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ORIGINAL ARTICLE

Digital coverage with flaps from the same or neighboring digits

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Abstract

Objective: Several flaps can be dissected from the same or neighboring digits for the reconstruction of relatively large soft tissue digital defects.

Material and Methods: In a 6-year period, 106 large soft tissue digital defects were reconstructed with the use of flaps in 101 patients. For the reconstruction of 75 fingertip defects 73 neurovascular, island or advancement flaps (42 homodigital, 18 heterodigital, 13 advancement) and 2 thenar flaps were used. The 31 defects of the proximal and middle phalanges were reconstructed with 3 intermetacarpal and 28 cross-finger flaps (17 de-epithelialized and 11 classic for dorsal and palmar defects respectively).

Results: All flaps survived. Subjectively, the results were rated as good or excellent in 69 of 73 distal defects reconstructed with neurovascular island or advancement flaps and in 29 of 31 proximal defects treated with cross-finger and intermetacarpal flaps. The mean DASH score was 4.1 and 3.34 for the neurovascular island/advancement flaps and the cross-finger flaps respectively.

Conclusions: This study elucidates the indications and presents the advantages and disadvantages of flaps used for reconstruction of proximal and distal digital defects. Good results can be obtained with appropriate flap selection and meticulous surgical technique. Hippokratia 2011; 15 (2): 153-156

Key words: digital defect, fingertip/pulp defect, flap, neurovascular flap, cross-finger flap

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Several flaps from the same or neighboring digits can be used for the reconstruction of extensive digital soft tissue defects with exposure of tendons and/or phalanges[1,2]. The aim of digital soft tissue defect reconstruction with the use of local flaps is to obtain wound coverage and a painless scar, to preserve adequate and functional length of the digit, to preserve the sensibility of the fingertip, and the interphalangeal joint motion[3].

There are three main factors that influence the choice of the most appropriate flap for the coverage of digital soft tissue defects: the size of the defect, its location (fingertip, proximal dorsal or volar) and the functional demands of the patient[2]. Anterior triangular flaps (Atasoy/V-Y flap) are sufficient to cover limited fingertip defects[4] whereas larger soft tissue defects require more sophisticated techniques. For fingertip reconstruction homodigital or heterodigital neurovascular island flaps provide coverage of the exposed phalange with skin possessing similar properties to the pulp[5-8]. For more proximal reconstruction, proximal/middle phalanges and proximal/ distal interphalangeal joints (PIP/DIP joints), the cross-finger flaps are useful alternatives[9-12], along with island flaps from the dorsum of hand (intermetacarpal and dorsocommissural flaps)[13,14]. Because of the unique functional requirements of the thumb, specific flaps have been proposed for thumb defects[7,15,16]. Apart of the superior aesthetic result, all these flaps also offer a gliding layer of tissue over the tendons, minimizing formation of adhesions.

In this study, we report the management and outcome of 106 large digital soft tissue defects with the use of alternative flaps from the same or neighboring digits. We focus on the comparison of two reconstructive options, the neurovascular island flaps and the cross-finger flaps, for coverage of relatively large digital soft tissue defects.

Material and Methods

In a 6-year period (2001-2007), 164 digital soft tissue defects were reconstructed with the use of flaps from the same or neighboring digits in 152 patients. Eight patients with 11 defects were lost to follow-up and were excluded from this study, whereas 47 smaller defects (in 43 patients) reconstructed with V-Y flaps, were also excluded. Thus, the study includes 106 large digital soft tissue defects in 101 patients, 85 male and 16 female (Table 1). The age of the patients ranged from 18 to 72 (mean, 42.4) years. The injuries were agricultural, industrial or domestic. Sixty-four injuries involved the right hand and forty-two in the left, and the distribution of the soft tissue defects in the fingers was as following: 17 thumb, 41 index, 28 long, 14 ring, and 6 small finger defects. The majority of injuries (75) were located at the fingertip and from the proximal 31 defects, 20 were dorsal and 11 were palmar.

For distal soft tissue defects 2 thenar flaps[17] and 73

Table 1: Alternative flaps used for the reconstruction of large digital defects.

Flap	Number
Neurovascular island	60
Advancement	13
Thenar	2
Cross-finger	28
Intermetacarpal	3

Table 2: Flaps for reconstruction of large distal defects.

	Thumb	Index	Other fingers
Homodigital	-	14	28
Heterodigital	2	14	2
Advancement	13	-	-
Thenar	-	-	2

Table 3: Flaps for reconstruction of proximal digital defects.

	Dorsal defect	Palmar defect
Classic cross-finger	-	11
De-epithelialized cross-finger	17	-
Intermetacarpal	3	

neurovascular flaps were used: 60 island flaps (42 homodigital and 18 heterodigital) (Figure 1A-B) and 13 advancement (including both neurovascular bundles). The distribution of neurovascular flaps for fingertip reconstruction is shown in Table 2. Cross-finger (28) and intermetacarpal (3) flaps were used for the reconstruction of 31 soft tissue defects of the proximal and middle phalanges to the DIP. For dorsal soft tissue defects 3 intermetacarpal and 17 de-epithelialized flaps cross-finger flaps (Figure 2A-C) were used, whereas 11 classic cross-finger flaps were applied to palmar defects (Table 3).

All patients were evaluated post operatively with objective and subjective criteria. Objective criteria included examination of two-point discrimination, measurement of the range of motion of the PIP and DIP joints, and tip pinch. Patient's subjective opinion was recorded: pain was evaluated with the visual analogue scale (VAS) with scores ranging from 0 (no pain) to 10 (very severe pain). Deformity complaints relating to sensitive scars, neuroma and cold intolerance were also recorded. Finally, the Disabilities of the Arm, Shoulder and Hand (DASH) score was also obtained[18]. The time to return to previous activities was documented and the functional outcome was ranked as excellent, good, fair and poor.

Results

All patients were followed for at least 18 months. The mean follow-up period was 77 months (range 18-91 months). All flaps survived. Static two-point discrimination in the homodigital, advancement and heterodigital flaps ranged from 3 to 10 mm, with an average of 5 mm. Sixty-two of these flaps had a static two-point discrimination between 3 and 7 mm and the remaining eleven flaps between 8 and 10mm.

The range of motion of the PIP and DIP joints was normal in 88 of the reconstructed fingers. The DIP loss of extension for fingers reconstructed with homodigital, heterodigital or advancement flaps was up to 20°. For the PIP joints of the reconstructed fingers the final mean range of motion was 95° (range, 60°-100°) for fingertip reconstruction with neurovascular island/advancement and thenar flaps and 90° (range, 50°-100°) for proximal digital reconstruction with cross-finger and intermetacarpal flaps. This difference was not statistically significant. All patients with loss of range of motion had an associated fracture and/or extensor tendon injury in the same reconstructed digit, indicating that the type of flap no direct effect on the range of motion. Tip pinch for the 43 cases of thumb and index fingertip injuries that were reconstructed with homodigital, heterodigital and advancement flaps, was evaluated with the Jamar dynamometer (Jamar Dynamometer, Sammons Preston, Inc) at the latest follow-up. The average tip pinch of the affected hand was 5.6 kg and the average tip pinch of the contralateral hand was 6.3 kg.

The mean VAS score was 0.3 (range 0 to 2) in patients with neurovascular island/advancement and thenar flaps and 0.2 (range 0 to 2) in patients with cross-finger flaps.

Figure 1:
A: Index finger pulp necrosis after an injection injury.
B: A heterodigital flap from the long finger is used for the reconstruction of the index defect.
C: Two months postoperative result of the donor and recipient site.

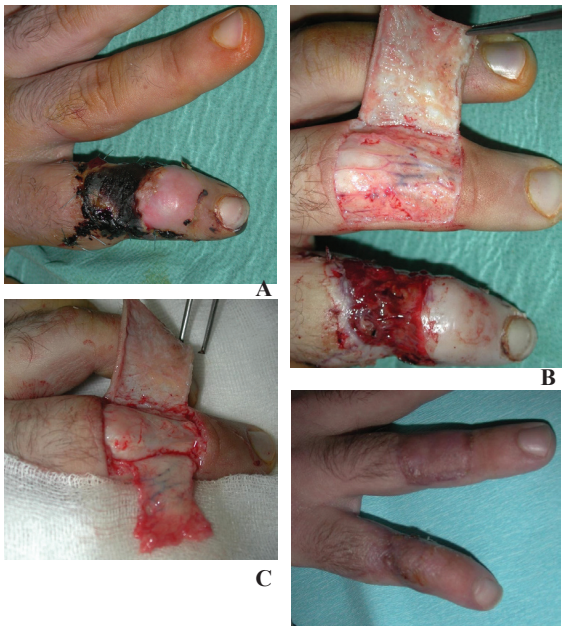

Figure 2:
Reconstruction of an index finger dorsal defect, resulting from necrosis **(A)** with a de-epithelialized cross-finger flap from the adjacent finger **(B,C)**.
D: Ten weeks postoperative result of the donor and recipient site.

There were no complaints about pain at rest or when using the finger, nor for sensitive scars. One patient presented with neuroma of the thumb after an advancement flap that required an additional surgical procedure for excision of the neuroma and reconstruction of the digital nerve. Mild cold intolerance was reported by five patients with neurovascular island flaps and four patients with cross-finger flaps; however, this did not impair function in work and other activities and lasted from 7 to 10 months postoperatively.

The appearance of the reconstructed finger was evaluated subjectively as good in 46 and excellent in 23 of the 75 soft tissue defects reconstructed with neurovascular island/advancement flaps (Figure 1C) and as good in 18 and excellent in 11 of the 31 soft tissue defects reconstructed with cross-finger flap (Figure 2D). The mean DASH score was 4.1 (range 0.0 to 13.3) in patients with neurovascular island/advancement flaps and 3.34 (range 0 to 10.83) in patients with cross-finger flap. All patients returned to their previous occupations within 25 to 90 days (average 32 days for neurovascular island/advancement flaps and 40 days for cross-finger flaps). Thereafter, manual workers continued their work without difficulties. Complications such as infection, delayed healing, complex regional pain syndrome and donor site morbidity were not encountered.

Discussion

The soft tissue digital defects included in our series were the result of recent injuries with relatively large (>1.5 cm), simple or complex tissue loss. Coverage with the appropriate flap provided excellent functional results with sensitivity, which ranged from satisfactory to completely normal.

Depending of the location of the relatively large (>1.5cm) soft tissue digital defect, various flaps may be dissected considering the sensibility and the quality of skin of recipient and donor site. Neurovascular island skin flaps, based on a single neurovascular bundle of the same (homodigital) or neighboring (heterodigital) digit, can be applied to most fingertip amputations, proximal amputation stumps and distal digital defects[7-8]. These flaps provide coverage of the exposed phalange with skin possessing similar properties to the pulp; thus additional shortening and painful stumps are avoided. They also provide reliable vascularity as well as normal sensibility at the fingertip where high quality perception is required. In contrast, the cross finger flaps may leave an insensitive pulp, the sensory return is often inadequate for fine pinch and consequently these flaps are not desirable for the reconstruction of fingertip injuries.

Cross-finger flaps can be used for more proximal digital defects of the fingers (proximal and middle phalanges, palmar-dorsal site) and for partially amputated thumb tip[9-12]. Flaps from the dorsal side of the adjacent donor digit can either cover a palmar (classic flap) or dorsal defect (de-epithelialized cross finger flap) of the recipient digit[9-12]. Island flaps from the dorsum of hand may be used for the reconstruction of proximal defects of the fingers, dorsal (intermetacarpal / dorsocommissural flaps) and palmar (dorsocommissural flaps). Finally, for injuries of the thumb specific flaps can be dissected such as the heterodigital neurovascular island flaps, the kite flaps and the volar advancement flaps (including both neurovascular bundles)[13,15]. The advancement flaps have the advantages of homodigital flaps: vascular and neural continuity that restores sensibility, and advancement of skin that preserves the length and joint mobility, and offers a well-padded tip.

The dissection of neurovascular island flaps requires the sacrifice of one neurovascular bundle of the finger. On the contrary, the cross-finger flaps are based on a network of of multiple longitudinally oriented vessels of the dorsum of the finger. These flaps are not indicated when the neurovascular bundle is injured, in crush or avulsion injuries and when there is a history of vascular disease. The dissection of the homodigital/heterodigital neurovascular island flap although technically more demanding, can be concluded in a single procedure, whereas cross-finger flaps must be separated in a secondary stage (division of the flap 3 weeks later under local anesthesia or general anesthesia in case of children). In addition, the immobilization of the adjacent digit before flap division in the case of cross-finger flaps, may result in stiffness of the finger, whereas the inadequate immobilization may lead to flap dehiscence or skin graft loss[19,20].

Our results confirm that function and final cosmetic appearance of the reconstructed digits is similar after re-

construction with neurovascular island/advancement or cross-finger flaps. Similar results are reported in the literature although the majority of the studies describe the surgical techniques of specific flaps. The few studies in the literature where series of patients with soft tissue digital defects are reported are limited, including 20-50 patients, without comparison of different types flaps[5,6,8,9,13,16,19,20,21]. Comparative studies include modifications of specific techniques of either neurovascular island flaps or cross finger flaps[7,12].

The above types of flaps for digital reconstruction require knowledge of the micro-vascular anatomy of the hand, of the functional requirements of each digit/location, and familiarity with microsurgical dissection. Careful selection and preoperative planning of the flap is needed to provide coverage of the pulp, to preserve the length of injured finger, to prevent adjacent joint contracture and to minimize donor site morbidity.

In conclusion, in cases of soft tissue digital defects the restoration of function and appearence without postoperative complications is feasible through the use of appropriate flaps for each digital segment and meticulous surgical technique .

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