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Volar V-Y advancement flap without suturing of proximal part for reconstruction of fingertip amputations

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ABSTRACT

Purpose: This study aimed to assess the results of volar V-Y advancement flap surgery without suturing the proximal part to reconstruct fingertip amputations.

Methods: Between 2018 and 2020, 18 patients (16 males, 2 females) who underwent volar V-Y advancement flap surgery without suturing the proximal part due to a fingertip amputation were retrospectively identified and included. All the clinical outcomes were obtained at the final follow-up appointment. The total range of motions of injured fingers and the same ones of the contralateral healthy DIP (distal interphalangeal) joint were measured. Fingertip tenderness was measured with Visual Analog Score (VAS). Cold intolerance and two-point discrimination (2PD) were assessed in the flap area.

Results: The mean age was 37 (range = 19–62) years, and the mean follow-up was 15 (range = 12–22) months. The thumb was injured in 5 patients, index finger in 7, long finger in 4, ring finger in 1, and little finger in 1. Partial or total flap necrosis was not encountered in any patient. There was 17.5 (range= 0-30)% deficiency in DIP joint range of motion in the injured finger compared to the contralateral healthy finger (p=0.38). The mean VAS for fingertip tenderness was 0.11 (range = 0–1). While no cold intolerance was encountered in 14 patients, it was minimal in 2 patients, mild in 1, and severe in 1. 2PD rate increased by 45% (range = 0–120) compared to the contralateral healthy finger($p < 0.034$). Sensory function was preserved in all patients.

Conclusion: Volar V-Y advancement flaps without suturation of the proximal part can offer good clinical and aesthetical outcomes, protect the finger contour, and reduce the risk of flap necrosis.

Key words: *Volar V-Y advancement flap, fingertip amputations, reconstruction surgery*

Introduction

Fingertip amputations can usually be seen in upper extremity injuries. Enough functionality and aesthetically satisfactory outcomes can be achieved with a successful replantation. However, it could fail in some cases because of the reasons such as type of injury, unsuitability of the vascular structures in the amputated part, technical restrictions, absence of advanced microsurgery experience, and lack of the required equipment. Several skin closure methods can be applied, such as composite graft, cross finger, thenar-hypothenar-abdominal flap, and stump closure with bone shortening

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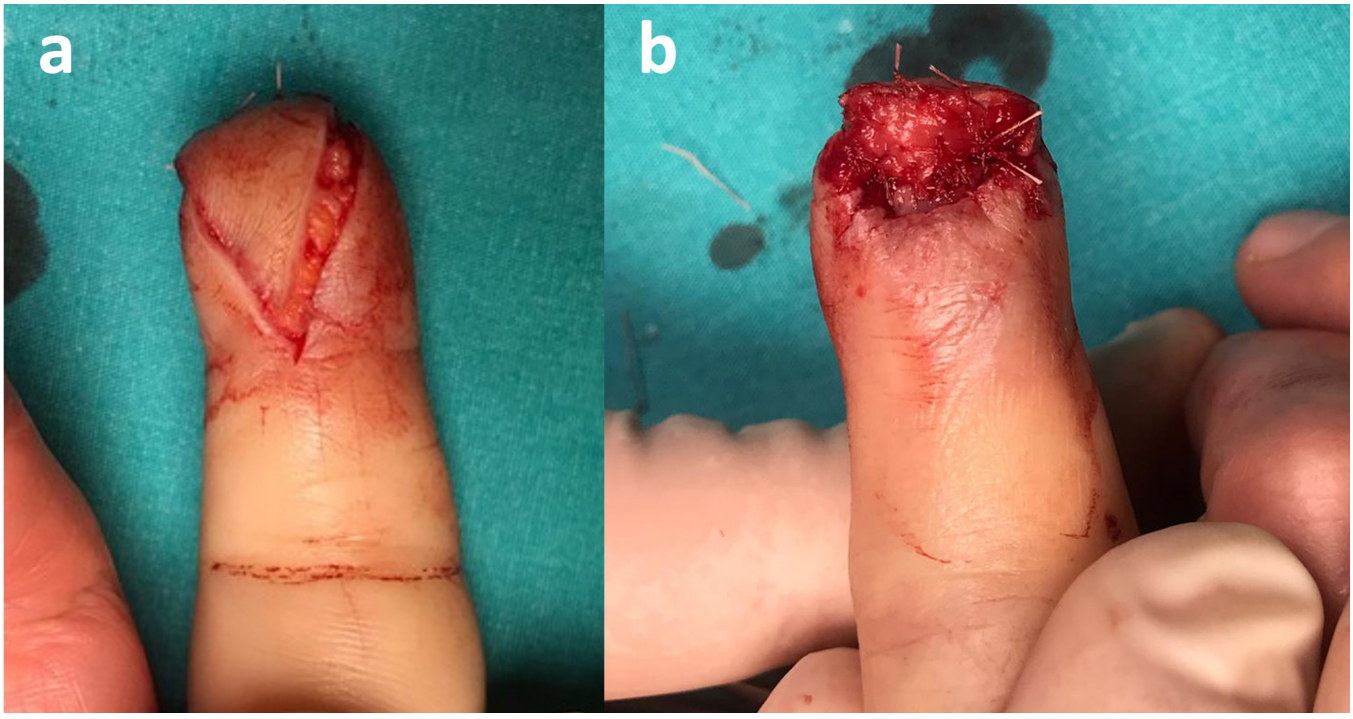

Figure 1. Volar V-Y advancement flap surgery without suturing the proximal part of the flap for reconstruction of a fingertip amputation **(a).** The distal part of the flap is sutured to the nail bed with sutures without tension **(b).**

if the replantation is an unsuitable option for the patients [1,2].

Current methods' superiority over each other has not been proven, even though they have different advantages and disadvantages [2,3]. The common goal of reconstruction is to obtain a fingertip that assists grip function, preserves finger length, has minimal donor region morbidity, and has a suitable aesthetic appearance and good functional results. Although volar V-Y advancement flap (Atasoy) is an easily applicable and practical method for the closure of transverse or dorsal oblique fingertip defects [4], this technique can cause reduce in the circumference of the pulp, hook nail, and flap necrosis. To overcome such problems, some fingertip reconstruction techniques in which the proximal part of the flap is not sutured have been described in the literature [5,6]. However, according to our literature review, little is known regarding such fingertip reconstruction techniques' clinical and functional results.

For the last few years, we have consecutively performed a volar V-Y advancement flap without suturing the proximal part for the reconstruction of fingertip amputations to protect the pulpal contour of the finger and reduce the risk of flap necrosis. The current study aimed to present our clinical outcomes and experience with this fingertip reconstruction technique.

Materials and Methods

The medical records of 23 patients who underwent volar V-Y advancement flap procedure due to fingertip amputations between 2018 and 2020 in our institution were retrospectively reviewed. Inclusion criteria were: (1) a diagnosis of Allen type 1 to 3 fingertip amputation, (2) ≥18 years of age, (3) at least 12 months of follow-up, (4) complete clinical medical records. Exclusion criteria included: (1) a history of failed replantation or composite graft surgery, (2) amputation for any reason other than trauma (neoplasm, infection, etc.), or (3) distal interphalangeal (DIP) joint involvement.

All the patients were evaluated based on the above eligibility criteria. After excluding five patients (4 were lost to follow-up, one was under 18 years old), the remaining 18 (16 males, 2 females) patients were invited

Figure 2. Clinical appearance of a fingertip amputation reconstructed by volar V-Y advancement flap without suturing proximal part 14 months after the operation.

to a final follow-up examination. The Institutional Review Board approved this study before data collection, and all participants gave informed consent.

Surgical Technique and Postoperative Management

All patients underwent similar surgical methods. Surgical prophylaxis (2 g cephazolin IV) was performed. The digital block was applied with 2-3 mL %0,5 Bupivacaine Hydrochloride. Local anesthetics combined with epinephrine were not preferred because of the disruption risk of the blood circulation in the flap. A triangular flap was designed with a marker pencil to form a V-shaped line starting from the wound edges with the apex on the DIP joint line. Surgical procedure with loupe using x2.5 zoom started after application of finger tourniquet.

The borders were determined by debridement and irrigation of the defect. An incision was made down to the subcutaneous tissue with a number 15 scalpel. The whole deep septa were dissected from both sides and distal of the flap by sharp scissors perpendicular to the skin and parallel to the fibrous septa. The movement to the distal of the flap, which was released from the flexor tendon sheath and periosteum, was checked. Flap viability was also checked at this stage by removing the tourniquet. One temporary 22 gauge needle was used to fix the flap to the distal phalanx to acquire flap stability and enable suture. The distal part of the flap was sutured to the nail bed with as few as possible 5-0 sutures without tension. 22 gauge needle was removed. No suture process was held for the proximal part of the flap, and the defect was left open and allowed to heal by secondary intention (Figure 1). After the surgical process, the area left open was dressed with mupirocin ointment (2%). Coban (3M) bandage was not used because of the risk of increasing flap pressure. We did not prefer the brace application.

Because the defective area was left open, it was irrigated and dressed with mupirocin ointment (2%) once two days until the secondary healing was obtained. After secondary healing, the sutures at the distal part were removed, and the dressing application finished. After a three-week control, use of the hand without any restriction was allowed with a home exercise program supported by a physiotherapist. Six-week, three-month, six-month, and twelve-month controls were carried out (Figure 2). Additional control was not suggested as long as there was no new patient complaint.

Clinical, Functional, and Aesthetic Evaluation

An independent hand surgeon, who did not attend to any of the operations, conducted the final follow-up assessment. Medical records are evaluated retrospectively. Necrosis found on the flap, durations of dressing process, time to return to the old job, and the job that needs the patient to use an operated hand were noted. The total range of motions of injured fingers and the

same ones of other hand DIP were measured with a goniometer comparatively. The difference between both fingers was determined as a percentage. Fingertip tenderness was measured with Visual Analog Score (VAS) by examination held with palpation. Cold intolerance was reported as no, minimal, mild, or severe [7].

Two-point discrimination (2PD) was measured in mm both in the flap area where the best response is taken and in the contralateral healthy finger, using Baseline® plastic two-point discriminator instrument (Baseline, White Plains, NY). 2PD ratio was defined as the proportion of the operated finger's value to the healthy contralateral finger. Sensory recovery, hook nail deformity growing, complications, and needs for secondary surgery are noted. Aesthetic and functional satisfaction was graded as very disappointed, disappointed, somewhat satisfied, satisfied, or very satisfied.

Statistical Analysis

All statistical analyses were performed with SPSS software (version 22.0. Armonk, NY: IBM Corp.). Nonparametric paired comparisons were made using the Wilcoxon signed-rank test. A p-value <0.05 was considered significant.

Results

There were 18 patients in the study (16 males; 2 females) with a mean age of 37 (range = 19–62) years. Two patients had comorbidities including diabetes mellitus (n = 1) and arterial hypertension (n = 1). The duration between trauma and surgery was 0.16 (range = 0–1) days. The mean follow-up was 15 (range = 12–22) months. There were ten right and eight left hands, with the dominant hand involved in 11 cases. Thumb, index finger, long finger, ring finger, and little finger were injured in 5, 7, 4, 1, and 1 patients, respectively. According to Allen's classification, 14 patients were type II, and four were type III [8]. In terms of occupations, seven patients were manual workers, five were farmers, two were office workers, two were housewives, one patient was a tradesman, and one patient was a student (Table 1).

Table 1. Demographic characteristics of the study participants.

Number of patients	18
Gender (Female/Male)	2/16
Age (year), mean (min–max)	37 (19-62)
Follow-up (month), mean (min-max)	15 (12-22)
Right/Left Wrist	10/8
Dominant/Nondominant Hand	11/7
Finger involvement	Thumb → 5 patients
	Index finger → 7 patients
	Long finger → 4 patients
	Ring finger → 1 patient
	Little finger → 1 patient
Allen classification	Tip II → 14 patients
	Tip III → 4 patients
Occupations	Manual workers → 7 patients
	Farmer → 5 patients
	Office worker → 2 patients
	Housewives → 1 patient
	Tradesman → 1 patient
	Student → 2 patients
Causes of fingertip amputations	Crush injury → 13 patients
	Laceration → 5 patients

The causes of fingertip amputations were crush injury in 13 patients and laceration in 5. The mean dressing duration was 14.8 (range = 12–20) days. All patients returned to their former occupations, and the mean duration to work with their operated hands was 26.8 (range = 17-34) days (Table 1).

Partial or total flap necrosis was not encountered in any patient. Range of motion (ROM) deficit of DIP was 17.5 (range = 0–30) % in the operated finger compared to the same finger of the contralateral healthy hand ($p = 0.38$). The mean VAS for fingertip tenderness was 0.11 (range = 0–1). While no cold intolerance was encountered in 14 patients, it was minimal in 2 patients, mild in 1 patient and severe in 1 patient (Table 2).

2PD ratio that was comparatively measured to the contralateral healthy finger was 45% (range = 0–120) ($p < 0.034$). Sensory function was preserved in all pa-

Table 2. Preoperative and final follow-up clinical outcomes of the patients.

Variables		P values
ROM deficit of DIP joint (%) mean (min max)	17.5 (0–30)	p = 0.38
VAS for fingertip tenderness mean (min max)	0.11 (0-1)	
Cold intolerance	No → 14	
	Minimal → 2	
	Mild → 1	
	Severe → 1	
2PD (%)* mean (min max)	45 (0-120)	p < 0.034
Aesthetic satisfaction	Very satisfied → 4	
	Satisfied → 11	
	Somewhat satisfied → 2	
	Disappointed → 1	
Functional satisfaction	Very satisfied → 15	
	Satisfied → 3	

ROM = Range of motion; DIP = Distal interphalangeal; VAS = Visual Analog Score; 2PD = Two-point discrimination; * increase in comparison with contralateral healty finger

tients. Hook nail deformity occurred in 3 patients with Allen type III amputation (17%). No patient needed a second surgery (Table 2).

Concerning aesthetic satisfaction, 4 patients were very satisfied, 11 patients were satisfied, 2 were somewhat satisfied, and 1 was disappointed. 3 patients, who stated somewhat or disappointed aesthetically, were patients with a hook nail deformity. Regarding functional satisfaction, 15 patients were very satisfied, and 3 were satisfied (Table 2).

Discussion

Hands and fingers are essential because of their practical support in daily routine and professional skills as well as aesthetic appearance [9]. Therefore, the surgeon's goal should be to provide a good aesthetic appearance besides functionality in hand injuries. In fingertip amputations, the available methods for soft-tissue closure have some advantages and disadvantages, and there is no consensus on which surgical option is the best [2,3,10]. V-Y advancement flaps have been suggested as the optimum surgical technique since other techniques such as cross-finger, thenar, or hypothenar may cause different donor site morbidities [2,3,11]. Techniques such as support with pin fixation and not suturing are defined to reduce tension in the sliding flap in which major complications such as flap necrosis can be seen. This necrosis is usually because of tense suturation or vasospasm caused by inappropriate dissection.

VY advancement flaps' neurosensory, functional and aesthetical outcomes are examined in some studies [3,12]. 2PD of the operated finger was measured 4-10 mm according to the 2PD measurement method, which is the most objective neurosensory function. This means the V-Y advancement flap increases 2PD distance by 0% to 250% compared to the other hand's same finger. A 45% increase was seen in our study, similar to the literature. Mostly DIP and PIP ROM were measured for functional results. Compared to healthy hands, no PIP ROM deficit and significant DIF ROM deficits are found [3]. Proximal interphalangeal joint ROM was not evaluated in our study, whereas passive DIP ROM decreased by 17.5 (range = 0-30) % compared to contralateral healthy hands. This difference was statistically insignificant.

Although subjective aesthetic satisfaction scores are rarely reported in studies, aesthetic satisfaction is associated with developing nail problems rather than fingertip appearance [3]. Previous studies reported a high rate of hook nail deformity as 29-35%. It is considered that tense suturation and bone loss supporting the nail bed from the inferior border cause the hook nail deformity [5,6,12]. Hook nail deformity occurred in 3 patients in our study, and all of these patients were Allen type 3, wherein bone loss is significant. We consider it is lower than the literature because we used more rarely volar V-Y advancement flap in Allen type 3-4 injuries. In previous studies, the tension in the distal flap was reduced by not suturing the proximal part or fixing the flap to the distal phalanx with one pin [5,6]. We used one temporary gauge no:22 needle for fixation, but we

removed it after suturation because of the thought that pin existence could cause flap necrosis. The distal part of our flap was less tense because we did not suture the proximal part, and it can be considered another reason for encountering minor hook nail deformity. In our observation of patients in whom hook nail deformity occurred, their aesthetic satisfaction was less (2 patients were somewhat satisfied whereas one patient was disappointed) compared to others.

VY advancement flaps are short processes that last 5-15 minutes [12]. Surgical time was not measured in our study, but we experienced shorter duration was another benefit of not suturing proximal. It is reported that it takes nearly 21 days to return to their job for patients [13]. We observed that some patients worked without using their operated fingers much earlier. Therefore, we consider the day that they use their operated finger. Mean dressing time for these patients was 14.8 (range = 12-20) days, and they can return to their job using operated fingers in 26.8 (range = 17-34) days.

To protect the finger contour, either flap design with a tapered apex or allowing the secondary defect to heal by secondary healing techniques are defined [2,6]. Our technique was formerly described as a surgical technique; however, its clinical and aesthetical results were not analyzed [5,6]. Francesco et al. evaluated the clinical and aesthetic results of vascular pedicles, which are highly skeletonized and left for secondary healing without suturing proximal to the distal interphalangeal joint line of the apex, which is a routine application in the flap, with a U-shaped design rather than a V-shaped design [12]. Although they did not observe necrosis in their series, the highly skeletonized procedure had a risk of necrosis. Our study applied the standard volar VY advancement flap, defined by Atasoy because there was no need to advance more than 1 cm, and vascular pedicles were not extremely skeletonized. As far as we know, our study is the first study that analyzes clinical and aesthetical outcomes of standard volar V-Y advancement flap surgery without proximal suturation.

When interpreting the present study's findings, some limitations should be considered. The major limitations were its retrospective nature, short follow-up period, limited sample size, and lack of a control group.

In conclusion, volar V-Y advancement flaps without suturation of the proximal part can offer good clinical and aesthetical outcomes and protect the finger contour thanks to less suture and tension, even though it takes a long time for wound care. Therefore, we recommend using this method for the reconstruction of fingertip amputations.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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