The visor flap: Preservation of length in finger amputations

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Methods of closure of the amputated finger stump are legion. Certain levels of amputation, however, demand preservation of length for optimum function. The visor flap provides this, together with sensation, padding and scars that avoid volar pressure points. The design of the flap follows the principles of three-dimensional rather than plane geometry.

**PRINCIPLES OF FLAP DESIGN**

The visor flap is a bipedicled flap based on the dorsal branches of the volar digital neurovascular bundles (Figure 1). Transverse amputations of the distal, middle and distal proximal phalanges are most suitable for this technique. Figure 2 illustrates the design of the dorsal flap. The volar/dorsal diameter of the amputation site is measured (A–B). To achieve adequate coverage, a similar area of dorsal skin must be obtained (A–C). Therefore, A–B is equal to A–C. The extent of the lateral incisions are to the mid axial line (D). The pivot point, D, restricts the volar transposition of this bipedicled flap because C–D is shorter than A–C. Therefore, a back cut (Figure 3) is made so that A–D1 is equal to C–D1. The new pivot point of D1 allows adequate volar transposition of the flap. The back cut must be through dermis only to avoid potential damage to the neurovascular structures in the subcutaneous plane.

The dissection is deepened down to but not through the paratenon level. The flap is undermined and transposed distally, and sutured with a nonabsorbable suture. The donor defect is covered with a split thickness skin graft and dressed appropriately: excess skin (dog ears) may be prominent laterally, but these should not be tailored because this may interfere with the neurovascular supply to the flap. Physiotherapy to maintain range of motion is initiated on postoperative day 7. Skin graft maturation and contraction aids in the resolution of the dog ears and acts as a force in drawing the volar scar dorsally, leaving a volar surface free of a potentially prominent and/or painful scar line.
Figure 1) Neurovascular supply to the dorsum of the digit

Figure 2) Flap design. A–B Diameter of defect; A–C Equivalent width of flap; D Pivot point (inadequate given the distance A–D)

Figure 3) Importance of the backcut. A–B Diameter of defect; A–C Equivalent width of flap; D Pivot point after backcut

Figure 4) A transverse amputation of the right index finger at the level of the distal interphalangeal joint. The bone is flush with the wound. The dorsal skin at this level is supplied by the dorsal branches of the volar digital neurovascular bundles

Figure 5a) The dorsal visor flap has been mobilized at the paratenon plane and transposed over the distal wound. The dog ears appear prominent at this stage

Figure 5b) Back-cut to allow adequate movement of the flap
CASE PRESENTATIONS

Case 1
A 32-year-old male sustained an amputation of the right index finger while working with a punch press. The amputation was transverse at the level of the distal interphalangeal joint. The bone was flush with the soft tissue (Figure 4). The distal amputation site was covered with a visor flap. The distal dorsal skin and soft tissue were transposed over the end of the stump, allowing for a sensate, well vascularized, padded covering (Figure 5a,b). A split thickness skin graft was applied to the dorsum of the skin layer at the donor defect (Figure 6a,b). The wounds were dressed for one week. At this time, motion of the proximal interphalangeal joint was commenced. Follow-up at one year showed a functional, cosmetically acceptable amputated stump of the index finger. Contracture of the split thickness skin graft pulled the volar scar dorsally away from the area of normal pressure. Dog ears similarly resolved with time (Figure 7).

Case 2
A 50-year-old male sustained multiple distal amputations of the fingers of his left hand as a result of a power saw accident. The amputated finger tips were traumatized. The amputation to the long, ring and little fingers were transverse and at the level of the distal middle phalanx (Figure 8). Visor flap closure was performed to provide maintenance of length, sensation and padding to the bone exposed distal finger amputations. The donor defect was grafted with a split thickness skin graft. At one year follow-up, the distal stump was well padded and free of dog ears, with normal sensation and a volar surface free of an incision scar (Figure 9).

DISCUSSION

Amputations of the fingers at various levels are common injuries. Less frequent, though, are amputations of the fingers that are amenable to replantation. If replantation of the amputated finger or finger remnant is not performed, a means of revision amputation for closure is necessary. Many closures of amputations have been described. These procedures depend on a number of factors including the finger involved, the level of amputation injury, the angle of the amputation, whether bone is exposed and the viability of adjacent tissue. In these amputations, where there is enough soft tissue available, direct closure can be achieved (1). Alternatively, if soft tissue is covering the bone and a skin defect exists, then the wound can be grafted or allowed to heal via secondary intentions (2). These are common and acceptable means of obtaining wound coverage and closure where bone is not exposed.

If the bone is exposed, further assessment and treatment are required to obtain wound closure. A simple and effective means of achieving this goal is to remove the distal exposed bone to a point where direct closure of the wound can occur. This allows for a well padded, sensate amputation stump. Many have advocated that this procedure for index finger injuries can be the treatment of choice because the loss of length may not alter function significantly, and the patient can undergo immediate rehabilitation. Preservation of length, however, is important in improving grip strength by acting as a longer lever. This may be true in all fingers, particularly the ulnar three digits.

There have been many descriptions of length-preserving procedures in finger amputations. With bone exposed, local, regional, distal and even free flaps have been used to achieve coverage and closure. Atasoy et al (3), Kutler (4), and Venkatasswami and Subramanian (5) have described V-Y advancements, either with volar tissue or lateral tissue to close the distal amputations. Atasoy flaps are best used to treat the dorsal oblique amputations. Bilateral Kutler flaps can advance over angled and transverse distal amputations. A volar scar, however, is common to each of these local flaps. This scar is not infrequently a source of ongoing discomfort on the pressure points of the distal volar finger. Step advancement flaps are neurovascularly intact and require meticulous dissection, achieving similar goals and outcomes as the Kutler flaps (6).

Other local flaps include the Ogo (7) and Flint/Harrison (8) flaps, which use the dorsal skin of the finger for coverage. The Ogo flap is an unipedicled, laterally based flap, trans-
posed from dorsum to distal amputation site. The donor site is then grafted. This flap does not maintain sensation, and the distal vascularity may be somewhat precarious. The Flint/Harrison flap is similar, but is based more proximally and can retain the neurovascular supply, thereby maintaining sensation. This flap, too, may have a limited distal vascularity.

Cross-finger flaps (9) and thenar flaps (10,11) have worked well for coverage, but, again, are not sensate and may interfere with the function of the other fingers or hand because of stiffness or pain. Modifications to the cross-finger flap have incorporated dorsal digital nerves, which are subsequently anastomosed with the volar nerves to achieve a sensate flap (12). These cross-finger, thenar and distant flap procedures require appropriate patient compliance and may be somewhat cumbersome.

Neurovascular island flaps using tissue from adjacent fingers can also be useful in providing sensate coverage (13,14). Similarly, the reverse digital artery flap from the lateral proximal phalanx uses the volar digital neurovascular supply of one side of the finger to provide vascularity and sensation to the flap and, hence, the recipient (15,16). These flaps also require meticulous dissection. More important, the patient may have serious problems due to persistent identification of sensation from the donor rather than the recipient site.

Free pulp transfer has been described for coverage of the distal finger amputations with appropriate neurovascular reconstruction (17-19). This can provide appropriate sensate coverage. Volar scars may still be present. Of more significance, the patient must undergo a lengthy operation and ex-
tensive hospital stay. This also requires microsurgical expertise, specifically notable for the small distal diameter of the distal digital vessels and nerves.

The visor flap was designed to address the goals of distal finger amputations. Length, sensate, vascularized padding and minimal volar scars are preserved with this procedure. The visor bipedicled flap is applicable for transverse amputations of the fingers taking advantage of the dorsal branches of the volar digital nerves and vessels (16). This reliable flap can be easily executed under local anesthesia in an adequately equipped emergency department, allowing the patient to be discharged immediately. After one week, mobilization of the digits is started to prevent stiffness in the remaining joints. As time progresses, the skin graft on the dorsum of the finger contracts, the dog ears are eliminated and the volar scars migrate dorsally.

The benefits of preservation of the bone length have been discussed above. It should be recognized, though, that preserving very small distal bony segments (close to the joints) may result in untoward flexion deformity. These cases may be best served by resecting this bony segment and allowing for primary closure.

The visor flap is introduced to provide the hand surgeon with an attractive alternative for coverage of transverse amputations of the middle and distal phalanges and can be considered for the more distal level of proximal phalangeal amputations.

Figure 8) Amputation of the long, ring and little fingers at the middle phalangeal joint. The visor flap has been transposed distally on the long finger.

Figure 9) Top and bottom. Two-year follow-up of the long, ring and little finger amputation. The stumps are rounded and well padded, and length is preserved. No revisions have been performed.
REFERENCES