

Vascularized tendon graft using lateral arm flap

5 microsurgery cases

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We treated 5 patients with soft tissue defects involving the skin and tendon with microsurgical transfer of vascularized tendon grafts from the upper lateral arm. All the flaps survived and recovery of motor

function has been satisfactory. The advantages of a composite upper lateral arm flap are its versatility, constant anatomy, and skin sensibility.

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Combined loss of skin and tendon of an extremity are usually treated with staged procedures. A one-stage procedure with a composite free flap has been suggested as an alternative (Taylor and Townsend 1979, Reid and Moss 1983). Song et al. (1982) first described the use of the upper lateral arm flap. Since then it has been further studied and applied to treat tissue defects of the hand (Katsaros et al. 1984), oral cavity (Matloub et al. 1989), and the foot (Shenag 1987). We have performed 5 vascularized tendon grafts using the upper lateral arm flap, and each patient has had a minimal follow-up of one and a half years.

Patients and methods

From 1986 to 1990, we treated 5 patients with post-traumatic combined skin and tendon defects referred to us after severe injury to the extremities. The ages of the patients ranged from 25 to 43 years. Follow-up

period was on average 3 (1.5-5) years (Table 1). The wounds were debrided and had been closed with split thickness skin grafts in emergency hospitals; the patients were admitted to us 4 (2-6) months after the primary injury. One patient (Case 2) had a chronically infected discharging sinus.

The patients were first treated by a physiotherapist to gain free joint motion. If the lesion was on the hand, we used an ipsilateral upper lateral arm flap so that the morbidity was restricted to a single extremity. Angiograms were not done, but we found Doppler studies useful. After dissection, the defects of the skin and tendon were mapped on a piece of glove which was sketched on the donor site (Hou and Urbaniak 1987). Extreme care was taken in harvesting the triceps tendon through a posterior incision. The lateral one third to half of the triceps aponeurosis was sharply dissected from the muscle without damaging the thin areolar paratenon. The nutrient vessels were traced to where they met the radial nerve. Sometimes difficulties were encountered because a venous plexus was often found

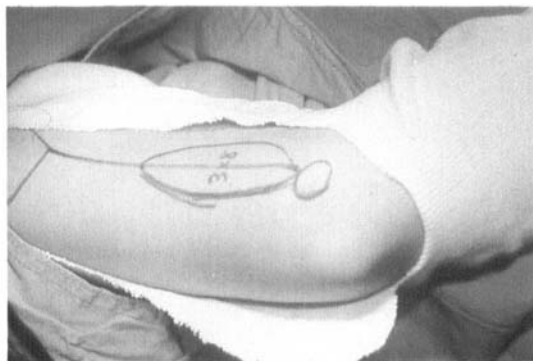
Table 1. Data of patients who received vascularized tendon grafts

Case	Sex	Age	A	B	C	Tissue loss	D	E	Results
1	M	33	1	1	R Ft	extensor hallucis longus	2	60	stable skin, big toe M-P motion 0°-30° lack of touching palmar crease dig II 1 cm, dig III-V 1.5 cm, incomplete n. recovery ambulation good, ankle motion 0°-30° left thumb interphalangeal motion 0°-45° full extension of III-V fingers
2	M	37	2	2	L Fm	flexor dig. superf. et prof. III-V, flexor carpi ulnaris, ulnar a. and n.	5	51	
3	F	25	1	2	L H	Achilles tendon	6	30	
4	M	43	2	1	L T	flexor pollicis longus	2.5	26	
5	M	30	3	2	L Fm	ext. dig. III-V, ext. carpi ulnaris	3	18	
A Injury			B Previous surgery			C Lesion side and location			D Months from injury to operation
1 traffic			1 primary healing			Ft foot			E Months follow-up
2 machine			2 skin graft			Fm forearm			
3 cutting						H heel			
						T thumb			

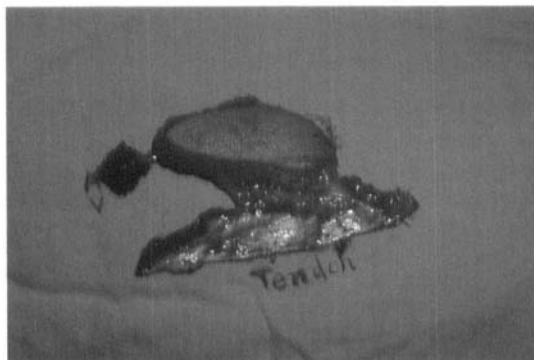
Figure 1. Case 3. A 25-year-old woman lost her Achilles tendon and overlying skin.



The skin was covered with a split thickness skin graft, but it was not stable.



A 3 x 8 cm upper lateral arm flap was designed on her right arm.



The flap with the tendon. The nutrient vessels to the tendon are shown with black arrows.



The appearance of the grafted skin and tendon. Dorsiflexion and plantar flexion of the ankle joint were satisfactory.

around the radial nerve. We obtained a nutrient vascular pedicle longer than 6 cm in all cases. End-to-side anastomosis of the artery and 1 or 2 end-to-end anastomoses of the vein were carried out under the microscope. Moreover, the nerve was reconnected in every case except Case 1. Then the triceps graft was rolled and bridged between the gaps of the tendon. Proper tension of the anastomosed tendon was adjusted. Post-operative care was the same as for a microvascular transfer, except that the grafted tendon was protected for 4 weeks and then followed up with gentle exercise supervised by a physiotherapist.

Results

All the flaps survived well. The range of motion at final follow-up was quite satisfactory. Tenolysis in the later stage was not required. The donor site healed uneventfully. The range of motion in the elbow was not affected and the strength of the triceps was not

weakened. Touching sensation in the flap appeared 3 months after surgery. Although no 2-point discrimination was detected, protective sensation did exist 1 year after surgery. Patients with flaps transferred to the foot and heel were walking well without any breakdown of the flap. All patients were quite satisfied with the results.

Case 3

A 25-year-old woman sustained a crush injury of the left lower leg in a traffic accident, and the fractured tibia was plated. A wound on her left heel became infected. After several debridements, the Achilles tendon was gone and the wound was closed by a split thickness skin graft. 6 months after the injury she was referred to us, without active plantar flexion of the ankle joint. The overlying skin was not stable (Figure 1) and the patient could not walk. On August 1, 1989 a lateral arm flap was designed on her right arm. A 3 x 8 cm upper lateral arm flap was harvested along with the 3 cm wide and 10 cm long tendon. The proximal gas-

Figure 2. Case 5. A 30-year-old sailor had a cut on the left forearm.



The cut on the left forearm.



The extensor digitorum (III-V) and extensor carpi ulnaris were lost.



After reconstruction the extension of left wrist and fingers were full.



The flexion of fingers was full. The former skin defect was corrected.

trocnemius and soleus were dissected and sutured with the tendon. The distal part of the tendon graft was anchored on the calcaneus with a pull-out wire. Postoperatively, a long leg cast was worn for 4 weeks, followed by a short walking cast for 2 weeks and a brace for 3 months. Physical therapy was started 6 weeks after surgery. 1 year after surgery the patient walked well and flexed the ankle joint actively to 30°. She could stand on her left forefoot alone and she was very satisfied with the results. The donor site was closed primarily. The strength and range of motion in the right elbow was normal; however, a slight hypertrophied scar was visible two years after surgery.

Case 5

A 30-year-old sailor cut his left forearm on a cruise. On admission 3 weeks later there was a 3 × 6 cm skin defect together with rupture of left extensor digitorum III-V and extensor carpi ulnaris (Figure 2). On October 27, 1990 a 3 × 6 cm ispalateral upper lateral arm flap with the tendon 2 cm wide and 5 cm long was

transferred. The finger extensors were repaired with vascularized triceps tendon graft. The extensor carpi ulnaris was grafted with a free palmaris longus tendon. The hand was immobilized with a volar splint for 6 weeks, and then physical exercises were started. One and half years later extension and flexion of the wrist and fingers were similar to the contralateral hand.

Discussion

The conventional treatment of a combined skin and tendon defect includes staged operations. The concept of a vascularized tendon graft where the viable tendon and skin are transferred together has been advocated by van Genechten and Townsend (1983). A groin flap coupled with a vascularized strip of external oblique aponeurosis was presented by Taylor and Townsend (1979). However, the groin flap is bulky and later defatting is frequently necessary. Vila-Rovira et al. (1985) used a dorsalis pedis flap with an overlying

vascularized extensor tendon to repair a defect on the dorsum of the hand and they achieved good functional results. However, the problems of the donor site hindered the popularity of the dorsalis pedis flap. Foucher et al. (1984) and Lovie et al. (1984) presented the application of either a radial or an ulnar forearm fascio-cutaneous flap. The palmaris longus, brachio-radialis, part of the flexor carpi ulnaris or radialis can be incorporated in the transfer. They are extremely useful in resurfacing dorsal and ventral defects of the hand. The main drawback of forearm flaps is the poor cosmetic appearance of the donor site. Also the tendons mentioned above are not big enough to match an Achilles tendon.

An upper lateral arm flap is a septocutaneous artery flap supplied by the posterior radial collateral artery which is a branch of the profunda brachii. Venous drainage is through concomitant veins that form a plexus where the vessels meet at the radial nerve. The triceps muscle inserts at the olecranon with an expanded aponeurosis which is 15 cm long and 5 cm wide. The lateral half of the tendon can be harvested with its loose areolar tissue. We have always found a rich vascular network which can be traced to the nutrient vessels. The tendon can be rolled and sutured with itself, so that the rough muscle side is inside. Since the tendon harvested is very strong, there is no problem in anastomosing the donor and recipient tendons. Not a single case experienced reduced range of motion of the elbow, and the strength of muscle regained its original state soon after the wound healed. By anastomosing the lateral cutaneous nerve with the recipient nerve, we achieved protective sensation to the flap.

The shortcomings of the upper lateral arm flap are few. Since we usually incorporate the posterior cutaneous nerve in the transfer, paresthesia over a small coin-size area on the elbow is present, but the intensity decreases with time. The scar tends to widen gradually, but is easily covered by a short shirt.

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