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CASE REPORT
Hand/Peripheral Nerve

A Reversed Inset Toe PIPJ Vascularized Joint Transfer for Finger PIPJ Composite Defect Reconstruction

Yu-Te Lin, MD, MS*
Charles Yuen Yung Loh, MBBS, MSc, MS, MRCS†

Background: Free vascularized joint transfers (VJT) are indicated for reconstruction of a composite defect of the finger joints. When the bone defect involves the proximal interphalangeal joint (PIPJ) and the full length of the middle phalanx, using the toe PIPJ with a shorter middle phalanx to reconstruct such a defect will be difficult. In this article, we describe an unusual application to repair the composite defect with a reversed inset of the toe PIPJ, where the proximal phalanx of the toe is placed distally and vice versa.

Methods: We describe a new technique to repair the composite defect with a reversed inset of the toe PIPJ. A 33-year-old woman sustained a crush injury to the left, middle, and ring finger, having fallen off her moped in a road traffic incident. A vascularized PIPJ from the second toe along with a hemipulp (1 × 4 cm) from the great toe transfer was performed with a reverse inset.

Results: With intensive physiotherapy and surgical tenolysis, a range of motion of 20–80 degrees at the new PIPJ was achievable. The joint motion was stable, and the radiograms of the finger demonstrated no visible joint degeneration. She reported the use of the finger, which improved overall hand function.

Conclusion: Reverse inset of toe PIPJs is possible in simultaneous reconstruction of damaged finger PIPJs and building up of bony length distally. *(Plast Reconstr Surg Glob Open 2021;9:e3338; doi: 10.1097/GOX.0000000000003338; Published online 26 January 2021.)*

Traumatic bone loss to fingers can be difficult to replace, and there exist vascularized or non-vascularized bone graft options. However, when faced with joint destruction and loss of digital phalanges, there is currently very little that can be done to reconstruct both defects at once. Proximal interphalangeal joint (PIPJ) arthroplasty can be performed, but, without adequate bone stock, this is not possible. Distraction osteogenesis techniques can also be employed, but when facing a traumatic loss of bone, bone graft often has to be used. The vascularity of the recipient bed can often be an issue after trauma with extensive fibrosis. Terminalization of the digit is often performed. However, in young patients who require a higher level of hand function, a vascularized toe joint transfer (VJT) can be considered to reconstruct both the PIPJ and the length of the lost digit.[1–3] Clinically, we met a posttraumatic finger bone and joint loss involving the PIPJ, middle phalanx, and distal interphalangeal joint. To align the reconstructed PIPJ along with the other finger joints, the toe vascularized joint transfers (VJT) was inset in a reversed way. This unusual method, to our knowledge, has not been described in the literature thus far, and we describe this case, along with the technique and subsequent management of scarring, to get a good range of motion.

*From the *Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Keelung City, Taiwan; and †Department of Plastic Surgery, Addenbrooke's Hospital, Hills Rd, Cambridge CB2 0QQ, UK.*

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METHODS

Case Example

A 33-year-old woman sustained a crush injury to the left middle and ring finger, having fallen off her moped in a road traffic incident. Primary treatments were provided at an outside hospital. She was referred to our center for left ring finger with a segmental bone defect at the distal part of the finger with a comminuted fracture of the PIPJ (Fig. 1). There was also an associated soft tissue deficiency on the dorsum of the finger. After thorough

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Fig. 1. Radiograph of the mangled left ring finger with segmental bone loss of the middle phalanx.

discussion with the patient, a vascularized PIPJ from the second toe along with a hemipulp (measuring 1 × 4 cm) from the great toe transfer was performed. Approval from the institutional review board (IRB) (Case number 201900174B0) was obtained for this study, and informed consent and HIPAA consent were acquired from the patient.

Based on the same vascular pedicles, the VJT and the hemipulp flaps were designed. During the flap harvest, the first plantar metatarsal artery (FPMA) was found dominant. To avoid dissecting the plantar foot or dividing the interosseous muscle for including a longer pedicle, a vein graft was taken from the dorsum of the foot. Lengthening of the FPMA was done at the side table before connecting it to the digital artery of the left ring finger. A 1-cm segment of the middle phalanx and 2-cm segment of the proximal phalanx were harvested. Because the toe proximal phalanx provides the greatest length of bone segment, the VJT was reversed in inset when transferred to the finger. The deficit of bone in the middle phalanx of the finger was replaced with the proximal phalanx of the second toe. This allowed maintenance of the PIPJ at the same height in the finger cascade to maintain flexion dynamics. A Kirschner wire was inserted from the fingertip to the proximal phalanx of the VJT for distal

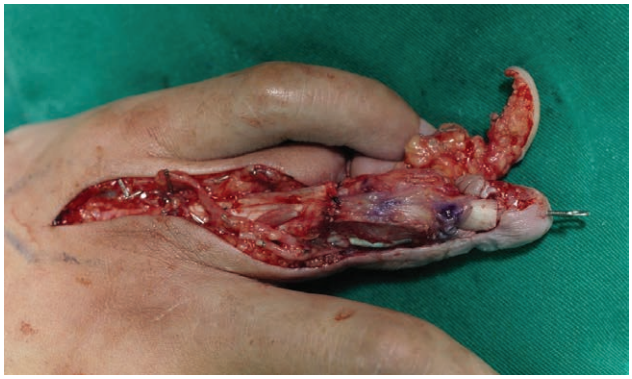

Fig. 2. Intraoperative photograph demonstrating the inset of the reverse VJT into the left ring finger defect.

osteosynthesis, and a cerclage wire was used at the proximal osteosynthesis between the toe middle phalanx and the finger proximal phalanx. Because the finger extensor from zone 1 to 4 was lost and the distal interphalangeal joint was fused, the toe extensor was employed to extend the PIPJ. The extensor digitorum longus (EDL) of the toe was placed distally when the VJT was reversed in inset. The distal part of the extensor hood was preserved to maintain its tendinous attachments to the periosteum, which was then repaired to the extensor digitorum communis of the ring finger itself (Fig. 2). The hemipulp was then covered on the dorsal defect of the ring finger. At the donor site, the bone resected from the finger was used as the bone graft. Two axial k-wires were used for the osteosynthesis.

RESULTS

The patient had a vascularized PIPJ and hemipulp transfer, which subsequently required a tenolysis of an extension contracture 5 months later. During the dissection, the deeper layer of the EDL was found adhered to the PIPJ, and this restricted the flexion of the joint. The deeper EDL was excised, and the insertion of extensor was preserved. After the passive motion of the PIPJ improved and became stabilized, a subsequent tenolysis of the FDP tendon was required with release of the FDS tendon, after another 5 months from the first tenolysis procedure.

The patient maintained a final range of movement at the PIPJ of 20–80 degrees at 3 years follow-up (Fig. 3). The joint motion was stable, and the radiograms of the finger demonstrated no visible joint degeneration (Fig. 4). She reported the use of the finger, which improved overall hand function. The patient had no complaints of her donor site toes from the left foot, as seen in a postoperative photograph 3 years down the line.

DISCUSSION

The use of VJTs in reconstruction of PIPJs is indicated in younger patients with a high demand for hand function; in pediatric patients; and also in cases with composite defects. Other alternative reconstructive options (including non-vascularized bone graft in combination

Fig. 3. Postoperative photograph of the reconstructed left ring finger PIPJ at 3 year follow-up.

with arthrodesis with local soft tissue flaps) were also discussed with the patient. A full discussion of the benefits, including obtaining and preserving a degree of range of motion in the PIPJ, was paramount to the patient and her wishes. It was the need for such a demand, coupled with our experience in vascularized joint transfer that we decided to perform this procedure on her. The use of the reverse inset of VJTs, however, has not been reported thus far. The ideal situation for this would be to gain additional bone length for the middle phalangeal defect when reconstructing the PIPJ.[4] A normally oriented VJT has the advantages of having a normal orientation of the pedicles and extensor tendons and requiring a shorter pedicle. However, the length of the middle phalanx of the toe usually cannot provide enough length for a longer defect. To reconstruct the length of the bone defect, inclusion of a longer proximal phalanx would result in malpositioning the PIPJ of the finger compared with the adjacent digits.

To place the PIPJ at its optimal location, a non-vascularized bone graft will be required to build up the length of the middle phalanx and that comes with bone graft morbidities such as donor site complications, non-union, and subsequent resorption of bone graft. This obviates any need for bone graft or distraction osteogenesis techniques. A staged approach where a non-vascularized bone graft is performed first followed by a VJT can be considered. The advantages are that bone length can be built up first, and bone stock will not be an issue to build on with a VJT. Nonetheless, a pedicled flap will be required to augment the soft tissue insufficiency of the ring finger at the first stage as well. The disadvantages of this approach are that this becomes a multi-stage procedure where increased risk of bone resorption, increased scarring, and fibrosis of soft tissues may occur, which may make the secondary transfer of VJT more difficult and cause a poorer outcome with stiffness and fibrosis. Sacrificing the second toe to include more soft tissue for the ring finger could be an option, but it was declined by the patient.

Finally, we used the VJT with a reverse inset and a hemipulp flap; a 1-stage reconstruction can be performed with replacement of bone joint and soft tissues. However, the disadvantages of this technique are that the pedicle

Fig. 4. Postoperative radiograph of the reversed inset VJT at 3 year follow-up.

and tendons are in a different orientation and we have to reverse the orientation of the tendon. A longer pedicle or vein graft may be required to allow proper orientation of the vessels and prevent kinking of vessels.

A high level of microsurgical technique is required when harvesting and insetting the VJT to avoid any problems in the immediate postoperative period. Careful calculation of vessel length to avoid kinks and twists in blood flow when mobilizing is necessary.[5] The EDL of the toe in this case was reversed and flipped upon itself, which later became a source of adhesions due to its bulk and required debulking later. A consideration in the future would be excising the extensor tendon of the toe and using it as a graft instead of flipping it upon itself to allow better alignment and movement postoperatively.[6] If extensor lag is encountered, reinsertion of the central slip in the extensor area may be performed.[7] A period of immobilization is required after VJTs, which is the same for reverse inset VJTs. Despite intensive physiotherapy, we find tenolysis procedures are often required after VJTs. Tenolysis was also performed in this case, which addresses the soft tissue contracture which may subsequently develop.

The reverse VJT provided the same function as that of the VJTs with normal orientation. It is particularly useful for reconstructing PIPJs and digits with loss of length at the middle phalanx. Close follow-up and revision tenolysis procedures are often required in conjunction with an intensive physiotherapy regimen.

Yu-Te Lin
Chang Gung Memorial Hospital
Chang Gung University College of Medicine
Keelung City
Taiwan

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