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Reconstructive

A Modification to Enhance the Survival of the Island FDMA Flap by Adding a Skin Bridge

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Background: Distal thumb injuries are common in high construction load regions, and it is a challenging task for the plastic surgeon to find the optimum choice that preserves thumb length and provides a sensory substitute to the lost tissue. Introducing first dorsal metacarpal artery flap has solved the dilemma. One drawback is that the flap is susceptible to distal necrosis, which can happen because of tight tunneling or insufficient venous drainage. We combined Foucher and Holevich characteristics to design a flap that promises to solve the problem.

Methods: This is a case series that includes 9 patients where we describe a technique that has the potential to enhance the survival of the first dorsal metacarpal artery (FDMA) flap and decreases the rate of distal necrosis via addition of a 5-mm skin bridge to the pedicle and by avoiding tunneling. Distal necrosis of the patients in this study patients was compared with that in a control of 10 patients in whom we did the conventional FDMA flap. Patients were followed for 6 weeks to trace early postoperative complications (infection, dehiscence, and necrosis) and the establishment of protective sensation (pain and temperature).

Results: None of our patients had distal necrosis, infection, or dehiscence, and all had protective sensation in the flap. In comparison, 4 patients in the control group developed distal necrosis.

Conclusion: FDMA is one of the best choices when it comes to distal thumb reconstruction, but it has the disadvantage of distal necrosis, which might be avoided when using the technique mentioned in this study. *(Plast Reconstr Surg Glob Open 2021;9:e3434; doi: 10.1097/GOX.0000000000003434; Published online 17 February 2021.)*

INTRODUCTION

Thumb trauma is a common hand injury in areas that have high load of construction work, and most of those injuries are limited to the tip. They are usually associated with exposure of bones and tendons, which mandates proper coverage of soft tissues.

Maintaining as much as a surgeon can of a thumb is required because it is the main functioning finger in the hand.[1] Achieving adequate length, mobility, stability, and sensation are the goals of a functional thumb reconstruction.[2]

The first dorsal metacarpal artery (FDMA) flap is an excellent option for coverage of these defects. It can be raised as a pedicled, island, or reversed flow flap.[3] Anatomically, FDMA is an axial pattern flap, and the blood supply comes from the first dorsal metacarpal artery, which is constant. Sensory branch of the radial nerve can be included in the flap pedicle to be raised as a neurovascular island flap.[4] This flap permits preservation of the whole length of the thumb when compared with other thumb reconstruction techniques described by many authors.[5] It is a one-stage procedure that allows early mobilization of the thumb. All of the above-mentioned factors make FDMA flap the ideal option for coverage of distal thumb defects. The main drawback of this flap is the possibility of distal flap necrosis, which may lead to infections, delayed wound healing, increased recovery time, and the need for further operations. In this study, we describe a technique that increases the flap survival.

METHODS

This study is a case series involving the use of a simple modification that combines characteristics from the conventional FDMA island and Holevich flaps. The procedure was conducted on 9 patients presented with work-related distal thumb injuries (Table 1). All patients were men with a mean age of 36.7 years, and all were construction

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workers who were injured by machines or crushed by heavy objects. All patients had volar tissue losses, and the mean size of the defect was 3.36 × 1.71 cm with tendon or bone exposure (Figs. 1 and 2). Four patients had full thumb length, and all were admitted as emergency cases. In our study, we mention a technique that preserves the venous drainage of the island FDMA flap by adding a skin bridge to the dissection (Fig. 3). The technique was carried out by the same surgeon in all cases. We compared the incidence of necrosis in our technique with that in a series of 10 patients in whom we did reconstruction of distal thumb injuries using the conventional FDMA flap (Table 2). The 2 groups of patients were around the same age, with work-related injuries. We did not conduct a statistical analysis because of the small sample size that would jeopardize the reliability of the study.

The flap was designed at the dorsal aspect of the proximal phalanx of the adjacent index finger. The boundaries were the crease of MCP joint proximally and the crease of PIP crease distally. Marking was done and a 5-mm skin bridge was drawn from the flap to the origin of FDMA at the junction between the bases of the first and second metacarpal bones, which is confirmed by a handheld 10 MHz Doppler.

A tourniquet is used in all cases that makes the surgery smooth and fast by eliminating blood from the field of dissection. The skin bridge contains at least 1 vein and provides excellent drainage of the flap. In our technique, tunneling was avoided, which prevents pedicle compression resulting from several factors, such as inadequate tunneling, edema, or hematoma. Instead, the incision was done from the origin of the artery to the defect along the thumb and the flap was inset.

Initially, using blade 15, a superficial incision (limited to dermis) was made distally and extended all over the marking of the flap. Then, the incision was deepened distally to the subvenous plexus and above the paratenon, a shiny structure over the extensor tendon. Here, when we dissected the skin bridge, we were able to see multiple veins using our X4 field magnifying loops running through the bridge, and we could preserve at least 1 of them. Then, using tenotomy scissors, the flap was dissected in the same plane until passing the distal portion of the sagittal band and then the plane was drawn deeper to include a small portion of the sagittal band proximally and fascia of the interosseous muscle. The dissection continues at that plane just distal to origin of the FDMA. Proper hemostasis was ensured throughout the procedure to all vessels at the edges.

At this point, the tourniquet was deflated and the flap was assessed. There were no worries about whether a bleeding delay from the flap edges would happen, as long as the vessels were nicely filled at the deep surface of the flap, which indicates intact sufficient perfusion. This delay is usually due to spasm and is self-limiting. Proper hemostasis was done, and the wound was closed in 2 layers using 0-4 Vicryl/0-4 Ethilon.

After that, the flap was brought to the defect and a superficial incision was done to inset the flap through it. Then, the flap was sutured to the raw area. We kept the donor area (paratenon) moist throughout the operation to avoid damage and loss of the bed for skin grafting.

We took the full-thickness skin graft from the medial aspect of the forearm, and aggressive defatting was done to enhance the graft intake. A slab for the first week postoperative was used in some cases.

Patients were discharged the second day postoperative after a change of dressing. We kept our patients for 1 day in the hospital for pain management. They were followed up in 1 week, then after 2 weeks, and then after 6 weeks. At each visit, wound-healing complications (dehiscence, infection, and scarring) and flap protective sensation (pain, temperature) were assessed. The pain assessment was done using the pin prick technique. Moreover, temperature was assessed using ice packs for cold, and immersion in warmed water for hot temperatures. The cosmetic result was subjectively assessed by patient opinion because we did not use any scale.

RESULTS

All flaps survived completely, without any necrosis. We did not have infections or wound dehiscence in any case. No keloids or hypertrophic scarring were observed. Two of the flaps had an epidermal blister at 1 week, which was debrided in the clinic, and the flap fully survived without necrosis. We believe that this blister was due to manipulation during procedure and the use of bipolar at the edges of flap. Compared with our control group, the incidence of distal flap necrosis in our technique was 0 of 9 patients (0%), and in the control, it was 4 of 10 patients (40%). All patient had proper pain and temperature sensations at the flap site. The cosmetic results of the wounds were

Table 1. Summary of the Injury Characteristics in the 9 Cases

No.	Gender	Age (y)	Type of Injury	Mechanism of Injury	Size	Necrosis	Wound Complications	Sensation Restoration
1	Man	23	Isolated soft tissue defect	Machinery injury	3 × 2 cm	No	No	Yes
2	Man	31	Tuft frx/soft tissue defect	Heavy object	2.5 × 1 cm	No	No	Yes
3	Man	19	Isolated soft tissues defect	Machinery injury	4 × 2 cm	No	No	Yes
4	Man	45	Comminuted frx distal phalanx/soft tissues defect	Crushing injury	2.5 × 2 cm	No	No	Yes
5	Man	57	Tuft frx/soft tissues defect	Crushing injury	3.6 × 1.5 cm	No	No	Yes
6	Man	33	Isolated soft tissues	Machinery injury	4 × 1.5 cm	No	No	Yes
7	Man	36	Isolated defect	Sharp degloving injury	3.2 × 1.8 cm	No	No	Yes
8	Man	23	Comminuted frx/soft tissues defect	Heavy object	4 × 2 cm	No	No	Yes
9	Man	64	Tuft frx/defect	Crushing injury	3.5 × 1.6 cm	No	No	Yes

Frx, fracture.

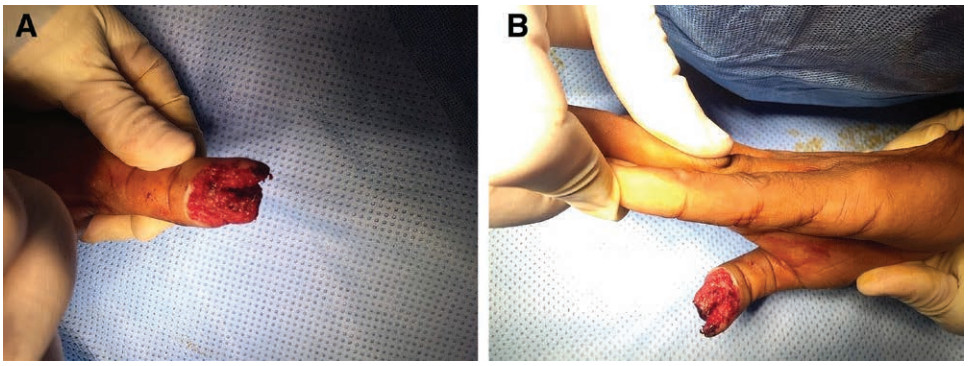

Fig. 1. Preoperative photographs of patient no. 7 in Table 1. A, Thumb defect. B, Mobility of fingers.

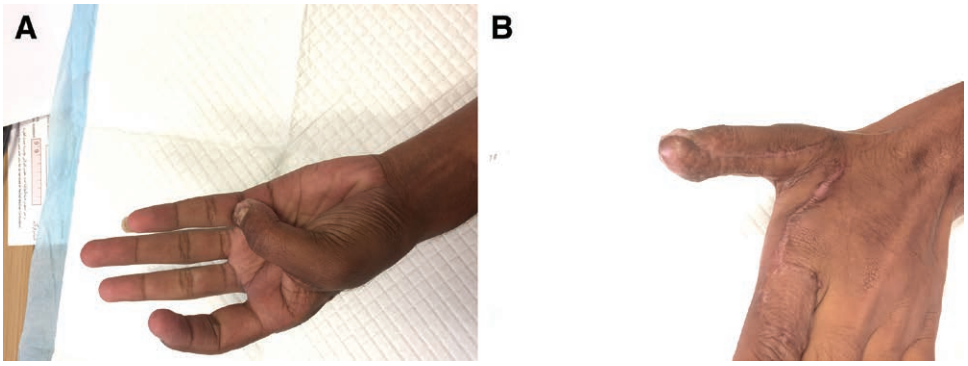

Fig. 2. Postoperative photographs of the same patient after 6 weeks. A, functioning of the thumb. B, Healing results.

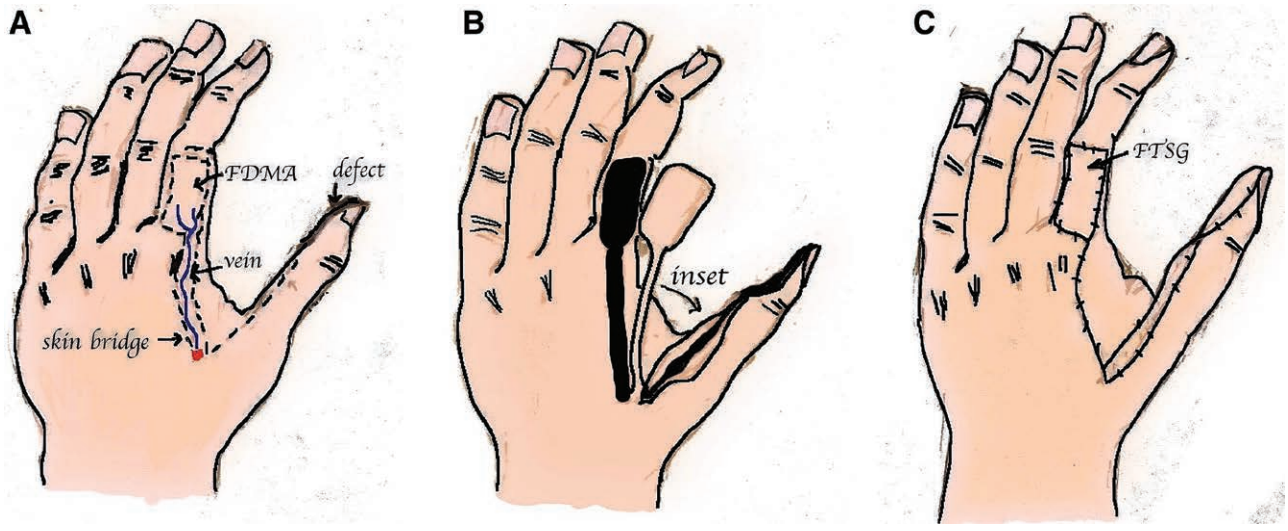

Fig. 3. Illustration of the FDMA flap technique used in our cases. A, Flap is designed with an attached skin bridge overlying the neurovascular pedicle. B, Flap is dissected and drawn to the defect after an incision is made between the origin of the artery and the defect. C, Donor site is closed using FTSG, and the rest with primary suturing.

acceptable in all patients (Fig. 2). No donor morbidity was noticed, and grafts were fully taken and healed properly on the preserved bed in all patients.

DISCUSSION

Distal thumb complex injuries were considered a challenging task to plastic surgeons owing to the need of preservation of the thumb length along with intact sensation. The use of the dorsal skin of the index finger to provide sensate skin cover in thumb injuries has been described by several authors. Many of these techniques have been 2-stage procedures and lacked the ability to reach the very far tip, which required shortening of the thumb.[5] Island FDMA flap (kite flap) was first described

Table 2. Summary of the Injury Characteristics in the Control Group

No.	Gender	Age (y)	Mechanism of Injury	Size	Necrosis
1	Man	23	Machinery injury	1.5 × 2 cm	Distal third
2	Man	35	Electric grinder	1.7 × 2.5 cm	Distal third
3	Man	27	Machinery injury	1.6 × 1.7 cm	No
4	Man	27	Machinery injury	2 × 2 cm	No
5	Man	41	Machinery injury	1.5 × 2 cm	No
6	Man	32	Heavy object	2 × 2.5 cm	Distal half
7	Man	20	Crushing injury	1.5 × 2 cm	Distal third
8	Man	33	Machinery injury	1.5 × 2.5 cm	No
9	Man	45	Machinery injury	1.3 × 2.5 cm	No
10	Man	28	Machinery injury	2 × 2.1 cm	No

by Foucher and Braun in 1979. It helped in maintaining the thumb length and was developed to include a sensory branch during dissection. Thus, as an island sensory flap, the FDMA flap has proved to be very useful in resurfacing of distal palmar and even dorsal defects of the thumb, as noted by Small and Brennen.[4]

The vascularity of the FDMA flap is maintained when the whole inter-osseous muscle fascia is included, which avoids the need for meticulous dissection of the artery that could lead to injury and loss of the flap.[6,7] In addition, its elevation does not involve the loss of a major arm artery like the radial when compared with using radial forearm flaps, to cover thumb defects.[8]

The main drawback is the necrosis of the distal part of the flap that could lead to further complications like delayed wound healing, infection, or even the need for further surgeries. This can be attributed to the tunneling of the island flap under the skin, which can become tight in the next several postoperative days because of the accumulation of a hematoma or edema. Another important cause could be the insufficient venous drainage of the flap that would lead to distal tip congestion and necrosis. One of the most common complications associated with the perforator flap is venous insufficiency, which leads to venous congestion, edema, and other related consequences.[9,10] Fang et al, in their study on rats, concluded that adding a skin bridge to a perforator flap is much more important as an additional route for vein drainage than for arterial input.[11]

In this study, we described a technique that eliminates both factors by adding a 5-mm skin bridge that includes at least 1 vein to optimize the drainage. Moreover, we did not use a tunnel to deliver the flap to the recipient raw area. Instead, we made a superficial incision from the origin of the FDMA to the injury site along the thumb and the flap was fit in place. Holevich (racquet) flap, which was introduced in 1963, has similar characteristics.[12] It was developed to ensure sensational reconstruction of the thumb. The main difference between the Holevich technique and our technique is that we were able to design a narrower skin bridge that contained a visible vein, which allowed minimizing the donor area that needs grafting. It also decreased the risk associated with morbidities. In our case, the graft did not cross the MCP joint compared with Holevich, which needed a bigger graft because of a bigger donor. In addition, we were able to supercharge the flap with a vein to avoid congestion.

Couceiro and Sanmartín compared 5 patients operated using the Holevich technique with 5 patients in whom the island FDMA technique is performed. The results showed less congestion and necrosis in the Holevich group.[13]

In comparison with Satish et al, who reported 1 incident of distal necrosis out of 9 (11.1 %), and Ghoraba et al, who had 1 distal necrosis out of 15 (6.6 %), we did not have necrosis in any of the 9 FDMA flaps that we used.[1,14] We followed our patients for 1 month to observe the wound healing process, and all our patients' wounds healed properly, with acceptable scars and hand function. This study aimed to introduce a new technique that could help enhance the survival of the FDMA.

There are some limitations in our study. Firstly, the study is a case series with a small sample size, which limited the ability to run a proper statistical analysis and comparison. Secondly, our cosmetic satisfaction assessment was subjective (patient opinion) because we did not use any scaling system. Thirdly, challenges in flap harvest that may lead to pedicle injury and flap necrosis were not discussed here because we are assuming the preservation of the pedicle in our comparison. We recommend testing this technique on a larger sample to get more reliable results, and following up the patients for a longer period for better assessment of aesthetic and functional outcomes.

CONCLUSIONS

FDMA is one of the best options to reconstruct distal thumb injuries, and for preserving the whole length of the thumb, it becomes a priority. In our article, we presented a simple technique that has the potential of increasing the survival of the FDMA flap and decreasing the rate of distal necrosis. It also eases and fastens the dissection during the procedure.

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