Volar Resurfacing of the Thumb with a Superficial Circumflex Iliac Artery Perforator Flap after Hydrofluoric Acid Burn

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Abstract

A right-hand-dominant 55-year-old male automotive mechanic presented 24 hours following a hydrofluoric acid burn to the volar left thumb. Despite the severity of soft tissue injury, the neurovascular bundles were intact. Although a free toe-pulp flap is often described to cover volar digit defects, the resultant 6- × 4-cm full-thickness injury of the thumb was too large to be adequately covered by a toe-pulp flap or other commonly used local flaps from the ipsilateral hand. The authors used a superficial circumflex iliac artery perforator (SCIP) flap to reconstruct the volar surface of the thumb from the tip to the metacarpophalangeal joint. They used an arterial anastomosis with the princeps pollicis artery so that the anastomosis was well outside the zone of injury. The patient recovered from the procedure without event and was discharged home on postoperative day 5. At his 2-week postoperative visit, protective sensation with diminished light touch was intact. The authors conclude that the SCIP flap is a technically challenging but versatile, thin flap with minimal donor site morbidity that can be used to resurface the volar aspect of the thumb. The SCIP flap is a valuable resource for the hand surgeon confronted with larger soft tissue defects of the hand.

Keywords

- hydrofluoric acid burn
- thumb reconstruction
- princeps pollicis artery
- superficial circumflex iliac artery perforator flap

Introduction

Hydrofluoric acid (HFA) is a chemical commonly used for industrial and household purposes.^{1,2} Despite its versatility, it is a dangerous acid that can destroy bone and soft tissue on contact. HFA is a weak acid with a high dissociation constant. Owing to this and the frequent dilution of the chemical for regular use, HFA burns may initially go unrecognized. It is not until the fluoride ions have bound free calcium in deeper tissues, altering cellular membrane permeability to potassium and causing severe pain, that the individual is alerted to contact with the chemical. Prompt treatment with decontamination and topical calcium gluconate to bind the fluoride ions is essential.²

Based on the extent of injury, debridement and reconstruction are often required. A free toe pulp flap is commonly

described to resurface small HFA burns to the thumb and finger tips.^{3–5} However, these flaps are inadequate to cover larger areas of damage to the hand and fingers.

Case Report

The patient is a healthy 55-year-old right-hand-dominant man who works as an automotive mechanic. The patient sustained an HFA burn to the left thumb 24 hours prior to presentation. He was working with HFA when he noted a hole in the thumb of his left glove. He washed his hands thoroughly. He did not detect any pain or injury to the thumb and returned to work. However, the following day, he noted significant pain, swelling, and discoloration of the volar aspect of the left thumb, extending from the tip to the metacarpophalangeal joint (MCPJ) crease (► **Fig. 1**). Upon arrival to the emergency

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Fig. 1 Preoperative appearance of the left thumb. The extent of injury was from the thumb tip to the metacarpophalangeal joint crease. The distal nail plate was removed to reveal that the nail bed was spared.

room, the affected thumb was copiously irrigated and topical calcium gluconate was applied until pain resolved. Serum potassium, free calcium, and magnesium were monitored, and the patient was maintained on telemetry. Plain films of the affected area demonstrated no cortical erosion of the underlying bone.

On physical examination, the affected thumb was exquisitely tender. Sensation to deep pressure was intact. Range of motion at the interphalangeal joint (IPJ) and MCPJ was preserved. The radial and ulnar digital neurovascular bundles demonstrated biphasic flow on Doppler auscultation.

Operative Details

The following day, the patient was taken to the operating room for debridement and coverage. Upon incision of the affected area, liquefactive necrosis of the tissue was evident (►Video 1). The resultant defect was 6 × 4 cm of full-thickness soft tissue loss. The flexor pollicis longus (FPL) tendon and the radial and ulnar neurovascular bundles were intact (►Fig. 2). No soft tissue padding remained on the volar surface of the thumb.

A superficial circumflex iliac artery perforator (SCIP) flap was designed on the ipsilateral groin and harvested as previously described (►Fig. 3).⁶ To avoid the zone of injury on

Fig. 2 The resultant defect after debridement of necrotic tissue yielded a 6- × 4-cm defect with intact flexor pollicis longus tendon and radial and ulnar neurovascular bundles, but no soft tissue padding.

Fig. 3 The superficial circumflex iliac artery perforator (SCIP) flap raised on the medial perforator prior to ligation.

the thumb, the princeps pollicis artery was identified and used for arterial anastomosis. A dorsal vein was identified for venous anastomosis. The arterial anastomosis was approximately 0.6 mm in diameter and hand sewn. The venous anastomosis was performed with a 2.0-mm venous coupler.

Outcome

The patient was discharged on postoperative day 5 without complication. At his 2-week postoperative visit, he reported an easy recovery. Semmes-Weinstein monofilament testing demonstrated 3.61 monofilament (0.4 g of pressure) sensitivity, which is consistent with protective sensation but diminished light touch. Although the flap remained mildly edematous and bulky for the volar thumb, the patient was quite happy and eager to return to work (►Fig. 4). He was addressing the edema with wrapping and occupational therapy. He returned to work immediately after the 2-week visit. He has not returned to clinic for follow-up since then.

Video 1

Intraoperative debridement of the left thumb, 3 days after HFA exposure, demonstrating liquefactive necrosis of the soft tissues. Cultures from the fluid were sterile. Online content including video sequences viewable at: www.thieme-connect.de/products/ejournals/html/10.1055/s-0038-1630146

Fig. 4 Two-week postoperative visit. Although the flap is mildly edematous and bulky at this early stage, Semmes-Weinstein monofilament testing demonstrated sensation at 3.61 (0.4 g pressure).

Discussion

The authors report a case of an HFA burn to the thumb that was successfully resurfaced with a SCIP flap. This reconstruction resulted in preserved protective sensation as well as durable and adequate soft tissue coverage for the volar surface of the thumb. Although the toe pulp flap has traditionally been described for such injuries,³⁻⁵ a toe pulp flap would not provide adequate soft tissue coverage for this defect. Other reconstructive options might include the heterodigital island flap or the first dorsal metacarpal artery (FDMA) flap. The aforementioned neurovascular flaps are not without morbidity, much of which is at the expense of other areas of the hand. Additionally, they do not consistently yield cortical reorientation,⁷ and often cannot cover a defect of this size.⁸ Furthermore, with neurovascular bundles intact, it is unnecessary to use a neurotized flap for reconstruction. In this case, the authors believe that the early return of protective sensation was due to the thin SCIP flap overlying the intact neurovascular bundles that allowed for some perception of light touch. They found that a thin free flap was the best option to provide thin but robust coverage for a defect of this size.

The SCIP flap is a derivative of the groin flap and subsequently often shares in its opprobrium. The free groin flap was described in 1973 by Daniels and Taylor.⁹ However, the procedure quickly fell out of favor due to donor site morbidity (largely lymphedema), anatomic variability of the vasculature, and thickness of the flap. In 2004, Koshima et al revisited the groin flap and applied principles of perforator flaps to pioneer the SCIP flap.¹⁰ Koshima and colleagues demonstrated success with the SCIP flap for reconstructive needs ranging from lower extremity to head and neck reconstruction.¹⁰⁻¹² Suh et al also purported the utility of the SCIP flap with its minimal donor site morbidity and ease of elevation.^{6,13} They addressed the concerns of anatomic variability with their 2017 study showing that the medial perforator originated from the superficial circumflex iliac artery in 94% of cases. Further, 95% of medial perforators could be found at a point 4.5 cm lateral to and 1.5 cm superior to the pubic tubercle. In 100% of cases, the

intraoperative anatomy was identical to the preoperative computed tomographic angiography (CTA) anatomy.

Conclusion

HFA is a chemical commonly used for industrial and household purposes. However, it is noxious to the skin and surrounding tissues. In this case of an HFA burn that destroyed the entire glabrous surface of the thumb but spared the neurovascular bundles and FPL tendon, the authors found that a thin, free tissue transfer with an SCIP flap provided adequate soft tissue coverage and protection without sacrificing the innervation or function of other areas of the hand. This is a technically challenging but versatile flap that should be considered in the hand and reconstructive surgeon's armamentarium.

Authors' Contributions

M.L.I. was the attending surgeon of record on this case and conceived the reconstructive plan for the patient. J.N.R. and A.M.G. were integral members of the reconstructive team and postsurgical care team. J.N.R. wrote the manuscript, and M.L.I. and A.M.G. edited and contributed to the final version. All the authors have seen and approved the final version of this manuscript.

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Conflict of Interest

None.

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