A Technique to Improve Foot Appearance After Trimmed Toe or Hallux Harvesting

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We describe a technique to improve the appearance of the donor site after hallux harvesting. The surgery has been used in 6 consecutive patients having a trimmed-toe–type transfer. Instead of the classic stump closure advised by Wei, the following steps were performed on the donor site: (1) removal en bloc of the second metatarsal and transposition of the second toe on top of the proximal phalanx of the hallux, (2) interposition of a tibial (medial) glabrous flap from the tibial aspect of the hallux onto the tibial side of the second toe to increase its size, and (3) eponychial flap to increase the nail show on the second toe. Fixation of the toe was achieved with K-wires and cerclage wire. Crossed K-wires stabilized the first to the third metatarsals for 4 to 6 weeks. Ambulation with a stiff sole was allowed a few days after surgery. The main advantage of this technique is the improved donor site appearance. As a bonus, the amount of skin that can be harvested with the trimmed toe is slightly increased. The main drawback is that the number of toes is reduced to 4. (J Hand Surg 2007;32A: 409–413. Copyright © 2007 by the American Society for Surgery of the Hand.)

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Since its introduction as a suitable alternative for thumb reconstruction,1,2 great toe transfer has been considered the best way of reconstructing an amputated thumb, especially after mutilating hand injuries.3–6

In the early days of great toe harvesting, when the metatarsal was included with the transferred toe, alterations in gait and/or foot pain were frequent.7,8 Several researchers have shown, however, that if a 1-cm stump of proximal phalanx, or at a minimum the whole first metatarsal, is left in place, minimal interference with foot function will occur.7–10 Having overcome the functional aspect, the donor site was a drawback, which detracted from a wider usage.

Several alternatives that minimize the donor site morbidity, such as use of the second toe11 or the so-called wrap-around,12 were also available, but neither was ideal. The second toe produces too small a thumb replica, and the wrap-around has among other limitations the fact that no motion exists at the interphalangeal (IP) joint.

Foucher at al13–15 devised the twisted-two-toes technique, in which some motion at the IP joint is obtained by wrapping the skin of the hallux around the proximal interphalangeal joint of the second toe. The foot donor site is closed by filleting the skin of the second toe, which is wrapped around the bony framework of the great toe. The twisted-two-toes technique is technically difficult and has not become popular; only a few articles about it have been published.16–19 The main collateral advantage of the technique, however—the way the donor site was closed—went unappreciated.

Bearing in mind this principle, we have developed a technique to improve the donor site after trimmed toe20 or hallux harvesting to avoid the classic stump closure. Three surgical maneuvers are performed: (1) transposition of the second toe on top of the proximal phalanx of the hallux, (2) enlargement of the second toe by interposing a flap on its tibial (medial) aspect, and (3) an eponychial flap to increase the nail show.21,22
Our purpose is to present the surgical technique and results in 6 patients who had this procedure.

**Surgical Technique**

The skin markings on the foot are similar to the classic trimmed toe on the medial side, but proximal palmar and dorsal V flaps extension are also included in the lateral side to allow easy transposition of the second toe later in the surgery (Fig. 1). The trimmed toe is elevated as recommended by Wei et al., with care taken to maintain the blood supply of the tibial (medial) flap that will be used in step 2. The toe is transferred to the hand after 15 to 20 minutes of reperfusion. To shorten the operative time, usually while the first team of surgeons operates on the hand a second team proceeds on the foot.

**Step 1: Second Toe Transposition**

The second metatarsal is exposed subperiostically, and an osteotomy is performed on its proximal fourth. It is then elevated distally, detaching all muscular insertions and dividing the intermetatarsal ligaments. On the fibular side care is taken to avoid damaging the second plantar intermetatarsal artery that at times is closely adhered to the plantar aspect of the metatarsophalangeal joint.23 The base of the proximal phalanx is then exposed subperiostically, and an osteotomy is performed. This allows us to remove en bloc the metatarsal-metatarsophalangeal joint with a small segment of neighboring proximal phalanx.

A 3/0 nylon stitch is preplaced for later reconstructing the intermetatarsal ligament. The second toe, now pedicled on the intact second plantar metatarsal–fibular digital vessels, is transposed on top of the proximal phalanx of the great toe. With bone clamps the first metatarsal is approximated to the third. Two crossed K-wires (1.4 mm) are inserted from the medial aspect of the foot, skewering the third metatarsal. Toe fixation is achieved with cross K-wires or Lister’s wiring plus an oblique K-wire. The preplaced stitch in the intermetatarsal ligament is then tightened (Fig. 2).

**Step 2: Second Toe Enlargement**

A midline incision is made on the tibial side of the second toe. The flaps are elevated in the supraperiosteal level up to the dorsal and plantar midline. Great care is taken in the plantar flap to keep the digital nerve intact (Fig. 3A).

The tibial flap that was elevated from the great toe’s medial aspect to reduce its size is now interposed in the medial aspect of the second toe, achieving a Y-V enlargement effect (Fig. 3B). Because this flap might have a marginal blood supply if too thinned during toe harvesting, care should be taken to protect it during trimmed toe elevation. During the time the tourniquet is released for toe reperfusion, the blood supply to this flap is carefully assessed. Obviously, if this flap blood supply is doubtful, this second step should be omitted.

**Step 3: Eponychial Flap**

Adani et al. and Bakhach et al.21,22 published a technique to increase the nail show in cases where the fingers have lost a major portion of the nail. We incorporated this technique in the last 4 patients.

Two longitudinal incisions are made following the
line of the paronichial fold deep to the nail plate and then to the bone up to the distal interphalangeal joint (Fig. 4A). Three to 4 mm proximal to the eponychial fold a rectangle of skin is de-epithelialized (Fig. 4B). The eponychial fold is then elevated from the nail plate and mobilized proximally, closing the de-epithelialized area (Fig. 4C).

Additional Procedures
In the cases where the long stumps of the tendons of the great toe (flexor and extensor hallucis longus) were not needed at the hand for carrying the suturing proximal to the wrist crease, then the corresponding flexor and extensor longus tendons of the second toe were divided and motorized by the great toe tendons. Standard locking stitches were used.

Postoperative Care
Ambulation was permitted on the heel after the second to third day. Unprotected walking was permitted at 4 to 6 weeks, at the time of the K-wire removal. Low-dose heparin was maintained until then.

Results
Six consecutive patients (age range, 29–61 y) had the initial surgery of transferring a trimmed toe to the thumb. All toes survived, although one required an early take-back for arterial insufficiency.

The procedure was modified by including the eponychial flap after patient 2. In 3 patients long flexor and extensor hallucis longus tendons were needed to perform the repair proximal to the wrist crease in the hand. In the other 3 patients the long flexor and extensor tendons were sutured to the corresponding tendons of the hallux in an attempt to improve the thrust.8 No differences were found, although the sample is small and no gait analyses were performed.

Slight valgization was present in all patients at the latest follow-up visit (Figs. 5, 6). We interpreted this as a consequence of separation of the metatarsals, because they retook their original position once the crossed K-wires were removed. One patient developed an early valgization of the second toe. This occurred early after surgery, largely because of an incorrect alignment of the proximal phalanges of the first and second toes during surgery. The deformity had not progressed at the 2-year follow-up visit. The patient rejected a new x-ray at this visit, claiming he had neither pain nor limitation. This patient is an active sportsman and is involved in amateur jogging at the same level as before the surgery.

All patients wear their regular shoes without any special inlays. One patient developed a keloid on the scar in the dorsum of the foot. This was treated by steroid injections with partial improvement.

No limitations on walking or at work were reported (2 patients retired because of the severity of their concomitant hand injuries). Patients were very satisfied with the cosmetic aspect of their feet, and all much preferred this modification to the classic stump closure (Fig. 5).

Discussion
Reducing donor site morbidity is a must in any reconstructive surgery. It is agreed that the great toe gives the best overall results for thumb reconstruction, particularly in multidigital amputations.3–6

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**Figure 3.** Step 2: Enlargement of the second toe. (A) A midline incision has been made on the tibial aspect of the second toe, and the flaps have been partially elevated from the periosteum in preparation for interposing the tibial flap (reflected proximally and highlighted by dots). (B) Immediate postoperative view. (The eponychial flap is pending). (Same patient as in Figs. 1, 2).

**Figure 4.** Step 3: The eponychial flap (different patient). (A) The flap design on the dorsum of the second toe. The area to be de-epithelialized is stippled. (B) After de-epithelialization of the flap, the eponychium is prepared for proximal mobilization. (C) The eponychial flap has been sutured proximally. Notice the increase in nail show (previous eponychial level has been marked with arrows).
Rather than functional issues, cosmetic morbidity is the major deterrent for its widespread use.

In 1980 Foucher et al. introduced the concept of twisted-two-toes, in which the bony framework of the hallux is preserved in situ and the skin of the second toe is wrapped around it. In this way the hallux was preserved in the foot, and some motion was obtained at the IP joint on the transferred toe. Tsai and Aziz proposed a slight modification of Foucher’s surgery that allows preservation of all 5 toes. Unfortunately all of these techniques are difficult, involving dissection of 2 free flaps (hallux, proximal interphalangeal joint), and have not gained popularity: only a few cases have been reported.

The second toe has a minimal functional donor site morbidity and nearly no cosmetic defect when the metatarsal is also removed. Unfortunately, it provides the weakest and least cosmetically appealing result when used as a thumb. In an attempt to minimize donor site morbidity, Morrison et al. introduced the wrap-around technique, which allows preservation of all 5 toes. Problems at the recipient site (eg, bone resorption, fractures, nail instabilities) and at the donor site (eg, ulcerations, hyperquatoritis, pain) have been reported.

Some motion at the IP joint was thought to be crucial when reconstructing the thumb for restoring the vise grip and also for pinching activities. This was the basis of the trimmed toe modification introduced by Wei et al.: the hallux is reduced by means of a tibial flap (as in the wrap-around technique), and the tibial aspects of the distal and proximal phalanges are also reduced. This modification achieved a closer-to-normal neothumb with some motion at the IP joint in a much less complicated way than the surgery of Foucher et al.; however, the cosmetic appearance at the foot was rather similar to that achieved with the classic hallux transfer (Fig. 5A).

Our modification includes 3 surgical maneuvers. Transposition of the second toe compensates for the hole left after hallux harvesting. The second toe is nevertheless rather small, and by using the tibial flap it is enlarged somewhat. Finally the eponychial flap adds a further cosmetic refinement, achieving a slightly larger nail. More important, the basic principle of not altering the first metatarsophalangeal joint is accomplished, and the second toe ray amputation is reported to have minimal functional consequences. One bonus of our modification is that during toe harvesting a surplus of skin from the foot is included, thus enabling the second toe transposition. These 2 triangular flaps can be used for web reconstruction (Fig. 6).

The procedure has the obvious drawback that a toe
needs to be amputated, adding further complexity to an already complex surgery. Moreover, compared with our present toe harvesting, in which we use the digital artery or the first metatarsal artery as the donor, a much longer proximal incision is needed to accomplish the proximal metatarsal osteotomy. One patient developed a keloid on the proximal foot scar. Some minor degrees of valguzation of the second toe were noted in all, but no alteration of the morphology of the metatarsophalangeal joint was detected by plain radiograms. Although no complaints from the donor site have been reported, neither gait nor functional analysis were performed in our study.

If the hallux is smaller than customary and hence does not require reduction by elevating the tibial flap, or if the tibial flap has a doubtful blood supply after harvesting, the benefit of using the medial flap to enlarge the second toe would not exist. All other maneuvers (toe transposition and eponychial flap) would help the donor foot equally.

This modification may give a wider application to the trimmed toe transfer, the hallux itself, or other variants when the great toe needs to be amputated. Such an irrationality for a hand surgeon, such as the inability to wear thong sandals again, may be sufficient for a patient to reject the hallux as a reconstructive option in an environment such as ours where foot exposure is the norm in summertime, particularly for girls and women (Fig. 7). The functional donor site limitations to date are inconsequential.

References