/or tendon) (Rutherford grade 6) and most were referred to our centre as lost case for limb salvage. Only patients capable of regaining functional ambulatory status were considered for operation. The follow-up lasted till April 2007, till major amputation or death.

Procedure

All patients had a preoperative angiography to determine the extent of the arterial disease and to choose the appropriate inflow and outflow vessel for the bypass graft.

Whenever possible, we preferred a simultaneous intervention to a staged procedure. Advantages of a simultaneous re-vascularisation and tissue transfer are that it is easier to connect the free flap to the arterial bypass and dissect the concomitant veins when no scar tissue is formed yet, it shortens the operation time (the flap was prepared by the plastic surgeons while vascular surgeons performed the bypass graft) and the outflow of the arterial re-vascularisation is enhanced by the free muscle flap transfer. When not too extensive, we even prefer to combine the debridement with the actual procedure to avoid further dissection of the debrided tissue.

The ipsilateral greater saphenous vein was preferred for distal re-vascularisations in an *in-situ* or in a non-reversed *non-in-situ* fashion; if unavailable, a reversed contralateral saphenous vein was used. When no ipsi- or contralateral saphenous vein was available, a cryopreserved homologous saphenous vein was favoured because of its length and resistance to infection (most patients had osteomyelitis at the defect). Heparin (100 IU kg^{-1}) was administered 2 min before anastomosis of the bypass graft. In 64% of the patients, a minor debridement or amputation was needed for osteomyelitis or gangrene before flap insertion.

Typically, a side-to-side anastomosis was performed on the distal pedal vessel leaving one end of the saphenous vein for an end-to-end anastomosis with the flap artery. In other cases, the re-vascularised tibial artery closest to the defect was used as inflow source for the free flap. The nearest concomitant tibial vein served as an outflow for the flap through an end-to-end anastomosis. If no deep vein was accessible, we anastomosed to a neighbouring superficial vein (six patients) or a mobilised lesser saphenous vein (six patients). At first we preferred the rectus abdominis muscle flap as a donor but due to donor-site wound-healing complications, gastroparesis and the fact that the inferior epigastric artery was frequently affected by atherosclerosis, we now favour the anterolateral thigh flap (ALT). According to our excellent results in reconstructive breast surgery, we recently switched to the use of perforator flaps, leaving the muscle in place and just transferring fat and skin tissue with its pedicle; This results in less postoperative pain and fewer wound-healing problems. The muscular flaps were fixed and covered with split-thickness skin grafts (Figs. 1—3).

Postoperative meticulous monitoring of the arterial graft and free muscle flap was achieved by hourly Doppler examination and temperature control. All patients were treated on an air-fluidised bed to prevent decubitus ulcers or pressure on the flap. As soon as the wound healed, a slightly compressive elastic stocking was applied for about 6 months to remodel the transferred muscle. Ambulation started in the third postoperative week. The median hospital stay was 48.3 days (range: 14—113 days). Some hospital stays were extended for social back-up problems. Patients were followed with serial duplex scanning of the arterial reconstruction and inspection of the free flap.

At present standard postoperative medication consists of daily low-dose aspirin and 72 h intravenous heparin followed by low-molecular-weight heparin (LMWH) in a prophylactic dose till ambulation, combined with clopidogrel or coumarins according to their co-morbidity. The patients were followed with serial duplex scanning of the arterial and flap reconstruction at 1 month, 3, 6, 12 months and then annually. Long-term follow-up was assessed through postoperative visits or telephone calls to treating physicians. Successful ambulatory function was defined as the ability of the patient to walk alone or with a cane or walker. Patients requiring a wheelchair for mobility or using their leg only for pivot functions were considered as non-ambulatory.