Reconstruction of the Achilles tendon region by free microvascular flaps.

9 cases followed for 1–9 years

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In 1981–89, 9 patients underwent reconstruction for complex injuries in the Achilles tendon region. 10 free microvascular flaps were used: 5 fasciocutaneous and 5 muscle or musculocutaneous flaps. In addition, 4 Achilles tendons and 1 tibial posterior nerve were reconstructed, 1 femoropopliteal bypass was performed, and 6 tibial fractures were treated. The patients were re-examined on an average 3.5 years after the reconstruction. The stability of soft tissues was good in all patients. Good contour was achieved in superficial defects with fasciocutaneous and in deep injuries with latissimus dorsi free flaps. The calcaneal tendon function was good in 5, fair in 2 and poor in 2 patients, depending on the severity of the underlying skeletal injury.

We conclude that free microvascular transfer offers one-stage reconstruction of complex, infected wounds in the Achilles tendon region, promotes fracture healing, and allows simultaneous tendon or nerve repair.

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The treatment of soft tissue defects in the Achilles tendon region is difficult, especially when they are associated with compound fractures or tendon defects. The minimal availability of local tissues together with poor blood circulation often hinders the use of local flaps, even in relatively small defects (Serafin et al. 1980, Koman 1986, Hentz and Pearl 1987). The reconstructive requirements include stable soft-tissue coverage on a functional calcaneal tendon, and a good contour for acceptable footwear and for esthetic reasons. Large, complex wounds can be reconstructed at one stage with a variety of free microvascular flaps combined with the necessary procedures for bones, tendons, vessels and nerves (Serafin and Voci 1983, Lidman et al. 1987, Wei et al. 1988, Waris et al. 1991). We report the long-term functional and esthetic results of microvascular reconstructions in the Achilles tendon region in 9 patients.

Patients and methods

In 1981–1989 we performed 10 free flap transfers in 9 patients with defects in the Achilles tendon region. All the patients were men aged 38 (18–62) years (Table 1). The etiology of the wounds was as follows: postoperative complications in 3 patients (repair of calcaneal tendon ruptures in 2 athletes and osteomyelitis after plating of a tibial fracture in one); 3 patients had severe comminuted compound fractures with soft tissue loss sustained at work (1 calcaneal and 2 distal tibial fractures); 2 patients had shotgun injuries in the Achilles tendon region; and 1 had a chronic ulcer due to poorly healed soft tissues after a comminuted compound tibial fracture, complicated by atherosclerotic disease. Each patient had a complex, infected wound which included the Achilles tendon. In addition, 6 patients had bone injuries and 3 had nerve injuries. The size of the soft tissue defect was 70 (9–200) cm^2. The patients had been operated on a total of 22 times before the microvascular reconstruction. The free flap reconstruction was performed within the first 2 months of the injury in 6 patients and from 7 months to 56 years in 3 patients.

The free flaps were selected according to the defect of each patient (Table 1). The calcaneal tendon was simultaneously repaired in 4 patients, partially removed in 3, and was totally removed or missing in 2. The tendon of 4 patients was repaired with Lindholm plasty in 2 cases, with a free fascia-lata graft in 1 (Figure 1), and with the tendinous origin of the latissimus dorsi flap in 1. The tibialis posterior nerve was reconstructed with sural nerve grafts in 1 patient (Figure 2). One patient had neurolysis. Open reduction and external fixation were performed in 3 patients (Figure 3), and in 3 others bone revision and sequesterectomy were performed. A 63-year-old patient with atheros-

Table 1. Microsurgical free-flap reconstructions of the Achilles tendon region

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	20	1	30	2	1	0	67 d	2	1,6	1	1	5	0	2										
							227 d		2	2	2	5	0	0	1	43	1	3	1	1	1	1	1	6,5
2	36	2	48	3	2	0	3 y	10	4	1	2	4	0	0	0	75	1	1	1	1	1	1	2	12
3	50	4	200	1	1	1	28 d	2	4	1	3	5	1	2	2	111	1	3	3	3	2	2	3	R
4	18	7	112	1,2	1	0	11 d	1	3	1	2	1	0	0	0	27	1	2	1	2	1	1	1	3
5	32	1	144	1	1	0	16 d	2	4	1	3	5	0	3	0	27	1	4	3	3	2	2	4	4
6	62	5,6	25	1,4	2	2	56 y	12	2	2	2	4	3	0	0	9	1	5	2	1	1	1	R	R
7	54	3	15	0	1	0	59 d	2	1	1	0	1	0	3	1,1	26	1	1	1	1	1	1	5	3,5
8	47	3	9	0	1	0	67 d	1	5	3	0	2	0	0	0	35	1	1	1	1	1	1	6	3
9	42	7	60	1,2	1	1	267 d	2	3	1	3	3	2	0	0	28	1	5	2	2	1	1	6	4

A Case
B Age
C Etiology
- 1 farming accident
- 2 postoperative (fall)
- 3 postoperative (sports)
- 4 industrial accident
- 5 railroad accident
- 6 atherosclerosis
- 7 gunshot

D Defect area (cm^2)
E Bone injury
- 0 none
- 1 comminuted tibial fracture
- 2 comminuted calcaneal fr.
- 3 closed tibial fr.
- 4 osteomyelitis

F Achilles tendon injury
- 1 total
- 2 partial

G Nerve injury
- 1 tibialis posterior
- 2 suralis

H Days/years before reconstruction
I No. of procedures before free-flap
J Free-flap
- 1 scapular
- 2 radial
- 3 latissimus dorsi muscle
- 4 lat. dorsi muscolocutaneous
- 5 fibular
- 6 flap loss

K Recipient vessels
- 1 tibialis posterior
- 2 tibialis anterior
- 3 fibularis

L Bone procedures
- 0 none
- 1 screw fixation
- 2 revision
- 3 external fixation

M Achilles tendon repair
- 1 proximal fascia flaps
- 2 fascia lata grafts
- 3 ld tendon
- 4 revision, no repair
- 5 tendon missing, no repair

N Other additional
- 0 none
- 1 tibialis posterior nerve reconstruction
- 2 tibialis posterior neurolysis
- 3 femoropopliteal by-pass

O Number of early reoperations
P Later corrections
- 1 flap reduction
- 2 talocrural arthrodesis

Q Follow-up (months)
R Stability of the flap
- 1 good, no breakdwons
- 2 good
- 3 fair
- 4 poor
- 5 restricted due to other injuries

S Walking ability[a]
- 1 excellent
- 2 good
- 3 fair
- 4 poor

T Ankle motion[a]
- 1 good
- 2 fair
- 3 pair

U Ankle flexion strength[a]
- 1 good
- 2 fair
- 3 no ankle movements

V Contour[a]
- 1 good
- 2 poor

W Footwear
- 1 normal
- 2 special

X Occupation
- 1 student
- 2 painter
- 3 storeman
- 4 farmer
- 5 teacher
- 6 manager
- R retiered

Y Sick-leave after recon. (months)
- R retired

[a]see Patients and methods

Figure 1. Case 8. A 47-year-old athlete had a wound infection after an attempted Achilles tendon reconstruction.

Wound infection with necrotic Achilles tendon after an attempted tendon reconstruction.

Reconstruction with a fascia lata tendon graft and a microvascular fasciocutaneous fibular flap from the same leg.

The patient has taken up running again.

Figure 2. Case 4. An 18-year-old man with a shotgun injury in the calcaneal region.

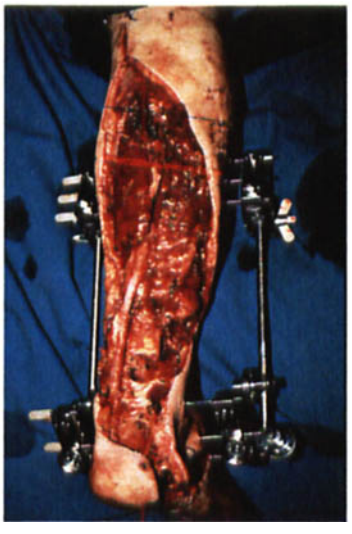
The injury.

The Achilles tendon was reconstructed with gastrocnemius aponeurosis flaps, and the tibialis posterior nerve with sural nerve grafts (arrow) from the other leg.

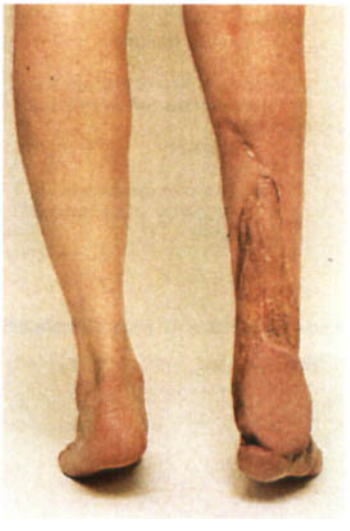
Soft tissue coverage was achieved with a latissimus dorsi musle flap with split skin grafts. The patient is able to walk without a limp for up to 3 km and to run briefly.

Figure 3. Case 5. A 32-year-old farmer with a severe crush injury from farm machinery.

A large complex wound with intra-articular comminuted fracture.



The defect after reduction and revision.



The fracture before and after healing. The patient is able to walk for 500 m with custom-made shoes.

clerotic disease required a femoropopliteal bypass reconstruction with a vein graft in the same stage. His Achilles-tendon region was reconstructed with a radial forearm flap; the flap carried a 12-cm pedicle, which was elongated with a 5-cm vein graft. In this patient the arterial supply of the flap was reconstructed from the groin to the calcaneus.

One scapular flap was lost because of arterial thrombosis, but the patient's ankle was later successfully reconstructed with a radial forearm flap. Another scapular flap developed venous thrombosis, but was saved by venous reanastamosing. 3 flaps needed minor revisions of the wound edges in the immediate postoperative period. The postoperative course of 6 flaps was

uneventful. Late procedures have been carried out for 3 patients in whom the scapular flap and 1 radial forearm flap needed contour revisions. The ankle joint was fused in 1 patient as soon as the primary wound had healed.

The mean follow-up time after the microvascular reconstruction was 3.5 years (9 months–9 years). The patients were examined and questioned about their mobility, the durability of their flaps and their footwear. The stability of the flap was classified as good if there were no soft tissue breakdowns. Walking ability was rated as follows: excellent (walking distance unlimited, able to run), good (walking distance 1–3 km, able to run briefly), fair (500–1000 m, obvious limp) or poor (less than 500 m, may need crutches). Active motion of the ankle joint was measured in degrees. The range of motion was considered good (> 50°), fair (15°–50°) or poor (< 15°). The strength in plantar flexion of the ankle joint was measured on a spring scale while the patient was standing. The value was given as the percentage of the strength the patient needed to rise on tiptoe with the reconstructed foot. If the patient could rise on tiptoe the value was 100 percent (good), 20–100 percent (fair) and < 20 percent (poor). The contour of a flap was rated as good if the patient could wear normal or one size larger than normal footwear, or if the circumference of the ankle together with the flap was less than 1 cm greater than the circumference of the healthy ankle. The contour was poor if the patient could wear only open footwear, could not wear boots, or if the circumference was more than 4 cm greater than that of the healthy ankle.

Results

The stability of soft tissue was good in all patients. Walking ability was rated excellent in 3, good in 1, fair in 2 and poor in 1; the walking ability of 2 patients was restricted because of other injuries. The active range of motion was good in 5, fair in 2 and poor in 2 patients. The strength of plantar flexion of the ankle was rated good in 5 and fair in 2 patients. 2 patients lacked all active movements in their ankle joints. Judging by their appearance, all the flaps were somewhat thicker than normal, but rated by measurements and footwear, the outcome was good in 7 and poor in 2 patients. 7 patients were able to wear normal shoes; only 2 patients had to wear custom-made shoes because of bone deformities; one of these patients also needs crutches from time to time. A fusion of his ankle joint is planned.

After the microvascular reconstruction 6 of the patients returned to their earlier—or slightly modified—work in 3 to 4 months. One patient went back to work one year after the reconstruction. A 50-year-old patient retired after ankle fusion, and one patient had already retired before the reconstruction.

Discussion

The Achilles tendon region is a functional unit, and injuries there may cause disability in ankle motion and walking or even lead to amputation. Because of the local anatomy, the bones, tendon, and nerves are often damaged together with the soft tissue cover (Colen et al. 1990). Conventional methods of repair, such as skin grafts and local skin flaps, often lead to a series of operations and scarring with poor functional results. Microsurgical free tissue transfers have made one-stage reconstruction possible (Serafin et al. 1980, Colen et al. 1990), even when other pathological processes, such as osteomyelitis or atherosclerotic vascular disease, are present. Vascular reconstruction has been recommended as a procedure prior to reconstructive surgery (Cronenwett et al. 1989). However, we have shown here that it is possible to carry out vascular reconstruction as part of the same one-stage operation. Moreover, uneventful healing of compound fractures or osteitic processes was seen in all 6 of our patients who underwent microvascular reconstruction of soft tissues. The calcaneal tendon can be simultaneously repaired with conventional methods, such as nonvascular tendon grafts, if adequate soft-tissue cover is achieved with a free flap. The loss of one flap among our patients was acceptable (Serafin and Voci 1983, Colen et al. 1990), especially if we bear in mind that the injuries of 9 patients were so grave they had to be operated on 47 times.

The free flaps were stable in all patients, and the friction of footwear caused no breakdowns even though the flaps were not neurosensory. As we (Rautio et al. 1989) and others have shown (Koman 1986, Noever et al. 1986), the sensibility of a free flap to the foot does not correlate with the stability of the flap. Functional results, e.g., walking ability, depend on the skeletal injury more than on the reconstruction used. If the injury only involves soft tissue and the Achilles tendon, it is reasonable to expect good functional recovery. The flap must be specifically selected for the patient, taking into account the extent and thickness of the defect and also the local condition of the recipient vessels. A good contour and esthetic outcome are achieved in superficial injuries with fasciocutaneous flaps, and in deeper injuries with muscle or musculocutaneous flaps. Donor site morbidity should also be considered in some patients, young ones in particular.

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