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CASE REPORT

Hand/Peripheral Nerve

Digital Reconstruction with a Nonfrozen Osteotendinous Allograft, Nerve Allografts, and Autogenous Radial Free Flap

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Summary: A 21-year-old man underwent amputation of his second to fifth fingers at the proximal phalanx level on the right hand. The third and fourth fingers were reconstructed with 2 toe-to-hand free transfers. The fifth digit was reconstructed with a nonfrozen osteotendinous allograft, nerve allografts, and autogenous radial free flap without immunosuppression. The patient was lost to follow-up for 19 years. He received no rehabilitation. He reported that he had experienced no adverse reactions to the materials or the graft, or infection, or fractures. No additional surgical procedures were performed. Today, the digit is functional and has acceptable aesthetic appearance. This outcome is similar to those obtained in digits reconstructed with frozen osteotendinous allografts and autologous cutaneous covers and opens the possibility for future research. *(Plast Reconstr Surg Glob Open 2015;3:e488; doi: 10.1097/GOX.0000000000000444; Published online 21 August 2015.)*

The gold standard for total phalangeal reconstruction involves the use of bone autografts, which can be either vascularized or not vascularized.[1] Bone allografts are another valuable option, and this type of allograft can be used fresh or freeze-dried, with pretreatment and freezing as the norm.[1] In 1985, the First People's Hospital at Shanghai reported the use of complete frozen nonvascularized osteotendinous allografts without immunosuppression and with a neurovascular free skin flap from the foot for thumb reconstruction in 10 patients.[2] In 2000, the same hospital reported the results of 270 reconstructed thumbs and fingers with a similar technique.[3] In 1991, Wendt[4,5] reported the transplantation of a fresh frozen osteoarthrotendinous allograft with autogenous soft-tissue coverage for thumb reconstruction without immunosuppression and with a 12-year follow-up. The reported cases obtained successful reconstructions but Charcot's arthropathies were present.[3]

We present a patient who received an osteotendinous allograft, nonfrozen, nonvascularized, and autogenous cutaneous cover to reconstruct a digit, without immunosuppression.

CASE REPORT

The patient was a 21-year-old man who experienced traumatic amputation of his second to fifth fingers at the proximal phalanx level on the right hand. Six months after the accident, the third and fourth fingers were reconstructed with 2 toe-to-hand free transfers. Recovery was uneventful and without complications.

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The patient recovered a basic grip following the surgery but asked for reconstruction of the fifth digit for work-related reasons (commercial highway bus driver). After explaining several options for reconstruction, including another free toe-to-hand transfer, all options were declined. Therefore, we decided to use a composite osteotendinous allograft, nonfrozen, nonvascularized, with digital nerve allografts, and autologous cutaneous cover using a radial forearm wraparound free flap and a split-thickness skin graft (Fig. 1).

The surgery was performed in 1991. The allografts were harvested after special permission from a donor who experienced a traumatic multiple digital amputation and who declined a replantation procedure. The graft had 12 hours of warm ischemia and 12 hours of cold ischemia at 4°C. Bone fixation was performed with interosseous compression wire, whereas tenodesis of the distal phalangeal flexor tendon was performed with a tendon autograft.

Both the extensor tendon and the lateral bands were repaired at the proximal phalangeal level with terminal-terminal repair of the digital nerves. Finally, we used a radial free flap to cover the allograft with arterial anastomosis between the radial artery and the arterial superficial arch.

The patient did not return for postoperative follow-up and, in fact, he was lost to follow-up for 19 years. As a result, he received no rehabilitation. When he did return to our clinic, he reported that he had experienced no adverse reactions to the materials or the graft, nor had he experienced any episode of rejection or infection. He also experienced no fractures or additional surgical procedures (Figs. 2, 3).

At physical examination, the digit had self-molded with daily use with acceptable aesthetic appearance. The active range of motion was complete at the metacarpophalangeal joint but minimal at the interphalangeal joints. Radiographs showed mild resorption at the middle and distal phalanx and good body union at the proximal phalanx.

The interphalangeal joints of the third and fourth reconstructed digits had 10 degrees of active range of motion.

The patient had grip strength of 30 kg in the left hand and 15 kg in the right hand. The key pinch strength in the third and fourth left fingers was 6 kg, 4 kg in the same right fingers, and 2 kg in the fifth right finger. Semmes-Weinstein testing revealed diminished light touch, and static 2-point discrimination testing confirmed protective sensation in the fifth digit. The free transferred toe-to-hand digits had overall diminished protective sensation.

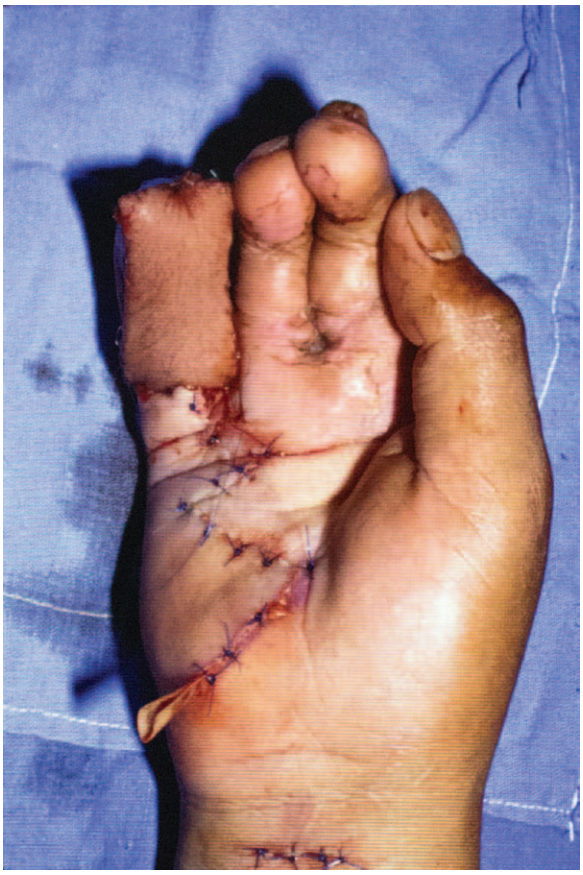

Fig. 1. Fifth finger reconstructed with a nonfrozen osteotendinous allograft, nerve allografts, and autogenous radial free flap. Immediate postoperative appearance.

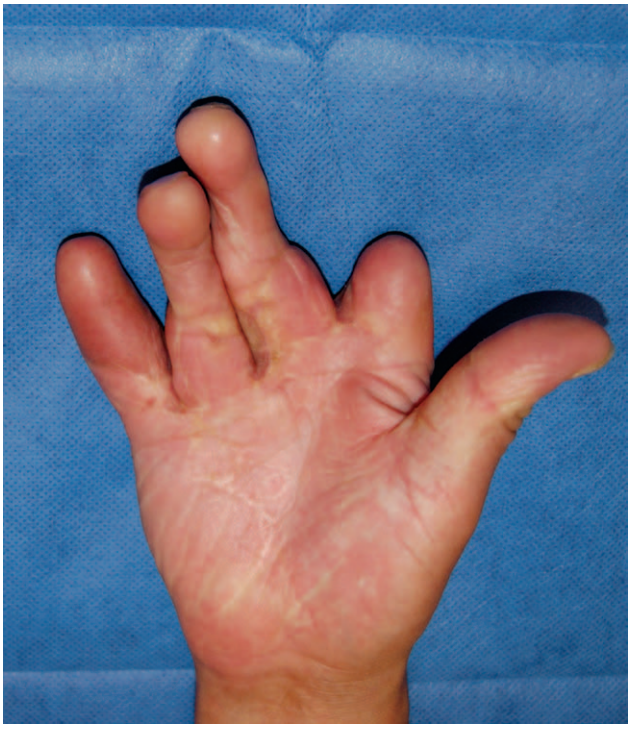

Fig. 2. Current clinical state 23 years after the procedure. Palmar view.

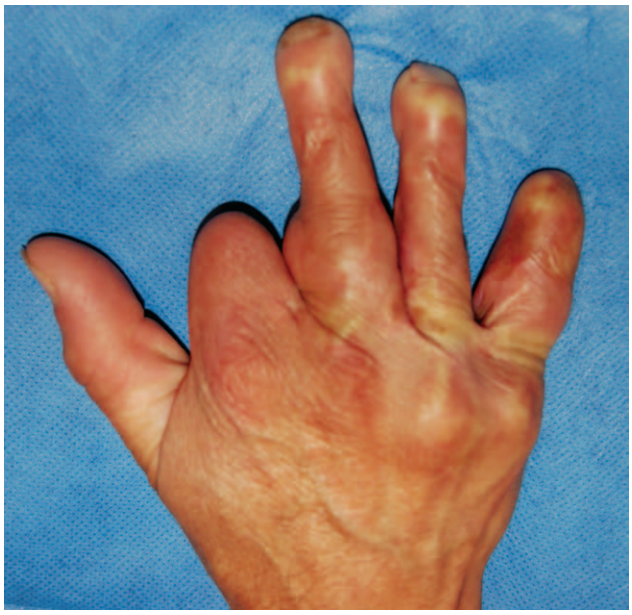

Fig. 3. Current clinical state 23 years after the procedure. Dorsal view.

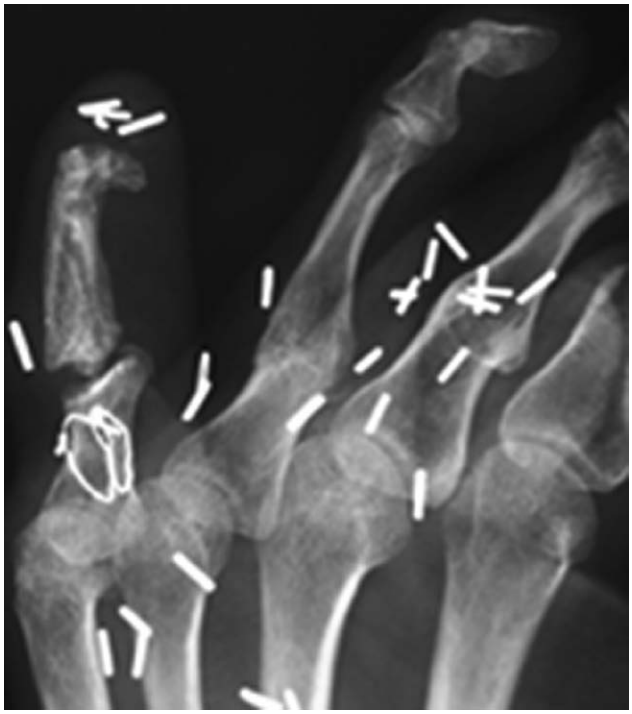

Fig. 4. Current x-ray control at 23 years after the reconstruction, showing mild bone resorption and Charcot's arthropathy.

Despite the incomplete results, the patient is fully satisfied; his hand is functional and he capably completed of all of his daily routine and work activities. His Dash score is 10. The patient provided written informed consent to publish the details of his case.

DISCUSSION

Fresh bone allografts cause an aggressive immune response, which causes them to be resorbed.[6] For this reason, freezing to −70°C is desirable, as it reduces disease transmission and diminishes cytotoxicity and antibody formation,[1] thereby diminishing the host's immune response so that immunosuppression is avoided.[7] Bone allografts must maintain contact with bone receptors and have a proper microenvironment for integration. The cases described by both Wendt[5] and Hou et al[3] successfully fulfilled these requirements, but some bone articular resorption and Charcot's arthropathy were present.

In our case, the allograft was nonfrozen and had 24 hours of total ischemia. It is possible that prolonged ischemia sufficiently reduces the antigenicity of the osteotendinous allograft with the hypothesis that the radial flap ultimately provides a beneficial microenvironment for the allograft.[8]

Freeze-drying alters bone, making it friable and prone to torsion and bending.[1] Despite resorption, this patient's reconstructed digit suffered no fractures or bending despite being on the dominant hand and used constantly under hard working conditions. In fact, sensation was better in the fifth digit allograft compared with the third and fourth toe-to-hand transferred digits.

Using a modified Weiland scoring system,[9] this case has good results for bone allograft transplantation with grade 6 for the proximal junction (remodeling) and grade 2 for the body of the graft (mild resorption) (Fig. 4).

We feel that the outcomes in this case were similar to those obtained with reconstructed digits with frozen osteotendinous allografts and autologous cutaneous covers. However, we recognize that the final outcome in our patient is uncommon and requires further research into the role of ischemia in nonfrozen allografts to confirm that composite allografts provide long-standing structural support.

Although this is a single case, it demonstrates that digits may be successfully reconstructed with osteotendinous allografts and autologous cutaneous cover without the setbacks of immunosuppression and opens the possibility for future research.

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