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Case Report
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Resurfacing of Two Separate Digital Defects using a Radial Forearm Fascial Free Flap with Neosyndactylization

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Abstract

We report a case of a 20-year-old patient who sustained a mutilating crush injury to the left hand. After thorough debridement and stabilization of the skeletal injury, a radial forearm fascial free flap was used to resurface the distal soft tissue volar defect of two adjacent digits. This thin fascial flap allows for stable soft tissue coverage and provides a gliding surface for the exposed tendons. The neosyndactylized digits were safely divided at 3-months follow-up, excellent functional and aesthetic results were achieved. The radial forearm fascia is a thin, durable, and pliable tissue that is based on the radial artery as a vascular pedicle. We consider this free fascial flap as a valuable option for coverage of multiple complex distal digit injuries using a single flap and highly recommend its use.

Keywords: Free fascia flap; Neosyndactyly; Digital resurfacing

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Introduction

Traumatic hand and digit injuries resulting in soft tissue loss pose many challenges for the reconstructive surgeon. These injuries may result in composite tissue loss to digits and require soft tissue coverage as well as bone, tendon, and nerve grafts. Coverage of exposed structures such as tendons, bones, vessels, or nerves at the dorsal and palmer surfaces of the hand requires thin, supple tissue to provide adequate range of motion and a satisfying aesthetic result. The use of local and regional flaps when possible to treat these injuries is a popular choice [1-4]. However, due to the limited amount of expendable tissue in the hand, this may result in a functional limitation at the donor site or simply may not be possible due to the surrounding zone of injury (multiple digit crush, avulsion injuries). Advancements in microsurgical techniques have allowed the use of free tissue transfers to treat these defects in the distal hand and fingers, allowing for improved range of motion and a more aesthetically pleasing appearance of the traumatized upper extremity [5-7]. We discuss a case of simultaneous coverage of two digital defects with a single fascial free flap with neosyndactylization.

Case Presentation

A 20-year-old, right hand dominant male sustained a significant crush injury to his left hand after a motor vehicle rollover collision. Initial evaluation of his injuries revealed a complex avulsion injury of the volar surface of his left middle and ring finger with open fractures of the distal phalanx of the middle finger and avulsion of the digital nerves to the middle and ring fingers (Figure 1). He underwent immediate irrigation and open reduction, percutaneous pinning of the phalanx fracture, and placement of a vacuum closure device to temporarily cover the soft tissue defect. The patient was taken back to the operating theatre 2 days later for definitive closure of this complex defect. Given the unique location involving the volar surface of multiple digits, the decision to perform a free radial fascial flap with split thickness skin graft and neosyndactylization of the affected digits was made.

An Allen test was performed preoperatively to verify that there was indeed a patent arch with retrograde flow to the hand through the ulnar artery. The volar wounds were then debrided and the incision was extended proximally to isolate the common digital artery for our microvascular anastomosis. The neurovascular bundles were carefully identified while the ulnar digital nerve to the middle finger and the radial digital nerve to the ring finger were transected with roughly a 2 cm segment loss at the level of the middle phalanx. These nerves were isolated and prepared for nerve grafting. A nearby dorsal vein was also isolated and prepared for our venous anastomosis.

Figure 1: Left hand multiple crush/avulsion injuries to volar middle and ring fingers distal to the proximal inter-phalangeal joint.

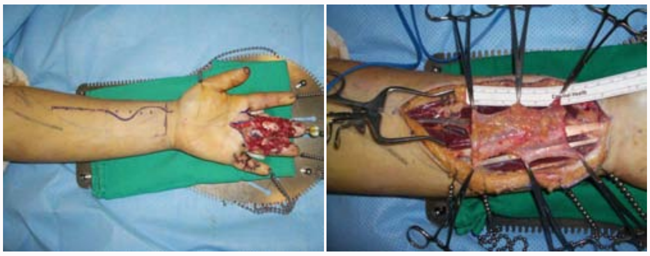

Figure 2: Intra-operative dissection. (a) Design of volar skin incision. (b) Harvesting of the radial forearm fascia.

Once the hand was prepared, we then turned our attention to harvesting the ipsilateral radial forearm fascial flap. The skin incision was designed in a straight line over the proximal volar forearm ending in a curvilinear fashion at the distal forearm (Figure 2A). Skin flaps were elevated medially and laterally, taking care to identify and preserve both the lateral antebrachial nerve and dorsal branches of the radial nerve in the subcutaneous tissue. Following elevation of skin and subcutaneous tissue, the radial forearm fascia was incised creating a 7 cm x 6 cm flap to cover both volar defects to the middle and ring fingers (Figure 2B). Perforators into the fascia from the radial artery were preserved. The radial artery and its venae comitantes were identified proximally and distally and protected throughout the dissection. The fascial flap was elevated off the muscle bellies below, taking care to preserve some paratenon over the underlying tendons. Once the fascia and vessels were raised, the vessels were divided distally and a proximal pedicle of roughly 8 cm was isolated and ready for division.

Interposition nerve grafting of the ulnar digital nerve of the long finger and the radial digital nerve of the ring finger using a segment of the lateral antebrachial cutaneous nerve from the forearm was performed prior to insetting the flap. The pedicle of the radial forearm fascial flap was then divided and the flap was partially inset using 4-0 chromic sutures to cover the exposed vital structures. The radial artery was anastomosed to the common digital artery in an end-to-side fashion using 8-0 nylon sutures in an interrupted fashion. After completion of the microvascular anastomosis all the digits were noted to be perfused and pink with flow across the anastomosis. A primary, hand sewn, end-to-end microanastomosis was then performed from the venae comitantes of the radial artery to a dorsal vein in the third web space. An implantable venous doppler probe was placed (Cook Vascular Inc, Vandergrift, Pennsylvania) around the venous anastomosis. The fascial flap was then covered using a very thin split thickness skin graft harvested from the right thigh. Primary closure of the forearm donor site was easily performed (Figure 3). The patient was placed in a bulky dressing and a dorsal extension blocking splint to avoid tension across the nerve and vessels repairs. The flap survived without complications and the patient underwent division of the neosyndactylized digits at 89 days from the original procedure without further complications or secondary procedures needed.

Figure 3: (a) Completion of insetting and skin grafting with closure of donor site. (b) 3 months postoperative with well healed donor site.

Discussion

Free flap transplantation allows for rapid closure of difficult wounds, provides a robust blood supply to the zone of injury, and facilitates clearing of infected wounds. Coverage of an upper extremity wound can be very challenging as it requires tissue that easily conforms to the contour of the forearm and hand, protects the underling structures, and provides a surface for tendon gliding. In our case the volar surfaces of the left middle and ring fingers distal to the proximal interphalangeal joints were extensively damaged secondary to a crush/avulsion injury. Loco-regional flaps such as cross finger flaps were not possible due to defect size and injury to neighboring digits [1]. Heterodigital or homodigital flaps may be of use in single injured digits with small defects. The reverse radial forearm flap is indicated for moderate-sized defects of the palmar and dorsal aspects of the wrist and hand out to the level of the proximal interphalangeal joints [6]. However, our defects extended beyond this level and any pedicled reverse radial forearm fasciocutaneous or adipofascial flaps would not likely be of adequate length. The free radial forearm flap has been used extensively for head and neck and upper extremity reconstruction [8]. The disadvantage of this flap is significant donor site morbidity due to the inability to directly close the donor wound, thus requiring split thickness skin grafting. However, given the location and complexity of this injured region we needed soft tissue coverage to be thin, pliable, and allow for gliding of the underlying tendons. Ismail et al. described a modification of this flap using only the forearm fascia as a free flap in 8 cases [9]. This modification not only allows for ease of donor site closure but also allows for the use of a fascia-only free flap to resurface the distal volar digits. Our case was further complicated due to the multiple injured digits requiring soft tissue coverage. When multiple adjacent fingers require soft tissue coverage, fascial flaps can be placed over the entire defect creating iatrogenically syndactylized digits. This allows for complete coverage of all defects using a single free flap. This requires a second procedure to divide the flap after adequate neovascularization has occurred. Although many papers have been written on the subject, the exact timing at which free flaps become independent of their vascular pedicle remains unclear. Oswald et al. [10] showed that occlusion of the vascular pedicle in microvascular free flaps on the 5th day resulted in survival of the flap in rats. With the exception of anecdotal reports, most of the published literature suggests that free flaps in humans are dependent on their pedicle for at least 15 to 17 days [11-15]. The condition and quality of the recipient site plays a large role in survival of these flaps. Ischemic, irradiated, and scarred beds are inadequate in providing late flap neovascularization compared to healthy recipient sites and therefore would be dependent on the vascular pedicle for longer periods of time [16,17]. In our patient the decision and timing of flap division was altered by the patient's unavailability.

In conclusion, the radial forearm free fascia (RFF) is a reliable flap with consistent vascular anatomy and low donor-site morbidity. This thin and pliable flap allows for its use in locations where contour and gliding are critical. The fascia is also ample so one can modify the size of this flap to cover several neighboring defects with a single arterial anastomosis. Our case underscores the utility of the RFF free flap in the management of complex hand and digital injuries and its use as a single flap for multiple defects. We highly recommend its use and believe that it should be part of the armamentarium of the reconstructive surgeon.

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