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CASE REPORT
Hand

Spare Part Reconstruction of Distal Pediatric Thumb Amputation

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Summary: Thumb tip amputations can be reconstructive challenges, particularly in pediatric patients. Reconstruction using composite grafting and local flap options has been described for tip amputations in the adult population. The authors describe the use of a spare part reconstruction using autologous bone graft and a reverse cross finger flap to preserve length and function for a distal thumb tip amputation in a young man. *(Plast Reconstr Surg Glob Open 2022;10:e4593; doi: 10.1097/GOX.0000000000004593; Published online 17 October 2022.)*

Distal fingertip amputations are commonly seen by hand surgeons. While replantation has been shown to have superior functional outcomes when indicated,[1] it is not always feasible due to injury mechanism, patient candidacy, or microsurgical skill availability. Alternatively, local flap reconstruction, composite grafting, or revision amputation are well described in the literature, with several techniques described. Shortcomings of these techniques include aesthetic deformity, shortened functional length, neuropathic pain, and cold intolerance.[2] In the pediatric population with the thumb affected, the shortcomings of these techniques are amplified given the demand and function afforded to a patient with a full thumb. Replantation in the pediatric population can be particularly challenging given size of vessels, vasospastic tendencies, and psychosocial care.[3] The described spare part technique employs advantages of both local flap and composite grafting techniques in an instance when microsurgical replantation was not possible to preserve length, function, and cosmesis.

CASE REPORT

A teenage right hand dominant healthy man presented with a left thumb dorsal oblique Ishikawa subzone III amputation after a table saw injury (Fig. 1). Clinical presentation and radiographs confirmed volar oblique injury pattern, distal level of injury with amputated distal phalanx just distal to the flexor pollicis longus insertion. Given the sharp mechanism, patient age, and digit affected, replantation was attempted. Preoperative discussion included potential failure of replantation, local flap reconstruction, or revision amputation as a salvage procedure. In the operating room under microscope magnification, a lack of viable distal targets for both arterial and venous anastomoses was discovered.

Spare part reconstruction using autologous bone from the amputated part, a pedicled reverse cross finger flap from his index finger, and skin graft from the amputated part was performed to preserve length. The distal phalanx tuft bone was irrigated, lightly debrided, and fixated using a 0.035-inch Kirschner wire. A radial based adipofascial reverse cross finger flap was elevated and used to cover the bone graft (Fig. 2). Glaborous skin from the amputated part was grafted on top of the reverse cross finger flap. (**See figure, Supplemental Digital Content 1,** which shows the inset and closure of reverse cross finger flap with overlying spare part skin graft. **http://links.lww.com/PRSGO/C199**.) The thumb and index finger were secured together using interrupted nylon sutures. The patient was discharged home the same day with oral antibiotics and a bulky splint.

Two weeks later, he returned for division of the reverse cross finger flap and revision full thickness skin grafting of the dorsal thumb tip. Postoperatively, the patient was compliant with activity restriction and hand therapy. At 2 months follow-up, radiographs confirmed minimal absorption of the distal phalanx tuft graft and good tissue healing, and the K-wire was removed. At 3 months follow-up, he had functional use of the thumb interphalangeal joint (+33/63 degrees motion) (Figs. 3, 4), and opposition to the small finger. His grip strength was 79% and lateral pinch

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Fig. 1. Clinical photograph of patient's initial presentation of right thumb distal amputation, volar oblique pattern, and Ishikawa subzone III with amputated part.

61% of his contralateral side. He had a 2-mm nail plate remnant that was removed electively at 5 months postoperatively. There were no issues with scar appearance, hypersensitivity, neuropathic pain, or cold intolerance. The patient had no further complications at 6 months follow-up and radiographs demonstrated good alignment, good length, and minimal resorption of bone graft. (**See figure, Supplemental Digital Content 2,** which shows the final six month postoperative follow-up radiographs in lateral view demonstrating minimal resorption and maintenance of length. **http://links.lww.com/PRSGO/C200**.)

DISCUSSION

Distal amputations in pediatric patients provide hand surgeons with a particular reconstructive challenge. Current literature has attempted to delineate when composite grafting or replantation is indicated, with attempts at replantation advocated for.[4] Challenges with pediatric replantation include increased incidence of vasospasm, difficulty with protection of reconstruction,

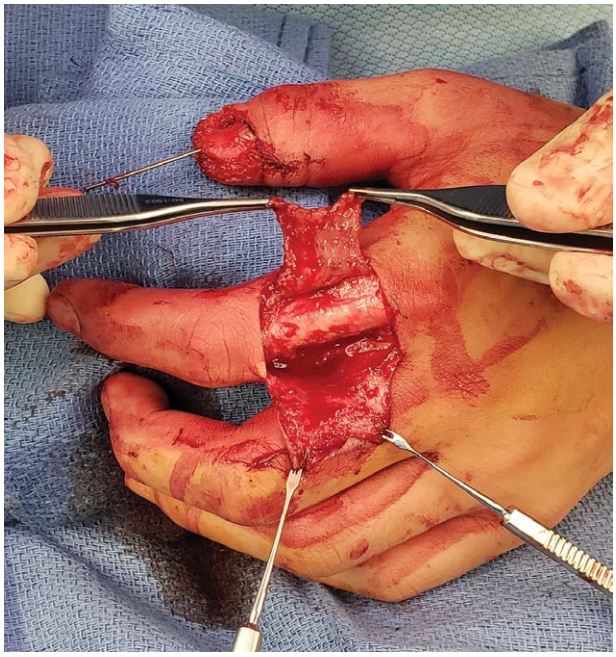

Fig. 2. Kirschner wire fixation of autologous bone graft and elevation of index finger reverse cross finger flap.

Fig. 3. Final 3-month postoperative follow-up photograph showing preserved length, range of motion, and cosmesis of reconstructed thumb tip. View of bilateral thumbs.

and psychologic burden on the patient.[3] Typically, in pediatric patients with thumb amputations, replantation is attempted. When replantation is not possible, the decision to perform local reconstruction, composite grafting, or revision amputation is encountered. In these cases, if a large component of bone is involved, the surgeon must trade length for definitive closure. While amputations distal to the thumb interphalangeal joint are well tolerated, an alternative reconstruction that preserves length with sensate and durable tissue provides the best functional and aesthetic outcome. The authors describe a case of spare part reconstruction in a non-replantable thumb amputation using autologous bone graft and index finger reverse cross finger flap.

Composite grafting has been examined in the pediatric population for fingertip injuries, with limited historical rates of success (61%), guarded expectations of full healing, and higher success rates in younger ages (below age 5).[5] Kiuchi examined the viability of composite grafting alone in 32 distal fingertip amputations with respect to Ishikawa injury level and mechanism of injury.[6] This study found that injuries in subzone I (100% complete or partial survival) and subzone II (71%) had good composite graft take. At more proximal subzones, only partial survival was found (subzone III 67%, subzone IV 60%). With respect to mechanism of injury, clean cut injuries had a better rate of complete survival. Prior studies have alluded to the adequate survival of composite grafting that includes bone, but the lack of functional use after grafting, particularly if crossing joint levels.[7] The presented patient had a clean-cut amputation that was distal to the interphalangeal joint and tendon insertions. Isolated autologous bone grafting was performed without added skin, soft tissue, and nail plate that are typical in a composite graft. The addition of a pedicled flap may have increased the likelihood of composite graft take due to its reliable vascular supply. Cosmesis via length of the thumb was prioritized in this case over nail bed preservation. Options for nail plate reconstruction at future stages include a prosthetic nail or nail bed grafting from the toe.

Fig. 4. Final 3-month postoperative follow-up photograph showing preserved length, range of motion, and cosmesis of reconstructed thumb tip. View of bilateral thumb and flexion at the interphalangeal joint.

The combination of grafting and local flap coverage has been described in adult populations. Thanik et al described the use of composite bone and nail bed grafting combined with a thenar flap for reconstruction of non-thumb distal amputations.[8] Indications were Ishikawa Zone I–III injuries not amenable to microsurgical replantation, similar to the case presented. This technique required three stages: thenar flap creation, flap separation and insertion of olecranon bone graft, and final sterile matrix grafting. A key pearl noted was to maintain the affected finger in as little flexion at the interphalangeal joints as possible to prevent stiffness. Benefits were preservation of bony length, maintenance of soft tissue padding to prevent a hook nail deformity, and nail preservation. In comparison, the described technique requires only two stages, allows the thumb to be in near full extension through the healing process, and takes advantage of the amputated tip's parts.

Han et al described the use of a reverse homodigital flap to cover composite osteocutaneous grafts in thumb tip reconstruction.[9] In a series of eight adult patients, the authors described using an ulnar sided homodigital periosteal flap to cover and revascularize bone and nailbed grafts taken from the amputated thumb tip. This technique was employed in only adult patients, with noted limitations at same digit donor sites, extended operative time, and technical skill needed to perform this technique. The current case employs a similar technique of a local flap to cover autologous bone graft, with added benefits of using an uninjured donor site (index finger), a relatively simple local flap (reverse cross finger), and application to the adolescent population.

Limitations of this technique include the inability to preserve the nail plate, a mild decrease in length (4 mm), and potential for loss of either flap or skin graft. The authors also understand that this defect was unique in its oblique orientation with well-vascularized volar tissue, healthy pediatric patient, and isolated clean mechanism.

CONCLUSION

Combined autologous bone grafting and reverse cross finger flap reconstruction for thumb tip amputations is a viable technique in select pediatric patients to preserve length, function, and cosmesis.

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