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. Achieving adequate length, mobility, stability, and sensation are the goals of a functional thumb reconstruction.

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. 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. This flap permits preservation of the whole length of the thumb when compared with other thumb reconstruction techniques described by many authors. 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.
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 shiny structure over the extensor tendon. Here, when we dissected the skin bridge, we were able to see multiple

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 fxr/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 fxr distal phalanx/soft tissues defect | Crushing injury | 2.5 × 2 cm        | No       | No                  | Yes                  |
| 5   | Man    | 57      | Tuft fxr/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 fxr/soft tissues defect | Heavy object     | 4 × 2 cm          | No       | No                  | Yes                  |
| 9   | Man    | 64      | Tuft fxr/defect              | Crushing injury  | 3.5 × 1.6 cm      | No       | No                  | Yes                  |

FrX, fracture.

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
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. Island FDMA flap (kite flap) was first described
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 Brennan.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.5 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.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 cases and fastens the dissection during the procedure.

Mohamed Badie Ahmed, MD Candidate
College of Medicine, QU Health
Qatar University
Doha, Qatar
E-mail: ma1510062@qu.edu.qa
ORCID: 0000-0001-8727-9101

ACKNOWLEDGMENTS

We acknowledge Qatar National Library for funding the open access fee for this publication. We are grateful to the peer reviewers for their valuable comments and feedback that led to substantial
improvement of this article. No ethical approval was needed for this study.

REFERENCES
1. Ghoraba SM, Mahmoud WH. Outcome of thumb reconstruction using the first dorsal metacarpal artery Island flap. World J Plast Surg. 2018;7:151–158.
2. Valauri FA, Buncke HJ. Thumb reconstruction–great toe transfer. Clin Plast Surg. 1989;16:475–489.
3. Sherif MM. First dorsal metacarpal artery flap in hand reconstruction. II. Clinical application. J Hand Surg Am. 1994;19:32–38.
4. Small JO, Brennen MD. The first dorsal metacarpal artery neurovascular island flap. J Hand Surg. 1988;13:136–8.
5. Ratcliffe RJ, Regan PJ, Scerri GV. First dorsal metacarpal artery flap cover for extensive pulp defects in the normal length thumb. Br J Plast Surg. 1992;45:544–546.
6. Foucher G, Braun JB. A new island flap transfer from the dorsum of the index to the thumb. Plast Reconstr Surg. 1979;63:344–349.
7. Krag C, Rasmussen KB. The neurovascular island flap for defective sensibility of the thumb. J Bone Joint Surg Br. 1975;57:495–499.
8. Soutar DS, Tanner NS. The radial forearm flap in the management of soft tissue injuries of the hand. Br J Plast Surg. 1984;37:18–26.
9. Hallock GG. Lower extremity muscle perforator flaps for lower extremity reconstruction. Plast Reconstr Surg. 2004;114:112–1130.
10. Galanis C, Nguyen P, Koh J, et al. Microvascular lifeboats: A stepwise approach to intraoperative venous congestion in DIEP flap breast reconstruction. Plast Reconstr Surg. 2014;134:20–27.
11. Fang F, Zhang Z, Wang K, et al. The skin bridge is more important as an additional venous draining route in a perforator-plus flap. J Surg Res. 2019;234:40–48.
12. Holevich J. A new method of restoring sensibility to the thumb. J Bone Joint Surg Br. 1963;45:496–502.
13. Couceiro J, Sanmartin M. The Holevich flap revisited: A comparison with the Foucher flap, case series. Hand Surg. 2014;19:469–474.
14. Satish C, Nema S. First dorsal metacarpal artery islanded flap: A useful flap for reconstruction of thumb pulp defects. Indian J Plast Surg. 2009;42:32–35.