Reconstruction of multiple metacarpal bone defect using segmental free fibular bone flap: Case report

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ABSTRACT

In this report we present a case of blast injury to hand, including multiple metacarpal bone defect. Bone defects were reconstructed using fibular flap. Structural integrity of metacarpal bones was preserved with good functional results.

Key words: Hand injury, fibula flap, metacarpal bone reconstruction

Introduction

Blast injuries to the hand are challenging cases to the reconstructive surgeon, since these injuries include bones, tendons, and loss of soft tissue. Staged reconstruction including nonvascularized and vascularized bone graft has been reported in the literature. The latter provides better union and uniformed structure. Many alternatives, including vascularized iliac bone flap, serratus anterior-rib composite flap and osteocutaneous fibula flap, were used for metacarpal and phalangeal reconstruction [1-4]. The most important advantage of the fibular flap is that it can be osteotomized reliably to reconstruct composite bone defects, as in mandibular reconstruction [5-7]. The flexibility of the flap allows the manipulation of osteotomized segments adapting to multiple metacarpal defects [3, 4].

In this case report, we describe our experiences using free fibular flap to reconstruct three metacarpal bone defects after blast injury.

Case Report

A 20 year-old man presented after blast injury to his left hand from gunshot resulting in a composite tissue defect at the dorsum of his hand. In physical examination, there was a wide, contaminated soft tissue defect at the dorsum of the hand. Skeletal damage included all metacarpal bones except the first one. The third metacarpophalangeal joint and third proximal phalanx included the defect. Soft tissue defects included extensor tendons of affected digits and overlying skin (Figure 1). Neurovascualr examination revealed that all digits were normal. After a systemic physical evaluation, the patient was taken to the operating room.

Under general anesthesia, the wound was irrigated and necrotic tissues were debrided meticulously. After the intraoperative evaluation of metacarpal bones, acute reconstruction was decided. Acute reconstruction of metacarpal bones using fibular free flap was planned. The osteocutaneous fibula flap was harvested...
in routine fashion as previously described [8]. The flap was elevated with 18 cm fibular bone from the left leg of the patient and osteotomised to three segments according to defects of the third, fourth and fifth metacarpal bone defects. Bone segments were adapted to defects and fixated with K wires (Figure 2). Bone segments for the third and fourth metacarpal bone defects were 6 cm length and the fifth one was 4 cm. Minimal bone parts were sacrificed between bone segments for better adaptation. The artery of the flap was anastomosed to the radial artery at the snuff box and the dorsal veins were used for venous anastomosis. The fibular flap was harvested in the osteocutaneous fashion but the skin flap had to be sacrificed because it restricted multiple osteotomies and the adaptation of bone segments to metacarpal bones.

Extensor system of the second finger was intact. The third one was reconstructed because the metacarpophalangeal joint was disrupted and the distal end of the bone segment was fixed to the proximal phalanx, with the finger in the neutral position. Fourth and fifth extensor systems were reconstructed by grafting of the palmaris longus tendon. Soft tissue defect over the hand dorsum was reconstructed with pedicled groin flap.

The groin flap was planned at the left inguinal area as in the classic approach [9,10]. Flap pedicle was divided three weeks postoperatively.

No complication was seen in the postoperative period. K wires were taken out six weeks after and physical therapy was done for a month. Scintigraphic evaluation six months postoperatively revealed that bone segments were alive (Figure 3). Extension deficit at third and fourth fingers was seen at this time and an additional tendon release procedure was proposed. In any case, the patient was satisfied with the result aesthetically and functionally (Figure 4).

Discussion

Complex composite hand defects are challenging reconstructive cases functionally and aesthetically. The reconstructive planning in these cases is mainly driven by the extent of the bone defect. Various composite flaps including bone have been used for the hand reconstruction [1-4]. Although these flaps can successfully cover the defects, limited bone harvest and donor
Multiple metacarpal reconstruction

The free fibular flap has been used widely for the reconstruction of weight bearing long bones, mandibular and maxillar reconstruction and metacarpal reconstruction [3-5]. Using a free fibular flap in composite metacarpal defects has many advantages. First of all, fibula flap can be reliably osteotomized for multiple metacarpal defect reconstruction. It provides an acceptable size match for metacarpal bones, has an excellent bone vascularity, which induces rapid bone healing and low donor site morbidity [4-8,11]. An important disadvantage of this flap is the unreliability of the septocutaneous perforators of the skin paddle [12]. In this case, because of the triple metacarpal bone defect, multiple osteotomies and adaptation of bone segments to metacarpal defects were restricted by skin paddle and the skin paddle had to be sacrificed.

Although conventional reconstructive strategies require staged reconstruction, the simultaneous combination of wound coverage with structural and functional restoration has been replaced conventional strategies. Delayed tendon reconstruction in a scarred site will cause muscle contracture and poor functional results. Tomiano et al. reported staged extensor tendon reconstruction [13], but that case involved chronic injury and the reconstruction site was scarred. But in the current case, acute extensor tendon injuries were reconstructed with intact extensor muscle units using tendon grafts on a relatively available and not scarred recipient site.

The skin defect over the hand was planned to be covered with the skin paddle of the fibula flap. However, osteotomies and adaptation of bone segments kinked skin paddle and its pedicle and made impossible the use of the skin paddle of fibula flap. Thus, alternative skin reconstruction procedures had to be evaluated intraoperatively. There were many alternative procedures to cover the dorsum of the hand, including distant and free flaps, but it was decided not to prolong the operation time much more and to use the pedicled groin flap.

The fibular bone segment used to reconstruct the third metacarpal bone was fixed to the proximal part of the third finger proximal phalanx. Alternative arthroplasty techniques have been described in the literature [14]. The joint was not reconstructed, because there was bone tissue loss over the third finger proximal phalanx. If the arthroplasty had been made between the bone flap and proximal phalanx, the new metacarpophalangeal joint would be in a misplaced anatomical location. If the bone flap had been shortened to make arthroplasty, the third finger would be shortened. These two alternatives would not improve the results aesthetically and functionally and it was decided to fix the bone flap to the proximal phalanx.

Conclusion

The fibula free flap in reconstruction of the hand provides satisfactory aesthetic and functional results at the recipient site with acceptable donor morbidity. This procedure should be considered a useful option especially for multiple metacarpal bone defects.

References

1. Reinisch JF, Winters R, Puckett CL. The use of the osteocutaneous groin flap in gunshot wounds of the hand. J Hand Surg Am 1984;9A:12-7.
2. Hui KC, Zhang F, Lineaweaver WC, Moon W, Buncke GM, Buncke HJ. Serratus anterior-rib composite flap: anatomic studies and clinical application to hand reconstruction. Ann Plast Surg 1999;42:132-6.
3. Lee HB, Tark KC, Kang SY, Kim SW, Chung YK. Reconstruction of composite metacarpal defects using a fibula free flap. Plast Reconstr Surg 2000;105:1448-52.
4. Lin CH, Wei FC, Rodriguez ED, Lin YT, Chen CT. Functional reconstruction of traumatic composite metacarpal defects with fibular osteoseptocutaneous free flap. Plast Reconstr Surg 2005;116:605-12.
5. Hidalgo DA. Fibula free flap: a new method of mandible reconstruction. Plast Reconstr Surg 1989;84:71-9.
6. Yajima H, Tamai S, Ono H, Kizaki K, Yamauchi T. Free vascularized fibula grafts in surgery of the upper limb. J Reconstr Microsurg 1999;15:515-21.
7. Wei FC, Chen HC, Chuang CC, Noordhoff MS. Fibular osteoseptocutaneous flap: anatomic study and clinical application. Plast Reconstr Surg 1986;78:191-200.
8. Taylor GI, Miller GD, Ham FJ. The free vascularized bone graft. A clinical extension of microvascu-
lar techniques. Plast Reconstr Surg 1975;55:533-44.

9. Knutson GH. The groin flap: a new technique to repair traumatic tissue defects. Can Med Assoc J 1977;116:623-5.

10. Bajantri B, Latheef L, Sabapathy SR. Tips to orient pedicled groin flap for hand defects. Tech Hand Up Extrem Surg 2013;17:68-71.

11. Anthony JP, Rawnsley JD, Benhaim P, Ritter EF, Sadowsky SH, Singer MI. Donor leg morbidity and function after fibula free flap mandible reconstruction. Plast Reconstr Surg 1995;96:146-52.

12. Schusterman MA, Reece GP, Miller MJ, Harris S. The osteocutaneous free fibula flap: is the skin paddle reliable? Plast Reconstr Surg 1992;90:787-93.

13. Tomaino MM, Plakseychuk A. Two-stage extensor tendon reconstruction after composite tissue loss from the dorsum of the hand. Am J Orthop (Belle Mead NJ) 2000;29:122-4.

14. Jones NF, Dickinson BP, Hansen SL. Reconstruction of an entire metacarpal and metacarpophalangeal joint using a fibular osteocutaneous free flap and silicone arthroplasty. J Hand Surg Am 2012;37:310-5.