

# V-Y Advancement Flap Coverage of Toe-Tip Injuries

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*Toe-tip injury presents a challenging problem. There are few techniques that provide cover for distal toe defects, and most injuries are usually treated with terminalization or a skin graft. In patients with toe-tip injuries where there is preservation of the plantar toe pulp, V-Y flap advancement is a therapeutic option. In this article, we describe the surgical technique used and present the results of 10 patients with dorsal oblique or transverse toe injuries that underwent V-Y flap advancement for defect coverage. Eight patients had distal great toe injuries, 1 had a dorsal oblique amputation of the third toe, and 1 had a transverse amputation at the metatarsophalangeal joint level. Mean follow-up was 5 months, at which time all patients had returned to their previous activity level, and showed acceptable levels of scarring. The V-Y advancement flap, commonly used in fingertip injuries, when indicated and carefully performed gives excellent contour and padding, maintains toe length, and provides good cosmesis for treatment of toe amputations. Level of Clinical Evidence: 4. (The Journal of Foot & Ankle Surgery 48(3):368–371, 2009)*

Key Words: amputation, injury, skin, toe, trauma, wound coverage

Various procedures have been described for distal foot reconstruction: adipofascial flaps for dorsal foot and ankle soft tissue defects (1); combined pedicled toe fillet flaps for lesions at the metatarsophalangeal joint (MTP) (2); retrograde-flow medial plantar island flaps for plantar defects (3–5); retrograde dorsalis pedis (6) or first dorsal metatarsal artery flaps (7–9); and distally based first web flaps using the dorsal communicating artery (10).

These methods have limitations and relatively few techniques have been reported for the distal toe, which often poses a challenge for the plastic surgeon (11). Local flap techniques are restricted to, at best, the proximal two thirds of the toe by the limited anterior reach afforded by their pedicle (8). They result in donor site morbidity by exposing tendons, scarring, or poor graft uptake (6).

This paucity of options has meant that distal toe injuries are treated conservatively, either with terminalization or skin

grafting. Skin grafting can result in a deformed, hypersensitive, and shortened tip. Although it is generally thought that the biomechanics of the foot are relatively unaffected by reduced toe length, the deformity is noticeable and patients may feel self-conscious (11, 12). Also, a shortened great toe does not allow the patient to wear thong or flip-flop style footwear, commonly worn in many countries.

The ideal procedure for distal toe injuries involving partial or complete nail bed loss should maintain toe length, and cover the defect with nontender, well-padded skin. An alternative to grafting or amputation is the V-Y advancement technique, commonly used in fingertip injuries where length reduction and cosmetic compromise are considered unacceptable. V-Y advanced flaps have been used in the sole of the foot in patients with Bowen's disease (13), and for diabetic foot ulcers involving the metatarsal head (5, 14). Dorsal oblique and transverse toe amputations are the best indication for this method, which requires sufficient toe pulp to allow V-Y lengthening. In this article, we present the results of a retrospective case series of patients with distal toe injuries treated with V-Y advancement.

## Patients and Methods

Patients with transverse or dorsal oblique toe lesions treated with V-Y advancement at our institution between March 2007 and March 2008 were included in the study, and descriptive characteristics of the patients are depicted in Table 1. The operative procedure entailed positioning the patient supine on the operating table and using spinal anesthesia and a tourniquet on the thigh. In transverse amputations, the remaining

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**Financial Disclosure:** None reported.

**Conflict of Interest:** None reported.

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doi:10.1053/j.jfas.2009.01.010

**TABLE 1 Patient details**

Patient	Age /Sex	Mode of Injury	Toe Injury	Type of Injury	Associated Nail Bed Loss	Size of defect, cm	Follow-up, mo	Complications
1	29/M	Heavy object	Great	Dorsal oblique	Partial	2 × 2	6	None
2	23/M	Heavy object	Great	Transverse	Complete	3 × 2	3	None
3	23/M	RTA	Great	Nail bed laceration	Complete	2.5 × 2	6	None
4	27/M	Heavy object	Great	Nail bed laceration	Complete	2 × 2	6	None
5	28/M	Heavy object	Great	Transverse	Complete	3 × 3	6	None
6	24/M	Crush injury	Middle	Dorsal oblique	Complete	1.5 × 1	6	None
7	31/M	Crush injury	Great	Dorsal oblique	Complete	2 × 3	5	None
8	58/M	Heavy object	Great	Transverse at MTP joint	Complete	5 × 2.5	3	None
9	21/M	Heavy object	Great	Dorsal oblique	Complete	4 × 2.5	6	None
10	29/M	Heavy object	Great	Nail laceration	Complete	2 × 2	5	None

**Abbreviations:** MTP, metatarsophalangeal joint; RTA, road traffic accident.



**FIGURE 1** (A) Dorsal oblique amputation of the left great toe with nail bed laceration. (B) The skin is incised, leaving the subcutaneous tissue and vascular supply intact. The fibrous septa are then cut, releasing the flap from the periosteum and the flexor tendon sheath.



**FIGURE 2** (A) The flap is advanced distally and sutured to the nail bed. (B) The excess subcutaneous tissue along the base of the flap may be removed to facilitate the closure. (C) The remainder of the incision is closed in a V-Y fashion. It is essential to avoid tension.

**FIGURE 3** The appearance of the great toe after 4 weeks. The flap provided good contour, padding, and nail-like appearance.



**FIGURE 4** (A) Gangrenous toe before amputation and V-Y flap advancement at the metatarsophalangeal joint, (B) The defect after amputation, and (C) Post V-Y flap advancement showing toe-length preservation at the metatarsophalangeal joint level.

part of the distal phalanx was shortened a few millimeters to facilitate the procedure. The base of the flap was the cut edge of skin where the amputation had occurred, and should be at least the width of the amputated edge of the nail bed. The apex of the triangle should be placed at the distal flexion crease to raise a longer flap, if needed. The side arms of the triangle are not straight, but are drawn as 2 gently curving lines to the apex. Cutting through the skin completely, while leaving the subcutaneous tissue intact, develops the flap. Both the skin and the deep septal attachments must be cut in order to advance the triangular volar skin flap over the defect (Figure 1). The flap is then mobilized by separating its deep attachments from the periosteum distally and the flexor sheath proximally, especially at the level of the flexion crease (Figure 2, A). The mobilized flap is then advanced distally and sutured to the edge of the nail bed with 4-0 nylon (Figure 2, B). The rest of the closure is performed in a V-Y fashion, starting with the proximal end of the incision (Figure 2, C). All patients had petroleum gauze dressings and a below-knee plaster of Paris slab. The sutures were removed on the tenth postoperative day. Weight-bearing ambulation was allowed after the second postoperative week.

## Results

A description of the data set is depicted in Table 1. There were 10 male patients in the case series, and their mean age was  $29.3 \pm 10.59$  years. The mean size of the tissue loss was  $3.51 \pm 6.7 \text{ cm}^2$ , and the mean duration of follow-up was  $5.20 \pm 1.23$  months. The injury was caused by dropping a heavy object on the toe in 7 (70%) of the cases, crush injury in 2

(20%) of the cases, and a motor vehicle accident in 1 (20%) of the cases. In regard to the type of digital tip injury, 4 (40%) were dorsal oblique defects, 3 (30%) were transverse defects (1 at the metatarsophalangeal level), and 3 (30%) were nail bed lacerations; and in only 1 (10%) patient was the nail bed only partially lost. Furthermore, 9 (90%) of the injuries involved the hallux, whereas the middle toe was involved in only 1 (10%) of the cases. None of the patients reported a significant past medical history. Nine (90%) patients were operated within 24 hours of admission, and 1 (10%) presented with a gangrenous great toe that had previously been fixated with a Kirschner wire at another institution. All of the wounds had primarily closed by 2 weeks postoperative, and all of the digits were considered adequately healed for regular activities, with minimal scarring, by 4 weeks following the repair (Figure 3). All of the flaps survived and there were no wound complications, and none of the patients experienced symptoms consistent with neuroma formation. Patients with adequate nail bed had good growth of nail, and in patients with amputations proximal to the nail bed the V-Y advancement flap gave a nail-like appearance. All patients had resumed their normal activities at follow-up. The patients could still wear sandals, common in India, after their wounds had healed. The patient with the MTP-level amputation is illustrated in Figure 4.

## Discussion

Niranjan and Vanstralen (11) described a reverse homodigital pedicle island flap for great toe reconstruction. They state that small great toe defects could be reconstructed

with V-Y flaps but there would not be sufficient tissue for large defects and “if the apex of the flap is planned over the sole of the foot it would encroach on the weight bearing part of the foot and cause painful scars.” V-Y advancement does indeed require sufficient padded tissue to cover the defect without, and this is not possible in large plantar defects. However, none of our patients, even the patient with an MTP-level lesion, reported painful scarring or altered sensation in their operated toe, and the V-Y flap is a simple technique with quick dissection and without the donor site morbidity caused by a pedicled island flap.

We are currently limited in our treatment options for distal toe defects (8). Skin grafts can be successfully used for defects of the non-weight-bearing area and where the subcutaneous pad has remained intact, but cannot be used to cover exposed tendon or bone, or on weight-bearing surfaces. Free flaps require specialized microsurgical equipment, which is not always available. The availability of skin from the second toe as a cross toe flap is insufficient to cover the larger surface area of the tip of the great toe. Cross toe flaps for the great toe are not available from the smaller second toe (15) and locally raised flaps do not reach the distal toe (16, 17).

Dorsal oblique and transverse amputation of the great toe may be reconstructed with V-Y advancement flaps, like that of the fingers and thumb (12). This technique has been described for plantar lesions in the foot (5, 13, 14). The arterial supply of the great toe is similar to that of the thumb; hence it is possible to raise a large piece of skin from the plantar aspect of the great toe, which may be advanced for dorsal loss of tissue of the great toe. The V-Y technique is very good for resurfacing the great, second, or third toe. The flap is easy to raise and primary closure of the donor site gives few sequelae. When there is amputation proximal to the nail bed, the use of lighter color plantar skin to replace lost nail bed results in a nail-like appearance.

In conclusion, there are several methods of flap reconstruction described for foot defects, but few for the tip of the great toe. The V-Y advancement flap can be used to reconstruct the transverse or dorsal oblique great toe amputations. The dissection must be meticulously performed, and adequately advanced. The main advantage of this flap, however, is that it provides near normal nail-like appearance and maintains

adequate length. We recommend this reconstructive flap technique in the management of dorsal and transverse defects of the great, second, and third toes.

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