Reverse Radial Forearm Flap Peforator used in Digital Revascularization

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Abstract There are very few reports in the literature of using pedicled flaps to revascularize distant tissue. Here, we describe the first description of using a radial artery perforator from a reverse radial forearm flap to revascularize a digit. Complex hand trauma presents multifaceted problems for the surgeon. This is illustrated by a recent case we treated of a severe hand crush injury, in which the two main problems were finger devascularization and a palmar defect. This required vein graft revascularization and local flap reconstruction. The initial management failed, and instead of repeating the same procedures, a single elegant solution was found. A reversed radial forearm flap was used for soft tissue defect coverage of the palmar defect, while a radial artery perforator was isolated for digital revascularization. This technique may seem excessive for digital revascularization, but in the correct context it overcomes “zone of injury” issues in major hand trauma and allows simultaneous revascularization with soft tissue defect cover.

Keywords Pedicled flap · Complex hand trauma ·
Reversed radial forearm flap · Perforator ·
Digital revascularisation

Introduction

Occam’s razor is a term embedded upon generations of medical students, dictating that *Entia non sunt multiplicanda praeter necessitatem*, or “entities should not be multiplied beyond necessity” (http://en.wikipedia.org/wiki/Occam's_Razor). In medical practice, this means that multiple explanations are not necessary when a single one is sufficient, and in a similar manner, a single surgical procedure may be more efficient than multiple ones.

This principle is illustrated in a recent case, in which a reverse radial forearm flap served multiple purposes. Firstly, it was used as soft tissue coverage, and secondly, it was also used for digital revascularization. A separate vessel for revascularization was therefore avoided. This case is also the first description of using a radial artery perforator for the purposes of digital artery revascularization. Previous cases have relied on anastomosis to the axial vessel only [1, 2].

Case History

A 24-year-old, right-hand-dominant, male factory worker sustained a crush injury to his right hand, after catching it in a rolling machine for 30 s. He presented to the emergency department 4 h later. On examination, he had sustained multiple burst lacerations of the volar skin of all fingers on his right hand. The ring finger was devascularized (Fig. 1). Radiographs indicated multiple phalangeal fractures of the index, middle, and ring fingers.

The patient was taken to the emergency operating theater and initial wound debridement was performed. The ring finger was the most severely injured, with a burst laceration along the volar surface of the digit, with crush injury and

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Figure 1 Original crush and degloving injury.

thrombosis of both digital arteries along the entire length of the proximal phalanx.

Multiple phalangeal fracture fixation was performed with Kirschner wires. The ulna digital artery of the ring finger was revascularized with a long vein graft running from the distal palmar crease to middle phalanx. The graft flowed first time. A transposition flap was rotated from the palm to cover the exposed vein graft.

One week later, the ring finger pulp was noted to be dusky, with the local transposition flap over the middle finger also appearing nonviable (Fig. 2). The patient was brought into the operating theater and, following debridement of further nonviable tissue, there was a defect of 6 × 8 cm overlying the palm, as well as the ring and middle fingers. The interposition vein graft to the ring finger was thrombosed (Fig. 3) and the pulp of the ring finger was avascular.

Intraoperative

A decision was made to use the reverse radial forearm flap to cover the soft tissue defect. However, it was felt that a

Figure 2 Hand immediately predebridement 1 week later. Note the dusky ring finger and necrotic palmar flap.

Figure 3 Degloved segment after debridement showing thrombosis of a venous conduit on the ring finger performed a week earlier.

further venous interposition graft would not be wise for a number of reasons. Firstly, to further move out of the zone of injury, an extensive vein graft to the superficial arch would have been required. Secondly, the new graft would have been at risk from compression from the radial forearm flap, which often develops slight edema in the postoperative phase. It was therefore decided to look for a perforator from the radial artery to revascularize the ring finger. This perforator had to fulfil two criteria: firstly, it needed to be in the correct position once the flap was rotated 180 degrees into the palm, and secondly, it had to caliber-match the recipient vessel. With these two things in mind, the reverse radial artery flap was planned and raised.

The reverse radial forearm flap was designed with a template, with the position of the ulna digital artery of the ring finger marked on the template (Fig. 4). The template was rotated 180 degrees to mark the necessary position of the perforating vessel required to revascularize the ring finger. Dissection was carried out with the specific purpose of identifying and preserving an appropriately positioned and caliber-matching perforating vessel. This was identified in a suitable position (Fig. 5) and dissected with a 2-cm pedicle length.

Figure 4 Template of reverse radial artery flap. Note the marking on the template for the position of the ring finger radial digital artery, and the corresponding mark on the forearm for potential perforator.

Figure 5 Radial artery and the perforating vessel (*black arrow*) chosen for digital revascularization.

Figure 8 Hand 1 year post syndactyly release. Note ulnar deviation of ring finger due to traumatic arthritis; however, patient had returned to a manual labor job.

Figure 6 Flap in situ showing the anastomosis of the pedicle perforating vessel to the ulna digital artery of the ring finger (*black arrow*). The radial artery is seen with a ligaclip on the end (*white arrow*)—note the difference in vessel caliber to the pedicle artery.

Figure 9 Hand in flexion.

Figure 7 Flap in situ.

Figure 10 Hand in extension.

The flap was rotated into position, and the perforator was anastomosed to ulna digital artery of the ring finger (Fig. 6). Flow was reestablished and the flap inset (Fig. 7).

Follow up

Two days postoperatively, the flap developed a hematoma, the source being a tear in a small vein, which was ligated. Follow up was otherwise uncomplicated and the radial forearm flap and the revascularized ring finger were viable a month postoperatively. The patient underwent syndactyly release 2 months later without compromise of the ring finger feeding vessels (Figs. 8, 9, and 10). Range of motion of the ring finger was 18–68 degrees at the proximal interphalangeal joint and 10–55 degrees at the distal interphalangeal joint. He resumed full employment as a manual worker 7 months after the injury.

Discussion

There are two previous reports describing simultaneous revascularization with pedicled flaps, all of which use the radial artery rather than dissect out a specific perforating vessel. These include the use of the radial artery to anastomose to the digital arteries of the thumb [2] and the

use of the radial artery flap to reconstruct the superficial arch [1]. We believe our case is unique in using a perforating vessel for the sole purpose of caliber-matching a vessel for distant revascularization.

This case illustrates the creativity available to today's microsurgeon, and also serves to highlight a few key principles. Firstly, when a microsurgical procedure fails, one must think carefully about the logic of repeating the same maneuver. Often, a completely radical approach is necessary. Secondly, "zone of injury" issues may mean repeated attempts at anastomotic revision are doomed to failure. Use of a distant pedicled flap may seem to be "overkill" for revascularization of a digit, but it does overcome zone-of-injury issues. Thirdly, this case is an elegant single solution to a multifaceted problem and emphasizes the concept of maximizing the use of all available tissue.

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