The Tibial Second Toe Vascularized Neurocutaneous Free Flap for Major Digital Nerve Defects

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Purpose: Most digital nerve defects can be reconstructed by means of nonvascularized nerve grafts or artificial tubes, for example. When the bed is poor, the defect is long, or there is a concomitant soft-tissue loss; however, a vascularized nerve graft may be a better option. Our purpose is to introduce a method of 1-stage reconstruction of complex neurocutaneous defects in the fingers and to report the results and clinical effectiveness at a minimum 1-year follow-up period.

Methods: From 1997 to 2005 there were 6 consecutive patients who had a combined soft-tissue and digital nerve defect reconstructed by a vascularized neurocutaneous flap from the tibial (medial) side of the second toe. Three were acute and 3 were chronic cases. One flap was used for the ulnar side of the thumb, 2 for the radial aspect of the index finger, 1 for the radial of the small finger, and 2 for the ulnar side of the small finger. The nerve gap averaged 4.2 cm, and the flap size averaged 3.2 × 2.1 cm. The flaps were revascularized with standard microsurgical techniques to local vessels in the fingers. The nerves were sutured with epineural stitches. A split-thickness skin graft was used to close the donor site of the toe.

Results: All flaps survived without complications. At the latest follow-up evaluation static two-point discrimination (s2PD) averaged 8 mm on the pulp. Three patients had normal sensation when tested with Semmes-Weinstein filaments. Subjective feeling was 78% of that of the normal side. Five patients rated their feeling as excellent on a subjective scale. The Disabilities of the Arm, Shoulder, and Hand questionnaire score averaged 5.

Conclusions: The tibial neurocutaneous second toe free flap is suitable for reconstructing a missing nerve and soft-tissue defect in the finger. We found good functional recovery and high satisfaction in this group of patients. The donor site morbidity has been minimal, although delayed healing is common. (J Hand Surg 2007;32A:209–217. Copyright © 2007 by the American Society for Surgery of the Hand.)

Type of study/level of evidence: Therapeutic IV.

Key words: Microsurgery, neurocutaneous defects in fingers, complex nerve defect, vascularized nerve grafts.

A digital nerve defect complicated by an associated soft-tissue loss poses a reconstructive challenge. Traditionally, combined defects have been dealt with in stages: first, coverage with a flap and second, reconstruction of the nerve gap.[1,2] This protocol entails a long recovery time and is cumbersome for the patient. In addition, the results of nonvascularized nerve grafting in scarred digital beds have been uniformly poor.[2–4] Furthermore, the cost of treatment is increased because multiple surgical procedures are needed and the disability time is long.

On the other hand, several experimental studies[5,6] have shown the benefits of reconstructing nerve defects by means of vascularized nerve grafts, particularly when the bed is scarred. Clinically, Rose et al[4,7] reported good results when reconstructing digital nerves on scarred areas without concomitant soft-tissue defect by means of vascularized deep peroneal nerve segments.

This article presents a case series in which the tibial (medial) second toe vascularized neurocutaneous flap was used for complex nerve–soft-tissue finger defects. Soft-tissue and digital nerve defects were reconstructed in 1 surgical setting with this flap. The surgical technique and patient outcomes are detailed.

Materials and Methods

From September 1997 to June 2005 we treated 6 consecutive patients who had a combined digital nerve and soft-tissue defect by means of a neurocutanoeus flap taken from the tibial (medial) aspect of the second toe (Table 1).

All were healthy adults with an average age of 37 years (range, 29–46 y). There was 1 woman (patient 5). Patients 2, 3, and 5 were smokers (≥1 pack/d). In 1 patient the defect involved the ulnar side of the thumb, in 2 the radial side of the index finger, in 1 the radial side of the small finger, and in 2 the ulnar aspect of the small finger.

In 3 patients the defect was acute and was treated as a delayed emergency (1–9 d after the injury). In the other 3 patients the defect was chronic. Two patients (patients 2, 4) were treated for correction of recurrent Dupuytren's surgery performed elsewhere. Patient 5 was treated in an outlying institution for an apparently benign wound in the volar aspect of the small finger. Patients 2 and 5 had had 2 previous unsuccessful surgeries for treating pain, and at the time they were not working and were labeled malingers. Specifically, patient 2 claimed he could not grip a steering wheel, and patient 5 could not wash glasses (she is a waitress) because of cold intolerance. Both were involved in litigation; patient 2 was involved in a malpractice suit. All but patient 4 were covered under worker's compensation.

No vascular study except unidirectional Doppler scanning on the foot and hand was performed. Smokers were advised to quit for at least 4 weeks after the surgery and, in the chronic case group, for 2 weeks before surgery.

Surgical Procedure

We first operate on the hand to know the sizes of the skin defect and the gap in the nerve. These are measured and transferred to the second toe.

The flap is outlined on the medial side of the second toe (Fig. 1A). A full hemicircumference can be elevated, but the size depends on the defect to be reconstructed. The flap is elevated under tourniquet after exsanguinations by elevating the foot. In principle, the procedure is similar to a standard toe harvesting, but it is much easier because neither bone nor tendon are included. Some peculiarities need to be highlighted. A subcutaneous vein first is isolated through a dorsal zigzag incision to the proximal edge of the flap. Through this same dorsal plane, usually in the vicinity of the first web, the terminal branch of

Table 1. Demographics

Patient	Age, y	Affected Nerve/Finger	Cause/Mechanism	Main Problem	Other	Previous Surgery	Time From Initial Insult to Flap
1	29	Radial/index	Saw	Neurocutaneous defect	—	Debridement	3 d
2	42	Ulnar/small	Dupuytren's	Dystrophic pain	Severe scarring and contracture	Dupuytren's × 2	6 mo
3	43	Radial/index	Circular saw	Neurocutaneous defect	FDS/FDP defect	Simple dressing	2 d
4	41	Ulnar/small	Dupuytren's	PIP stiffness and contracture	Lack of skin, anesthesia ulnar side	Dupuytren's × 2	3 y
5	30	Radial/small	Glass laceration	Dystrophic pain	Severe scarring and contracture	Skin loss × 2 and Z-plasties	13 mo
6	46	Ulnar/thumb	Saw	Neurocutaneous defect	50% lac FPL, radial digital nerve defect	Debridement	9 d

FDP, flexor digitorum profundus; FDS, flexor digitorum superficialis; FPL, flexor pollicis longus; lac, laceration.

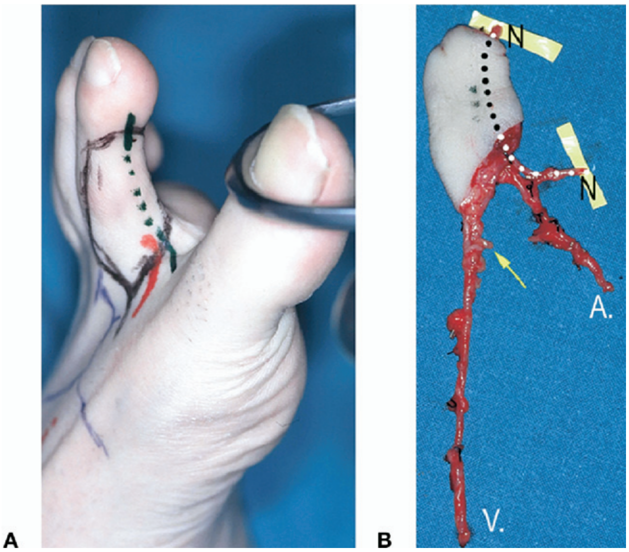

Figure 1. Patient 3. (A) Design of the tibial neurocutaneous second toe flap (patient 3). (B) The flap once raised; the digital nerve (N) has been highlighted by dots. The arrow points to a minute twig of the deep peroneal nerve that was not used in this case (see Discussion). A, first dorsal metatarsal artery; V, subcutaneous vein.

the deep peroneal nerve is located. If large enough (see Discussion) this is also tracked to the flap. Then the most proximal and plantar aspect of the flap is incised, and the digital artery and nerve are isolated and traced proximally as needed, as in a standard toe-to-hand dissection.

The distal aspect of the flap is then incised to isolate the digital nerve. For a comfortable neurorrhaphy later in the hand, several millimeters are dissected distally. When needed the artery can be included for a flow-through montage in the finger (only on 1 occasion in this series). Once all the vessels and nerves are isolated the flap is elevated from dorsal to plantar: first above the peritenon of the extensor, then the periosteum, and finally above the flexor pulleys. Great care should be taken to maintain a graftable bed on the toe. The nerves are cut distally and proximally, and the flap is pedicled only on the proximal vessels. The tourniquet is then released, and blood flow is assessed (Fig. 1B).

The nerve grafts varied from 2.5 to 6.0 cm. (average, 4.2 cm.), and the flap averaged 3.2 × 2.1 cm in size (maximum length and width: 4.1 and 2.5 cm, respectively; minimum length and width: 2.7 and 1.9 cm, respectively) (Table 2). The flap is transferred to the hand, and the nerves are sutured to the corresponding stumps with standard microsurgical techniques. For the neurorrhaphy of the digital nerve and the terminal branch of the deep peroneal nerve, we use 3 or 4 epineural stitches with both 9-0 or 10-0 nylon. A sizable deep peroneal nerve was found in 3 patients. The technique of arterial and vein repair and the postoperative protocol has been reported recently[8] (Figs. 2, 3). Once patients started to appreciate some recovery of sensibility they were taught to palpate blindly different tissue fabrics and coins to improve the quality of their sensibility. No formal therapy was given, however.

Closure of the donor site is performed with a split-thickness skin graft taken from the instep of the foot and tied over a bolus. Seven to 10 days later this dressing is changed. Ambulation is allowed on the second to third postoperative day; intermittent foot elevation is recommended until healing (Fig. 4). Patients are discharged 4 to 6 days after the surgery (average, 5 d).

Table 2. Surgical Details

Patient	Nerve Graft Size, cm	Flap Size, cm	Artery Donor ⇒ Recipient	Tibial Digital Nerve	Deep Peroneal Nerve	Admission, d	Donor Site
1	2.5	2.7 × 1.6	FDMA ⇒ CDA (e-s)	RDN ⇒ TDN ⇒ RDN	N/A	6	—
2	6.0	3.0 × 2.3	FDMA ⇒ Rad DA (e-e)	UDN ⇒ TDN ⇒ UDN	UDN ⇒ DPN	4	Delayed healing
3	3.5	3.6 × 2.1	FDMA ⇒ CDA (e-s)	RDN ⇒ TDN ⇒ RDN	N/A	6	—
4	5.2	4.1 × 1.9	FDMA ⇒ CDA (e-s)	UDN ⇒ TDN ⇒ UDN	N/A	6	Delayed healing
5	3.8	3.0 × 2.2	MPDA ⇒ Rad DA (e-e)	UDN ⇒ TDN ⇒ UDN	UDN ⇒ DPN	4	Delayed healing
6	4	2.7 × 2.5	MPDA ⇒ Ulnar DA (e-e)	UDN ⇒ TDN ⇒ UDN	UDN ⇒ DPN	5	—

CDA, common digital artery; DA, digital artery; DPN, terminal branch of the deep peroneal nerve; e-e, end-to-end; e-s, end-to-side; FDMA, first dorsal metatarsal artery; MPDA, medial plantar (tibial) digital artery; N/A, not available (see text for further details; Rad, radial; RDN, radial digital nerve, TDN, tibial (medial) digital nerve; UDN, ulnar digital nerve.

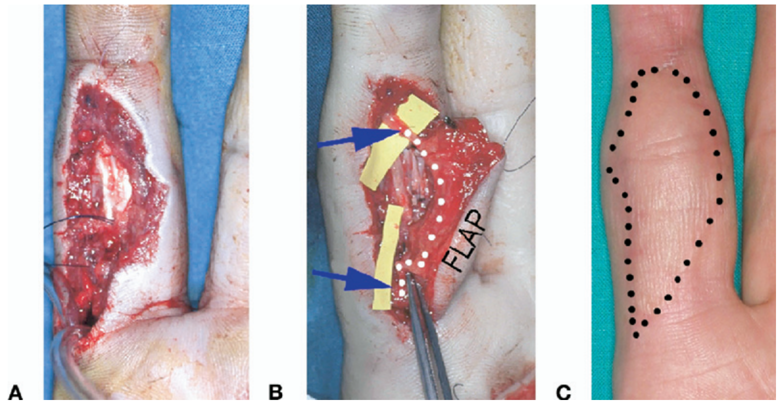

Figure 2. Patient 3. (A) The defect on the radial side of the index finger. (B) The nerve gap has been spanned by the tibial digital nerve. The flap is retracted ulnarly. (C) Five years after surgery. (A) Extension. (B) Flexion.

Outcome Studies

The flap, surgical findings, incidences, and complications data were obtained from the patients' charts.

At the last postoperative follow-up visit a final neurologic assessment was performed. For objective examination, standard tests for assessing sensibility—moving-two-point discrimination (2PD), static-2PD, and Semmes-Weinstein monofilaments (2.83, 3.61, 4.31, 4.56, 6.65)—were performed. The sensibility was explored on the autonomous zone of each finger (terminal volar pad on the side of the injured nerve) while the patient's eyes were closed. The flap sensibility also was studied, and all were compared with the normal pulp.

The results were measured subjectively in 2 ways. First, patients graded their perceptions of feeling on the damaged area compared with the healthy side (0%, none–100%, normal). Then, as recommended by Goldie et al,[9] a visual analog scale (VAS) was used to grade patients' assessments of pain, fine touch, temperature, discomfort in cold weather, and stiffness of the finger. For each of these, normal was allotted a value of 10 points, giving a maximum score of 50 points (Goldie et al scale).[9]

Patients were asked to complete the Disabilities of the Arm, Shoulder, and Hand questionnaire[10] after surgery. They were also asked to assess the cosmetic aspect of the donor site using a VAS (0, very ugly–10, normal) and to report any functional limitation that the donor area may have caused. To evaluate the morbidity of the donor site the American Orthopaedic Foot and Ankle Society questionnaire for lesser toes was also provided.[11] Because of the limited sample size no statistical analysis could be performed.

Figure 3. Patient 3. The pliability of the flap can be appreciated in this functional result 5 years after the reconstruction.

Results

All flaps survived without vascular complications and healed primarily. Range of motion exercises were started 7 to 10 days after the surgery except in patient 3, who had a flexor injury on the same finger

Figure 4. Patient 3. The donor site at 5 years.

and was kept splinted for 3 weeks. Patient 3 had a flexor tenolysis 1 year after the surgery to improve his range of motion at the distal interphalangeal joint. Patient 4 had a flexor contracture at the proximal interphalangeal (PIP) joint of the surgically treated finger as a result of a recurrence of Dupuytren's contracture. No other surgery has been performed on any hand.

Patients resumed their previous occupations without limitations at an average of 96 days after surgery. If we exclude patient 5 (discussed later), all went back to work in less than 3 months.

Final assessments of results were performed at a mean of 4 years (range, 10 years maximum, 1 year minimum) after the surgery (Table 3). Objective results were as follows. Moving 2PD averaged 5 mm on the flap and 5 mm on the pulp. Static 2PD averaged 7 mm on the flap and 8 mm on the pulp. Four patients felt the 2.83 monofilament on the flap and 3 felt it on the pulp (normal sensation).

Subjectively, sensibility perception on the pulp averaged 78% compared with the normal side (range, 60%–92%). None of the patients had stiffness, except for the patient whose Dupuytren's recurred. None of the patients had cold intolerance on the hand or the donor site. (We live in a mild Atlantic weather–type area where the temperature is only occasionally below 0°C in wintertime, and our experience might not be similar to that in colder climate areas. It should be emphasized, however, that both dystrophic patients (2, 5) had severe cold intolerance before surgery. On the Goldie et al[9] subjective scale, 4 patients scored excellent (41–50 points) and 2 good (31–40 points) (see Table 4). Patients averaged a score of 5 on the Disabilities of the Arm, Shoulder, and Hand questionnaire, but one of them scored 16. This patient recently had surgery elsewhere for a Dupuytren's contracture on the contralateral left hand and was disappointed with the result on the left hand (Table 3).

Partial graft loss on the foot occurred in 3 patients. In 2 the loss was minor and healed by secondary intention with home daily dressings in 4 to 6 weeks. Patient 5 had a loss of nearly all the skin graft and initially refused a second skin grafting under local anesthesia. Four months later, she accepted a second skin grafting, which took fully. All patients had been ambulating since postoperative day 7, including patient 5. No differences were reported by patients whose donor site healed primarily versus those who healed secondarily at the latest follow-up evaluations regarding pain or cosmetic deformity on the foot. Overall, patients rated foot appearance as 9 on a

Table 3. Results

Patient	RTW, d	F/U Period, y	m2PD		s2PD		Semmes-Weinstein		Subjective Recovery	Cold Intolerance	Goldie et al Scale[9]	DASH[10]	Foot Appearance (VAS)	AOFAS[11]
			Flap	Pulp	Flap	Pulp	Flap	Pulp						
1	80	10	3	5	6	6	2.83	2.83	92	No	50	0	8	95
2*	90	5	4	5	6	7	2.83	3.61	75	No†	50	16	9.5	95
3	75	5	3	4	5	6	2.83	2.83	80	No	42	4	9‡	100‡
4	90	3	8	7	9	10	3.61	4.31	60	No	37	5	9.5	100
5*	150	2	7	5	9	7	2.83	2.83	90	No†	50	1	8	95
6*	90	1	7	7	9	9	3.61	3.61	70	No	40	1	7	100

AOFAS, American Orthopaedic Foot and Ankle Society; DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; F/U, follow-up; RTW, return to work.
*Terminal branch of the deep peroneal nerve repaired.
†Severe cold intolerance before surgery.
‡This patient had an acral melanoma on the neighboring large toe treated by distal phalanx amputation 4 years after the initial surgery.

Table 4. Detailed Results of the Scale of Goldie Et Al[9]

Patient	Pain	Fine Touch	Temperature	Cold Intolerance	Stiffness	Total	Outcome
1	10	10	10	10	10	50	Excellent
2	10	10	10	10	10	50	Excellent
3	9	7	9	10	9	42	Excellent
4	9	6	10	10	2	37	Good
5	10	10	10	10	10	50	Excellent
6	9	6	8	9	8	40	Good

Goldie et al devised a scale to grade subjectively the sensory results after digital nerve repairs. A VAS was used to grade patients' assessment of pain, fine touch, temperature, discomfort in cold weather, and stiffness of the finger. For each of these, normal was allotted a value of 10 points, giving a maximum score of 50 points. Excellent, 41–50; good, 31–40; fair, 21–30; poor, 0–21.

VAS. Patient 3 had an amputation of the distal phalanx of the large toe for an acral melanoma 4 years after the neurocutaneous flap. This lesion did not exist at the time of the initial surgery and was treated elsewhere. Despite this, the patient has no complaint regarding the donor foot and scored 100 on the American Orthopaedic Foot and Ankle Society questionnaire.

Discussion

Occasionally the surgeon has to deal with a combined loss of palmar soft tissues and a digital nerve defect. Scerri et al[12] presented a modification of a V-Y flap to bridge combined neurocutaneous defects of up to 1 cm in the fingers. For larger defects, the classic way of dealing with this combined injury is a 2-stage procedure: a local flap and a secondary interpositional nonvascularized nerve graft harvested from the forearm.[1,13,14] We were not satisfied with this classic approach because it requires 6 or more months for some sensibility to be restored. Poor results have been reported.[2–4] This is not surprising because a nerve graft obtains its nutrients and revascularizes from the recipient bed,[15] and in this setting the bed will be scarred.

Several investigators[16–19] have advocated vascularized nerve graft when long gaps need to be bridged or when the recipient bed is poorly vascularized. Unfortunately most available vascularized nerve graft donor sites that can be combined with a skin flap[16–20] are not appropriate for a digit defect. First, the morbidity on the donor site might far outweigh the benefit of restoring a digital nerve, and second, the skin carried is so thick that at best it is only appropriate for palmar defects.[17,20,21]

Koshima et al[22] refined the Rose and Kowalski[4] deep peroneal vascularized nerve graft to include the skin overlying the first web for reconstructing a neurocutaneous defect in the finger. They reported good clinical results in a patient. This flap has several drawbacks, however. Foremost is the fact that the skin-grafted web can be a source of major morbidity[23,24]; second, the skin flap does not adhere to the bone, and during grasping and gripping it will be unstable. Finally, the anatomic variations are quite common at the first web level, and the nerve can travel far from the nutrient vessels,[25,26] making the flap unusable.

To deal with a more consistent flap we decided to use the tibial side of the second toe and use the tibial digital nerve as an interposed vascularized nerve graft.[27,28] The tibial neurocutaneous free flap fulfills all the requirements set for an ideal nerve graft by Taylor and Ham[16] and del Piñal and Tayor[29]: constant anatomy, minimal functional loss after the nerve has been used, and a dependable blood supply paralleling the nerve over a long distance. The flap has a dual innervation: plantarly from the tibial (medial) digital nerve and dorsally from the terminal branch of the deep peroneal nerve. In every case the tibial digital nerve was consistent, proximally and distally, and could be sutured as a vascularized nerve conduit graft. Conversely, the terminal branch of the deep peroneal nerve could never be isolated on the distal aspect of the flap, and in some cases it was reduced to a minute twig proximally, not amenable to suturing, and was not included. Although the sample is small, the flap sensibility was the same in both groups. We hypothesize that as is the case for the arteries of the dorsum of the foot and toes, there is a kind of competition among the plantar (posterior tibial nerve) and dorsal (deep peroneal nerve) nervous systems and that the territories overlap.

Three of our patients had acute surgery for a combined soft-tissue–nerve defect, and the other 3 had surgery several months after the originating event. In 2 of the 3 chronic patients (2, 5), incapacitating dystrophic pain was the main issue. Patient 2 had had surgery for Dupuytren's disease on 1 occa-

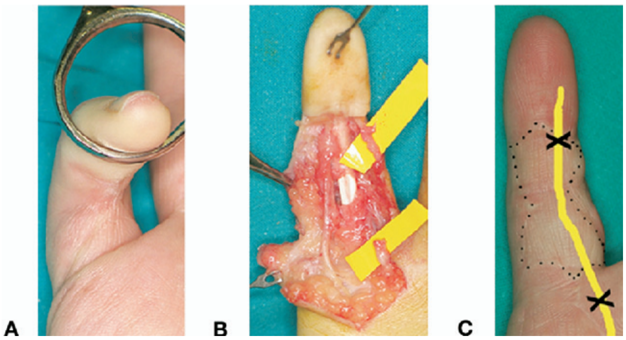

Figure 5. Patient 5. (A) Status after a simple laceration with surgery performed on 2 occasions (one for treating the dystrophic pain). Note blanching on the skin during traction with an instrument, attesting to the soft-tissue shortage. (B) Recreation of the true soft-tissue defect. Neuroma and glioma under yellow backgrounds. (C) Extension at 18 months and flap highlighted by dots.

sion and patient 5 for a simple laceration. Secondary surgery elsewhere for controlling postoperative pain resulted in an increase in both pain and digital contracture (flexion contracture at the PIP joint of 60° [patient 2] and 80° [patient 5]). Patient 2 had been to a pain clinic and was receiving treatment. Exploration in both patients showed that the nerves were lacerated and were densely embedded in restrictive scarring from the proximal phalanx to the DIP joint. Concomitant soft-tissue loss was evident once the finger was extended (Fig. 5). Radical excision on the scarred tissue and transplantation of well-vascularized tissue have been successfully used in the setting of dystrophic pain secondary to adherent nerves.[30] The tibial second toe neurocutaneous flap seems a reasonable alternative to promote primary nerve healing and avoid nerve adhesions.

In the final chronic case (patient 4) the flap was used for treating a case of second recurrence of Dupuytren's contracture (third surgery). The purpose of the flap was to address a condition in which residual scarring did not provide a suitable bed for nerve grafting. Despite full correction of the deformity in the early postoperative period, the contracture recurred (90° in the PIP joint in the last visit).

Considering our mixed results in treating severe recurrent Dupuytren's disease, we cannot recommend use of this flap until we gain more experience. For us, its role is now limited to the situation of severe contracture in the setting of an ungraftable bed and/or the need for pulley or nerve gap reconstruction.

At the time of flap planning, the surgeon should take care to account for the defect's location to avoid dangerous crossover of vessels and nerves. This fact may be behind some of the problems Macionis[27] reported in his case. As a rule, radial digital defects should be reconstructed with homolateral toe flaps and ulnar digital nerves with contralateral flaps. The flap is relatively easy to raise and with experience can be elevated in 30 to 45 minutes. The only critical aspect during harvesting is the need to isolate and ligate two constant but tiny arterial branches of the digital artery that are located just proximal and distal to the toe's PIP joint (Fig. 6).[28] After a very short course from its origin these branches dive deep into the tendon sheath, and they are equivalent to the proximal and middle transverse digital arteries of a finger.[31] We have moved over the years from the large vessels (first dorsal metatarsal artery) to the smaller digital arteries. This entails some more microsurgical difficulties, but the procedure is more expeditious because the dissection is much faster. (Surgery in our last 2 patients was completed in less than 3 hours for the whole procedure).

The objective results in this series are similar to those reported for single neurorrhaphy or when primary nerve graft has been performed.[1,9,13,14] Our

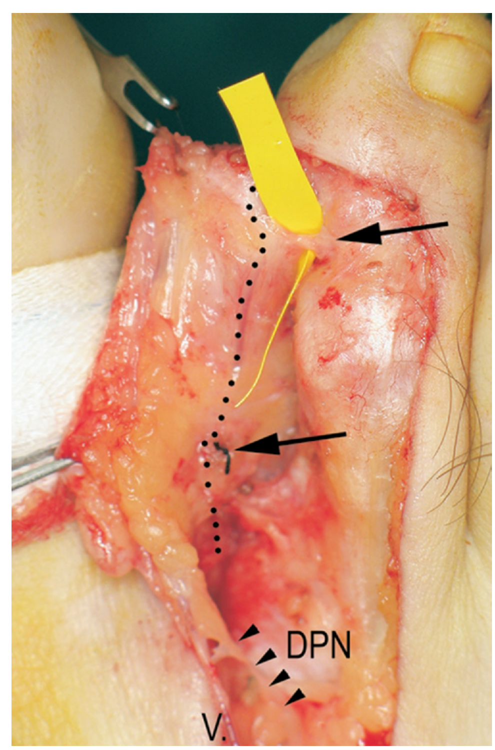

Figure 6. The course of the digital artery has been marked by dots on the deep surface of a tibial second toe neurocutaneous flap. The critical deep branches diving into the flexor sheath have been highlighted by arrows (the proximal branch has already been ligated). The subcutaneous draining vein (V) and the deep peroneal branch (DPN) to the flap (arrowheads) have been marked proximally.

results, however, are much better than when a flap has been used and the nerve secondarily reconstructed or when grafts were placed directly on scarred beds.[2,3,5] In those circumstances most patients did not recover 2-point discrimination, and/or referred pain, and/or cold intolerance.

Rose and Kowalski[4] reported slightly worse results in 5 patients who had a vascularized deep peroneal nerve graft under quite similar conditions to our patients. This may be explained in part because they reconstructed a slightly larger defect and also because there was a longer delay from the injury to the reconstruction. Their flap, however, did not have venous outflow "as no veins were available in the palm,"[4] and they relied on compensation via flow-through on the arterial side. It is impossible to know, then, if venous infarct on the transplanted nerves has occurred, and if so, how this fact has affected the results. Our neurocutaneous flap required an efficient outflow to avoid necrosis. To overcome the absence of appropriate veins on the palm mentioned by Rose and Kowalski,[4] wherever necessary we use the following artifice: a channel is made bluntly with Metzenbaum scissors in the appropriate intermetacarpal space, and a silicone tube (taken from an intravenous line) is passed through this tunnel. Now, by attaching the vessel to the end of the tube and pulling through, the vein would pass dorsally, thus permitting a comfortable venous anastomosis to be performed there. With this artifice large distances can be spanned without the need to open the skin.

Based on our experience and results we believe that the tibial second toe neurocutaneous flap has a role in the management of complex defects in the fingers. It is best indicated when the defect involves a critical sensory area (ulnar side of the thumb, radial side of index or opposing finger, ulnar pulp of the small finger). In our opinion, however, it also has a major role in cases of severe chronic scarring after multisurgery and dystrophic pain in any given finger. The flap is not suitable for spanning long nerve defects (longer than 6 cm), for which other vascularized grafts may be indicated.[16–20] The procedure also has the drawback that microsurgical skills and familiarity with dissection of small vessels are required. Needless to say, we believe that other less-involved procedures—local flaps plus nonvascularized nerve grafts or conduits[32,33] or even cross-nerve suturing[34]—should be favored for the less vital acute neurocutaneous defects such as those on the central fingers, radial part of the small finger, or ulnar part of the index finger.

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