

Making the Best of a Bad Situation: Case Report of a Nonreplantable Four-finger Amputation with Flap Coverage and Partial Hand Prosthesis Utilization

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Summary: Partial hand amputations (PHAs) are often associated with detriments to self-expression, independence, and employment. Modern partial hand prostheses, coupled with reconstructive surgery, may greatly mitigate the physical, psychological, social, and financial impairments caused by PHAs. The MCPDriver is a body-powered prosthesis and is an example of one of these modern, easy-to-use prostheses. This case report describes a 30-year-old man who experienced a traumatic, nonreplantable four finger degloving amputation of digits 2–5 at the level of the proximal phalanges. Initial reconstruction included preserving the length of the amputated phalanges and using a pedicled groin flap for soft tissue coverage with the goal to ultimately facilitate the use of a partial hand prosthesis. Once the PHA was stable, the multidisciplinary hand team held several discussions to review how to revise the flap for an MCPDriver. Staged debulking surgeries and syndactyly releases facilitated a successful fitting with the prosthesis. The patient resumed employment and bimanual tasks shortly after being fit with the prosthesis. The patient also reported significant improvements in his mental health and in the quality of his social interactions. This case illustrates how reconstructive surgeries coupled with partial hand prosthesis utilization can restore form and function following amputation. Familiarity with the modern classes of upper extremity prostheses and collaborating within a multidisciplinary hand team will likely enhance reconstructive outcomes following traumatic PHAs. (*Plast Reconstr Surg Glob Open* 2022;10:e4253; doi: 10.1097/GOX.0000000000004253; Published online 13 April 2022.)

Partial hand amputations (PHA) are amputations occurring distal to the wrist and can involve the complete or partial loss of the thumb, digits, and/or transmetacarpal regions.¹ The functional and psychosocial impacts from the loss of either hand at any level cannot be understated. Some of the consequences of experiencing a PHA include negative perceptions of wholeness, limitations in independence, altered social interactions, and difficulty maintaining employment.^{2–4} Partial hand prostheses

may greatly mitigate these limitations when reconstructive routes are unfeasible or inadequately restore hand form and function.¹ Using SCARE criteria,⁵ we present a case of a 30-year-old warehouse worker who sustained degloving amputations of digits 2–5 through the proximal phalanges. Multidisciplinary collaboration facilitated a successful fitting with a partial hand prosthesis that improved hand form and function.

CASE REPORT

A previously healthy, right-hand dominant, 30-year-old man presented to our trauma 1 hospital for a crush avulsion injury to the left hand after being caught between two industrial rollers at work. The patient's previous medical history was noncontributory, and his social history was negative for tobacco or recreational drug use. The left hand showed substantial degloving with amputation of the index through small fingers through the proximal

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phalanges and volar thumb degloving down to the flexor tendon with an intact flexor pollicis longus. The radial pulse in the left UE was intact. Radiographs of the left UE elbow, wrist, and hand were obtained and revealed soft tissue swelling of the wrist and traumatic amputation of the digits 2–5 through the proximal phalanges. No other fractures or dislocations were present.

The amputated digits were deemed inappropriate for any attempt of replantation due to the severity of soft tissue injury (Fig. 1). The surgical team then chose to preserve length of the amputated phalanges rather than disarticulating or amputating through the metacarpophalangeal joints (MPJs) to facilitate the eventual use of a partial hand prosthesis. Vascularized soft tissue coverage with a pedicled groin flap was applied to the hand with a small slip of the flap to volar thumb four days after presentation. Before flap placement, the flexor digitorum superficialis tendon of the index finger was sewn to the A2 pulley to increase the strength of MPJ flexion. The degloving trauma volarly inhibited this intervention from being performed on digits 3–5 as the A2 pulleys were not intact and the flexor digitorum superficialis tendons were shortened. After performing the groin flap to the hand, DermaClose (Synovis Micro Companies Alliance, Inc., Birmingham, Ala.) was used to progressively approximate the posterolateral aspect of the donor site that was unable to be closed primarily at the time of

surgery. The patient tolerated these interventions well, and the division of the groin flap pedicle was performed a month later (Fig. 2).

After consulting with the UE prosthetist, a surgical plan was created to tailor the reconstructed hand for fitting with MCPDrivers (Naked Prosthetics Inc., Olympia, Wa.). Several debulking surgeries including liposuction and direct incision were performed over the following months followed by syndactyly releases. The syndactyly releases were staged to address one webspace at a time to minimize the risks of devascularizing the skin flaps. The webspaces were created with local flaps utilizing syndactyly principles without the need for skin grafting (Fig. 3).

Hand therapy was used intermittently throughout the patient's recovery to keep the joints supple for the MCPDriver. In this case, because the patient's residual fingers were slightly less than the ideal length 1.5–2 cm beyond the webspace, the UE prosthetist performed three interface design revisions to achieve the desired functional outcome. This included designing novel, custom high temperature vulcanized silicone rings to activate the MCPDrivers. Changing the ring material increased the friction between the residual digits and the prosthesis,



Fig. 1. The extent of the injury can be visualized in this dorsal view of the hand. Replantation was not a viable option as the amputated digits were crushed.



Fig. 2. This image depicts the hand after being successfully divided from the groin flap and after several debulking procedures were performed, but before the syndactyly releases and webspace creations. Although stable, this PHA did not restore hand form or function. The patient was unable to be employed during this time and he reported major psychological and social detriments to his health.

preventing slippage during active range of motion. The size of the rings also needed to be decreased within 1 week of delivery due to significant volume reduction in the residual digits once the patient began using the prosthesis on a regular basis (Fig. 4).

Through the efforts of the hand surgeon, UE prosthetist, and hand therapist, the patient has since reentered the workforce in an office setting, has a DASH score of 8.3, and reports improvements in his mental and social health. (See Video 1 [online], which demonstrates the patient with his prosthesis shortly after being fit.) (See Video 2 [online], which demonstrates the patient with his prosthesis after the prosthetic modifications were complete.) Both videos highlight how the prosthesis restores unilateral and bimanual function. With his prosthesis, the patient can perform nearly every at-home or in-office activity, including preparing meals, using utensils, carrying a glass of water and trays of food, zipping up jackets and other clothing items, swiping his credit card, and typing on a keyboard. However, the patient cannot lift more than approximately 10 lbs with his prosthesis, likely due to his relatively short residual digits, which limits his ability to lift weights using this particular prosthesis. In the future, the patient may explore passive positional prosthetic devices such as Point Partial (Point Designs LLC, Lafayette, Colo.) or

GripLock (Naked Prosthetics Inc., Olympia, Wa.), which may enable him to lift more weight.

DISCUSSION

The patient's loss of digits 2–5 created a 60% impairment of the hand, which produced concomitant disability and psychological distress.⁶ Reconstructive methods were explored at each stage of this patient's clinical course, and rehabilitation with prosthesis utilization was ultimately chosen as it could restore finger length, improve hand function, and mitigate his social anxiety.^{7–9} Relying on the UE prosthetist's expertise, the MCPDriver was selected as a good patient-fit because it could harness the patient's intact MPJ, restore synchronous hand motion, and would provide protection to the residual phalanges through its roll-cage design. (See Video 2 [online].) Hand surgeons encountering similar traumatic PHA should preserve the length of the proximal phalanges as amputating or disarticulating at the MPJ will prevent the use of this prosthesis. A safe principle to follow is to preserve as much length as possible if prosthesis utilization is the desired long-term treatment goal. Along with flap revisions and staged syndactyly releases, another surgical intervention that increased the usability of the MCPDriver was joining the remaining flexor digitorum superficialis of the index finger to the A2 pulley. This increased the prosthesis's



Fig. 3. Hand form and function was greatly improved after performing syndactyly releases on the second, third, and fourth webspaces. Full-thickness skin grafting was not needed to provide soft tissue coverage to the remaining fingers or web commissures.

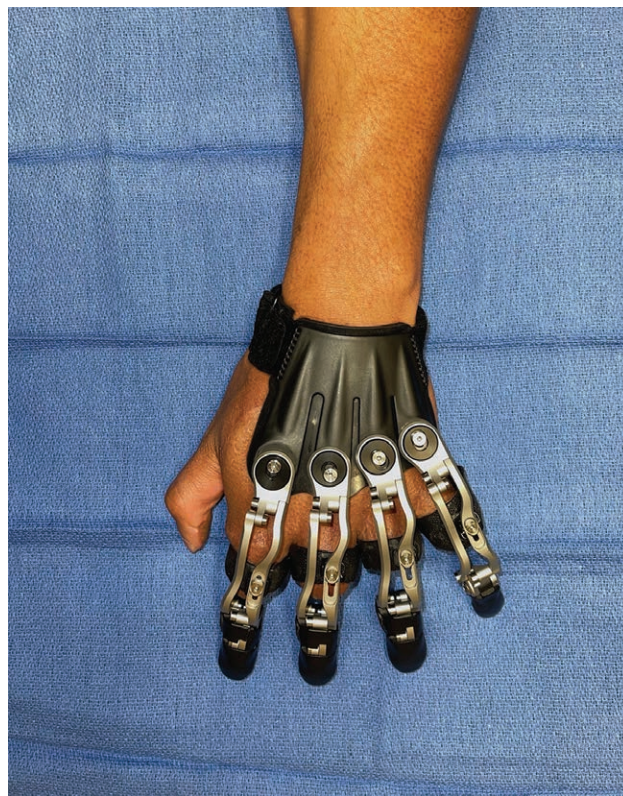


Fig. 4. The patient was a candidate for the MCPDriver after reconstruction was complete. Since being fit with his prosthesis, the patient has resumed employment and reports improvements in his psychological and social well-being.

force of flexion. As illustrated in this case, these surgical interventions facilitated a successful prosthesis fitting and ultimately enabled the patient to resume employment. The MCPDriver also greatly improved the patient's perceptions of wholeness and improved his confidence during social interactions despite it being mechanical-like in appearance. Other clinicians working with partial hand amputees should also report their findings as the literature on these devices remains limited.

Effective, patient-specific solutions are achievable when multidisciplinary team members collaborate.¹ As described in this case, the UE prosthetist provided the vision for what was needed to make a body-powered MCPDriver prosthesis usable and the surgical team provided the technical knowledge and expertise to contour the residuum. Multidisciplinary hand teams will also benefit from the contributions of hand therapists and PM&R physicians.^{3,10} As illustrated in this case, although the efforts of the multidisciplinary team were not lifesaving, they were quality of life—restoring.

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