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Magdy Abdalmoktader

*Plastic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt*

Usama Abdelfattah

*Plastic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt*

Mohamed Elsayed Badwy

*Plastic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt, Asurgeon2m@gmail.com*

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# Evaluation of Dorsal Digital Artery Perforator (DAP) Flap in Finger Tip Injury Reconstruction

Magdy Abdalmoktader, Usama Abdelfattah, Mohamed E. Badwy \*

Department of Plastic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

## Abstract

**Background:** Finger perforator flaps are also known as digital artery perforator (DAP) flap since their blood supply originates in the correct digital artery. A perforating vessel originating from the digital artery adjacent to the distal interphalangeal joint (DIPJ) is responsible for the flap that is raised on the lateral surface of a finger.

**Aim and objectives:** To evaluate the dorsal digital perforator Flap in fingertip injury reconstruction.

**Subjects and methods:** This study included 20 patients suffering from fingertip injuries. Selected from those who are seeking treatment in the emergency room of the plastic surgery department, Al-Hussien & Bab Elsheria University Hospital, Faculty of Medicine, Alazhar University Nasser Institution Hospital (Cairo).

**Results:** There was no significant difference between 2 points discrimination value between the injured hand and contralateral hand or between injured fingers and other fingers in the same hand. All patients were satisfied with their scar appearance. 3 patients had venous congestion. One patient had a postoperative infection subside by local wound care. 2 patients had superficial ischemia in the flap that healed by the second intention.

**Conclusion:** Dorsal digital perforator flaps appear to provide outstanding functional and aesthetic effects in reconstructing fingertip injuries without compromising the digital artery. In addition to allowing for full active finger motion, the dorsal digital perforator flaps have been related to a low incidence of problems and morbidities.

**Keywords:** Propeller Flap; Fingertip Reconstruction; Perforator Flap, Dorsal Digital Artery Perforator Flap; Dorsal Digital Artery

## 1. Introduction

The fingertip is a specialized structure that enhances the aesthetics of the hand while also facilitating fine motor activity and sensation during prehension. The fingertip is easily damaged since it is the first part of the upper extremity to make contact with the outside world during exploration and manipulating tasks.<sup>1</sup>

The most prevalent issue dealt with by hand surgeons is the repair of soft tissue abnormalities in the fingers. Surgeons of the hand have a difficult time deciding on the best way to repair finger skin abnormalities due to the need for proper flap coverage for retaining finger length and look and for meeting both aesthetic and functional objectives.<sup>2</sup>

V-Y advancement flaps, thenar flaps, cross-finger flaps, or digital artery island flaps are some of the most common methods used to correct skin abnormalities on the fingers.<sup>3</sup> The limitations of these methods, however, are readily apparent. A maximum advancement

distance of 1.0 cm is usually observed for the V-Y advancement flap. A two-step procedure is necessary to implement a cross-finger or thenar flap. Major artery compromise is the result of the digital artery island graft technique. Dorsal perforator flaps are a critical issue in the field of hand surgery that necessitates the development of a novel method of repair for finger skin defects.<sup>4</sup>

Both the dorsal fascia island flap and the propeller perforator flap have been developed for therapeutic use on the basis of anatomical research. Researchers have discovered that the proximal and middle phalanges of the finger each have two or three dorsal perforators of the digital artery. The extensor digitorum aponeurosis receives blood in a segmented pattern. The proximal and distal phalanges receive their blood supply from the branches of the appropriate digital arteries. These branches supply the extensor tendon and dorsal cutaneous tissue and are relatively constant.<sup>5</sup>

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\* Corresponding author at: Plastic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt. E-mail address: [Asurgeon2m@gmail.com](mailto:Asurgeon2m@gmail.com) (M. E. Badwy).

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The aim of this research was to assess the dorsal digital perforator artery ((DAP) Flap in fingertip injury reconstruction.

## 2. Patients and methods

This study was a retrospective trial which was performed on 20 patients suffering from fingertip injuries aged from 6 years to 70 years, both males and females, selected from those who are seeking treatment in the emergency room of the plastic surgery department, Al-Hussien & Bab Elsheria University Hospital, Faculty Of Medicine, Al-Azhar university, Nasser institution hospital(Cairo ) All of them were operated in our operation rooms with the application of organized and simplified approach by doing fingertip injuries reconstruction by dorsal digital perforator flaps.

Inclusion criteria: Age above six years in addition to below 70 years, fingertip injuries with bone or tendon exposed, and distal phalanx defect that causes length defects in the thumb or deformity in other digits.

Exclusion criteria: Patients with age less than six y or more than 70 y, Circumferential defects at the proximal or distal phalanx, Severe Ischemia post-injury at fingers of the hand and Patients suffering from peripheral vascular diseases.

### Methods

#### Initial Assessment:

All cases were initially seen at the emergency room. Thorough examination and assessment were carried out. This included History (Personal history, Present history, Past history) and examination (Screening for other general or local injuries was done following the guidelines of the Advanced Trauma Life Support (ATLS) program. Assessment of the injured Hand).

#### Initial management: Preoperative

investigations: Laboratory investigations, hand x-ray.

Third-generation preoperative surgical chemoprophylaxis Each individual was administered intravenously (IV) cephalosporins, such as one gram of cefotaxime sodium, an hour before surgery to provide time to mark the perforator and plan the flap. Operative technique:

Operations were done under magnification using a magnifying loupe with a tourniquet.

Anaesthesia: With the patient in the supine position, local anaesthesia or regional (ringe block at base of finger) with lidocaine was given to the patient.

The surgical approach: detection of the perforator flap using the Doppler 8MHz for DAP flap or anatomical as the perforator is constant skin marking, Tourniquet application, Prepping and draping, Debridement of the raw area, Dissection and elevation of the flap proximal to distal with preserving the paratenon Flap positioning and coverage of the donor site

primarily or with graft.



Figure 1. Operative technique.

#### Postoperative care and follow-up:

For the first 5-10 days following surgery, the finger is covered in a loose, bulky cotton bandage, and the arm is slightly raised.

Patients were seen with the following frequency: Early diagnosis of problems, including flap venous congestion and ischemia, requires monitoring every 4 hours for the first 48 hours, twice weekly for the first month, or every 2 weeks for the second and third months.

In each visit, individuals were assessed for the following:

#### Wound healing

Flap sensory functions like pain, paresthesia, or anaesthesia. The feeling of the flaps was examined utilizing the static 2-point discrimination (2PD) test, or the total active motion (TAM) of the damaged and donor fingers was assessed utilizing a goniometer during the final follow-up. The updated American Society for Surgery of the Hand standards were used to categorize two-point discrimination (excellent, <6 mm; good, 6-10 mm; fair, 11-15 mm; bad, >15 mm). The Cold Intolerance Scale was used to measure the flaps' susceptibility to cold.

Severity Score (CISS) questionnaire. Mild (0-25), moderate (26-50), severe (51-75), and extremely severe (76-100) were the four categories for the score. A visual analogue scale (VAS) with a 10-cm line scored from 0 to 10, with 0 being the least and 10 being the most severe.



Figure 2. 4 months after operation.



Figure 3. intraoperation.



Figure 4. Postoperatively (A) 1 month later, (B) 2 months later

Statistical analysis

Statistical analysis was performed utilizing SPSS 22nd edition; numeric data were presented in mean ± Standard deviation and were compared using student T-test or one-way ANOVA. Categorical data were presented in frequencies and percentages and were compared using the

Chi2 test. Continuous variables were correlated using the Pearson correlation test. Any p-value <0.05 was considered significant.

3. Results

Table 1. Demographic data.

| PARAMETER             | VALUE                |
|-----------------------|----------------------|
| SEX                   | Male N (%) 12 (60%)  |
|                       | Female N (%) 8 (40%) |
| AGE (YEARS) (MEAN±SD) | 32.1 ± 17.17         |

This table showed that 12 males were included while 8 females joined our study. Mean age of involved cases was 32.1 ± 17.17.

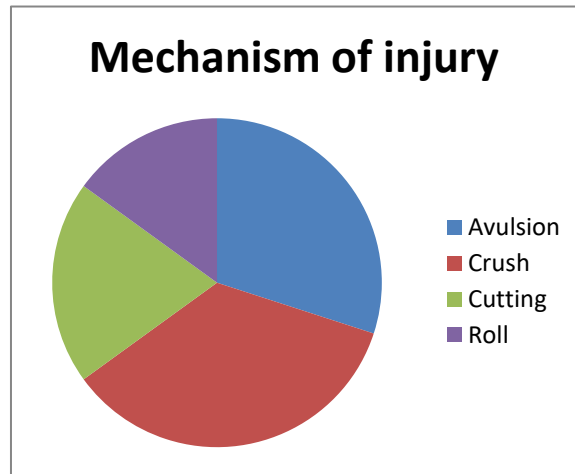


Figure 5. mechanism of injury

Table 2. Injury and flap size

| PARAMETER                      | VALUE       |
|--------------------------------|-------------|
| AVERAGE INJURY SIZE MM         | 4.11 * 1.96 |
| AVERAGE FLAP SIZE (LATERAL) MM | 2.61 * 1.86 |
| AVERAGE FLAP SIZE (DORSUM) MM  | 2.27 * 2.17 |
| GRAFT USE N (%)                | 4 (20%)     |

This table that averages injury size was 4.11 × 1.96. Average lateral flap size was 2.61 × 1.86. Average dorsum flap size was 2.27 × 2.17. 4 patients needed graft take.

Table 3. color change

| SKIN COLOR           | N  | %  |
|----------------------|----|----|
| Normal               | 13 | 65 |
| Hypopigmented (scar) | 2  | 10 |
| Hyperpigmented       | 4  | 20 |

This table showed that 13 patients had normal skin pigmentation.

2 patients had hypopigmented skin. 4 patients had hyperpigmented skin.

Table 4. outcome measured

| OUTCOME                     | VALUE    |
|-----------------------------|----------|
| COMPLETE ROM                | 18 (90%) |
| SATISFYING APPEARANCE N (%) | 18 (90%) |

This table showed that all patients had satisfaction about their scar appearance.

Table 5. Comparison between 2-point discrimination and total active motion in both hands.

|                                     |                | INJURED HAND | OPPOSITE HAND | P VALUE |
|-------------------------------------|----------------|--------------|---------------|---------|
| 2-POINT DISCRIMINATION MM (MEAN±SD) | volar          | 6.4 ± 1.3    | 3.2 ± 0.8     | <0.001  |
|                                     | Dorsum         | 7.2 ± 1.2    | 5.3 ± 0.8     | <0.001  |
| TOTAL ACTIVE MOTION (MEAN±SD)       | Injured finger | 255.3 ± 15.5 | 264.9 ± 15.2  | >0.05   |

P value <0.05: significant. P value >0.05: insignificant

This table showed that there was significant difference between 2 points discrimination value between injured hand and contralateral hand.

Table 6. Complication.

|                         | N | %   |
|-------------------------|---|-----|
| VENOUS CONGESTION N (%) | 3 | 15% |
| INFECTION N (%)         | 1 | 5%  |
| ISCHEMIA N (%)          | 2 | 10% |

This table showed that 3 patients had venous congestion. 1 patient had post operative infection subside by local wound care. 2 patients had superficial ischemia in the flap that heal by 2nd intention.

#### 4. Discussion

When a person touches anything, the sensation is sent to the brain via the fingertip, which is the furthest end of the finger. The distal phalanx, or interphalangeal joint when referring to the thumb, is the anatomically defined end of the finger. This is where the flexor digitorum profundus and extensor tendons insert. <sup>6</sup>

Fingertip degloving injuries are a common form of hand trauma that results in tissue abnormalities and bone exposure and requires reconstruction using broad, innervated tissue flaps. The therapy is to restore physiological function, aesthetic effectiveness, and sensibility. <sup>7</sup>

The main results of this research were as follows:

In our study, we found that 12 males and eight females joined our study. The mean age of included patients was  $32.1 \pm 17.17$ . After evaluation, it was revealed that those 13 patients had injuries on the right side. 5 patients had thumb injury. The other 5 cases had Index finger injuries. 3 patients had a middle finger injury. The other 3 cases had ring finger injuries. 4 patients had little finger injury. Six patients had avulsion tears. 7 patients had crush injuries. 4 patients had a cutting injury. 3 patients had roll injuries.

The average defect size was  $4.11 \times 1.96$ . The average flap size was  $2.61 \times 1.86$ . The average dorsum flap size was  $2.27 \times 2.17$ . Four patients

Our results are consistent with Zhu et al., who aimed to determine how successful the transfer of perforated digital artery flaps was in repairing fingertip deformities. Six examples of fingertip reconstruction utilizing digital artery perforator flaps were examined, with a mean age of 33 years (range, 23-49 years), four men, and 2 females. <sup>8</sup>

In addition, our findings are in accordance with those of Güleç et al., who set out to research and compare the efficacy of two flap procedures for fingertip reconstruction: the innervated digital artery perforator (IDAP) flap

and the homodigital reverse-flow flap. Their research on 33 individuals who underwent fingertip reconstruction utilizing either an IDAP flap (15 patients) or a homo-digital reverse-flow flap (18 patients) revealed that individuals who underwent reconstruction utilizing IDAP flaps had a mean age of  $32.1 \pm 17.17$ . One woman (6.7%) and 14 men (93.3%) made up the total. <sup>9</sup>

In our study, we found that, regarding the mechanism of injury, 6 patients had an avulsion, seven patients had a crush tear, four patients had a cutting tear, and three patients had a roll.

Consistent with the goals of the current investigation by Wang et al., we provide our clinical experience with coupled flaps and assess their efficacy. Using a dorsal digital perforator flap in conjunction with a cross-finger flap for innervated repair, they studied 16 patients (13 males and three women) with fingertip degloving injuries. They discovered that, with regard to the mechanism of damage, four individuals had crushed tears. A roll tear was diagnosed in 1. <sup>10</sup>

In our study, we found that the average defect size was  $4.11 \times 1.96$ , the average volar flap size was  $2.61 \times 1.86$ , and the average dorsum flap size was  $2.27 \times 2.17$ . Four patients needed grafts.

In agreement with our results, Basat et al. found that the flap sizes ranged from 2.50 to 8 cm<sup>2</sup> (average: 4.25 cm<sup>2</sup>), and four patients needed grafts taken. <sup>11</sup>

Our results are consistent with Ozcanli, H., & Cavit, A., who found that flap size was between 2x1 cm and 2.5x1.5 cm. <sup>12</sup>

In our study, we found that 13 patients had normal skin pigmentation, 3 had hypopigmented skin, and 4 had hyperpigmented skin.

Our results are consistent with Wang et al., who reported that the skin tone of 13 individuals was considered normal, whereas that of 1 individual was hypopigmented, and that of 2 individuals was hyperpigmented. <sup>10</sup>

Also, our results are consistent with Ozcanli, H., & Cavit, who found that mild hyperpigmentation was detected in 2 patients. <sup>12</sup>

In our study, we found a significant difference between the 2 points discrimination value of the injured hand and the contralateral hand. There was no significant difference between the injured and donor hands in comparison to the contralateral hand.

The average static 2PDs on the dorsal digital perforator flaps were  $7.3 \pm 1.0$  mm (range, 6-10 mm), while they were  $5.4 \pm 0.7$  mm (range, 4-6 mm) on the contralateral fingers, which is consistent with our findings. The static 2PD average was significantly different ( $P < 0.001$ ) among the contralateral fingers and the dorsal digital perforator flaps. The injured fingers had a mean TAM of  $256.4 \pm 15.2$  (range, 215-273), while the uninjured fingers had a mean TAM of 263.8

$\pm 15.3$  (range, 217-275). The mean TAM of the injured and uninjured fingers did not differ significantly ( $P = 0.2196$ ).<sup>10</sup>

In line with the current study, Güleç et al. found that static 2-point discrimination is an important outcome of fingertip reconstruction, and its mean was  $4.87 \pm 1.88$ .<sup>9</sup>

In our study, we found that three patients had venous congestion, one patient had postoperative infection subsidence by local wound care, and two patients had superficial ischemia in the flap healed by the second intention.

These results are consistent with Güleç et al., who found that three patients had venous congestion.<sup>9</sup>

In accordance with the present research, Özcanlı et al. determined that 12 individuals experienced venous congestion; nevertheless, all cases cleared within a week of surgery with no additional secondary interventions being required.<sup>13</sup>

Also, our results are consistent with Ural, A., who found that one patient had a postoperative infection.<sup>14</sup>

#### 4. Conclusion

Excellent functional and aesthetic outcomes are achieved when the dorsal digital perforator flaps are used to reconstruct the fingertip after injury without compromising the digital artery. Complete active finger motion is preserved with the dorsal digital artery (DAP) perforator flaps, and there is a low risk of complications and morbidity. As a result, the dorsal digital perforator flap could be an effective method for treating various fingertip abnormalities.

#### Disclosure

The authors have no financial interest to declare in relation to the content of this article.

#### Authorship

All authors have a substantial contribution to the article

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#### Conflicts of interest

There are no conflicts of interest.

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