Serratus Anterior-rib Composite Flap Partial Thumb Reconstruction

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Summary: The serratus anterior-rib composite flap is a well described and versatile flap used for reconstruction in a variety of anatomical regions. However, reconstruction of a thumb defect using this flap has not been well described since first mentioned in the literature by the Buncke et al group 20 years ago. The authors describe the use of this technique for thumb reconstruction in a complex defect from a gunshot wound. (Plast Reconstr Surg Glob Open 2022;10:e4358; doi: 10.1097/GOX.0000000000004358; Published online 6 June 2022.)

A young right-hand-dominant man presented with an isolated right thumb gunshot injury involving soft tissue, bone, and tendon (Fig. 1). Radiographs revealed first metacarpal shaft and proximal phalanx base fractures with complete metacarpophalangeal joint destruction. (See figure, Supplemental Digital Content 1, which displays plain radiographs of initial injury showing destruction of thumb metacarpal head and shaft, proximal phalanx base, and metacarpophalangeal joint. http://links.lww.com/PRSGO/C48.) Examination revealed defects of the first webspace, first metacarpal head, and proximal phalanx, as well as transection of extensor pollicis longus (EPL), extensor pollicis brevis (EPB), and abductor pollicis longus tendons. Distally, partial sensation to light touch and Dopplerable digital arteries were appreciated. The patient was otherwise healthy, a daily smoker, and employed at a local restaurant.

At initial debridement, EPL, EPB, adductor pollicis, and superficial radial sensory nerves were tagged. K-wire fixation was used to preserve webspace and thumb position. The first webspace was reconstituted with local tissues, leaving a radial dorsal thumb base soft tissue defect. A wound vac was applied. Interval workup included an angio-gram confirming an intact palmar arch and both digital arteries supplying the thumb. The defect encompassed 75% of his metacarpal and 50% of the proximal phalanx.

Four days after presentation, definitive reconstruction was performed with a free serratus anterior/seventh rib composite flap. He was positioned in the right lateral decubitus position. The defect was debrided (including metacarpal and proximal phalanx to bleeding edges) via sagittal saw. Examination revealed an intact flexor pollicis longus, a large EPL tendon defect, disinserted EPB tendon, intact abductor pollicis longus tendon, and intact adductor pollicis attached to the distal fragment of the proximal phalanx. Thenar muscles were tagged and planned for insertion to the flap via bone anchors. The CMC joint was intact. The palmar branch of the radial artery and cephalic vein were prepared as recipient vessels. A palmaris longus tendon graft was harvested in anticipation of tendon repair after flap inset.

A curvilinear incision was made at the anterior edge of the latissimus dorsi, with elevation of skin flaps to expose the serratus muscle. The latissimus was elevated off the serratus to isolate the serratus vascular pedicle, which had one proximal and one distal branch. The proximal branch to the serratus was preserved, and the distal branch was used for flap harvest. The long thoracic nerve was protected distally. Dissection of the two inferior-most slips of the serratus muscle was performed, preserving attachment to the seventh rib. The rib was exposed with subperiosteal dissection posteriorly. With parietal pleura protected, a sagittal saw was used to cut the rib circumferentially. Dissection was continued through the intercostal muscles, with ligation of the intercostal neurovascualr bundle proximally and distally to complete rib harvest. The rib was found to be well perfused from the anterior periosteum and muscle attachment (Fig. 2). After flap harvest, three small tears in the parietal pleura were repaired primarily. Thoracic surgery placed a pigtail chest tube, and the flap donor site was closed primarily.

Flap inset was then performed. The rib was cut down to 5.5 cm and temporarily fixated with K-wires. The rib was...
positioned at the metacarpal base with the natural curve of the rib to mimic native metacarpal curvature. Before final fixation, passive ranging of the neo-thumb was used to ensure positioning allowed for desired pinch and opposition. Using 26-gauge wire, 90/90 wire fixation was carried out, providing excellent fixation. The rib was pinned in abduction to prevent webspace contracture. Subsequently, vessel anastomosis was performed in an end-to-end fashion to the palmar branch of the radial artery and cephalic vein.

The EPL tendon was repaired using the palmaris longus tendon graft passed between muscle and bone, and secured using Pulvertaft weave. Tenodesis of EPB to EPL was performed. Thenar muscles were re-secured using a suture anchor drilled into the flap rib. Serratus muscle was inset and skin grafting performed. (See figure 2, Supplemental Digital Content 2, which displays serratus-rib flap inset to the right hand. http://links.lww.com/PRSGO/C49.)

The patient’s postoperative course was unremarkable, with routine removal of chest tube on postoperative day two. The patient was immobilized for 2 weeks and followed up as an outpatient. At the 2-month postoperative mark, radiographs showed stability of his bony reconstruction, and clinical examination showed satisfactory healing, bulk, and contour of his soft tissue reconstruction (Figs. 3, 4).

The patient underwent routine removal of buried hardware and was back to playing video games, performing occupational therapy, with expectation for full return to work thereafter.

**DISCUSSION**

Composite free flaps supplied by the thoracodorsal system have been well described in head and neck and
lower extremity defects, but less commonly for hand reconstruction.\(^1\)\(^,\)\(^3\) The serratus anterior-rib (SR) composite flap has been touted for its reliability, long pedicle, ease of surgical dissection, quantity of bone combined with muscle bulk, and minimal donor site morbidity. Hand and phalangeal reconstruction using the SR flap was first proposed by the Buncke group 20 years ago, where it was employed for first metacarpal reconstruction in two patients successfully.\(^5\) This group performed cadaveric studies and found multiple advantages of the SR flap. Their anatomic study showed reliable perfusion in the sixth to ninth ribs via serratus periosteal perforators originating from the thoracodorsal and posterior intercostal vessels. Rib harvest, especially in adults, affords a large quantity of bone, which can be cut down to size. Although pleural adhesion to the posterior periosteum was noted by the authors, it did not cause significant intraoperative complication, as was confirmed in this case. This flap minimizes donor site morbidity, as harvest of the lower three slips of serratus is permissible without causing scapular winging.\(^4\)

Kitazawa et al described another thoracodorsal-based composite flap using serratus anterior fascia and scapular bone for phalangeal defects.\(^2\) Advantages cited for this specific flap were the small size match of scapular bone to phalangeal bone, fascia facilitating tendon gliding, and lack of donor site morbidity. Compared with this variation, the SR composite flap is more easily dissected and has muscle attached, facilitating postoperative monitoring.

Georgescu and colleagues describe a series of SR composite flaps for extremity reconstruction, including hand and digital reconstruction.\(^6\)\(^,\)\(^7\) In a described case of thumb metacarpal reconstruction for a crush injury in a pediatric patient,\(^8\) the authors attempted to preserve the proximal phalanx base, used the dorsal radial artery branch and cephalic vein for anastomosis, used EIP to EPL tendon transfer to restore thumb extension, and fixed the rib with a single K-wire. In their series, the authors reported an average time to bone union of 2 months postoperatively in the hand. Other findings were that the curved morphology of rib bones leads to improved pinch despite the loss of the MCP joint, as well as the relative preservation of the surrounding muscle/tendon repairs. In our patient, fixation was performed using 90-90 wiring and K-wire stabilization. Postoperatively he was immobilized for 2 weeks, after which the patient did not participate in formal therapy. Despite this, at 2 months, the patient had evidence of bony healing and had returned to daily activities. Further, the SR composite flap facilitated tendon and muscular reconstruction, with the patient having adequate range of motion postoperatively.

This report has limitations. Long-term follow-up with objective pinch/grip outcome measures were not obtained, as the patient was lost to follow-up. Alternative reconstructive options in this complex defect include Masquelet reconstruction, toe-to-thumb reconstruction, or other free flaps, including fibula reconstruction. These other reconstructive options have potential advantages of facilitating staged tendon reconstruction, alternative donor sites, and varying technical difficulty.

**CONCLUSIONS**

Unique features of the described case are the blast injury etiology with multilevel damage to bone, muscle, and tendon, all of which were reconstructed using the SR composite flap. The authors advocate for this flap as a potential viable reconstructive option for complex thumb defects.

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