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Scientific/Clinical Article

Rehabilitation of a patient following hand replantation after near-complete distal forearm amputation

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ABSTRACT

Study design: Case report.*Introduction:* Reports of comprehensive rehabilitation following hand replantation are limited.*Purpose of the study:* To describe hand therapy of a patient following hand replantation.*Methods:* Right hand dominant 55 year-old male assessed 9 days following left hand replantation to treat distal forearm amputation. Patient presented with dorsal blocking orthotic. Initial status: AROM digits and thumb 0–20° extension, 0–40° flexion; absent light touch sensation; 0–1/5 hand strength. Patient underwent 70 hand therapy sessions over 13 months focusing on A/PROM, therapeutic exercise, neuromuscular re-education, and modalities to address functional limitations.*Results:* Hand therapy discharge status: AROM digits and thumb form composite fist, thumb opposition to digit 3, light touch sensation (monofilament) 4.03 (digits 2, 4) and 4.17 (digits 1, 3, 5); 3– to 4–/5 hand strength.*Discussion:* Hand therapy allowed for near complete functional return of the hand following replantation.*Conclusion:* Comprehensive Hand therapy aided restoration of adequate sensation and strength for functional use of the replanted hand.*Level of evidence:* 4

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Introduction

Loss of a limb can have devastating ramifications to an individual's social, physical and emotional well-being, severely affecting a person's activities of daily living (ADLs), employment skills, and recreational activities.¹ Replantation is a surgical procedure utilized to reattach a limb that has been amputated, which involves reattachment of the anatomical components that have been severed, including the anastomosis of the arterial in-flow, as well as the venous return in most cases.² Advances in modern microsurgical technology and a clearer understanding of tissue healing in response to trauma have resulted in a reasonably predictable success rate with replantation of an amputated extremity.³ The success of digital replantation is well documented. Since successful hand and distal forearm replantation is less common, there are only a small series of published case studies.^{3,4} The available research regarding hand replantation focuses on surgical outcomes, stating favorable functional outcomes are possible with appropriate surgical and

postoperative rehabilitative care, despite a generally decreased return in sensibility and a significant amount of cold intolerance of the hand.¹ The hand replantation literature does not discuss in any detail however, the intense, lengthy rehabilitation involved in achieving successful functional outcomes following surgery. Therefore, the purpose of this retrospective case report was to describe the comprehensive hand therapy treatment associated with the rehabilitation of a patient following hand replantation surgery after traumatic near-complete distal forearm amputation.

Methods

Patient information

The patient was a 55 year-old right hand dominant white male who sustained a near complete amputation of his left distal forearm after his sleeve was caught in a Miter saw. He was admitted to a local hospital and was immediately flown to a specialty hospital for replantation by an orthopedic hand surgeon. He had a past medical history of coronary artery disease, coronary artery bypass graft surgery, hypertension, jaundice from alcoholism (quit 26 years prior to injury), and depression.

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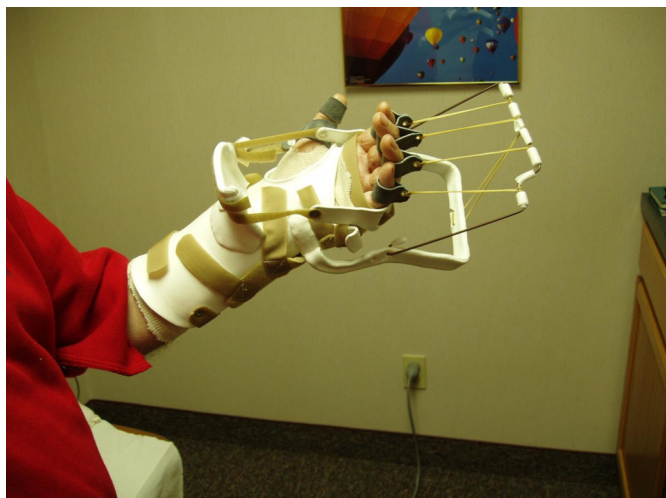


Fig. 1. Initial presentation of patient in orthosis.

Prior to the accident, the patient lived with his wife, was employed as an engineer and was independent with all ADLs. The patient reported having a strong desire to return to work and his previous independent living status. The patient provided informed consent for the retrospective review and subsequent professional presentation of his treatment case.

Replantation surgery

The replantation included open reduction and internal fixation of the ulna (with six-hole plate) and radius (with eight-hole plate). This was followed by repair of all injured tendons: flexor digitorum profundus (FDP) 2–5, flexor digitorum superficialis (FDS) 2–5, flexor pollicis longus, flexor carpi radialis, flexor carpi ulnaris, palmaris longus, extensor carpi ulnaris, extensor digitorum 2–5, extensor digiti minimi, extensor pollicis longus and brevis, abductor pollicis longus, extensor carpi radialis longus and brevis. The radial and ulnar arteries were repaired, followed by repair of the median, ulnar, radial (superficial branch), and dorsal ulnar sensory nerves. The basilary vein was repaired, and a 3 cm vein graft repair was made of the cephalic vein. Closure was achieved with advance of skin flap and the use of a skin graft. Total tourniquet time of the surgery was 2 h and 45 min.

Hand therapy examination

The patient initially presented to hand therapy nine days post-surgery wearing an orthosis (fabricated by an orthotist in

consultation with the treating physical therapist who was a certified hand therapist [CHT]) and sling for his left wrist and shoulder, respectively (see Fig. 1). The orthosis placed the hand in mid-position to protect the flexor and extensor repairs and prevent early clawing. The patient reported constant pain at a level of 2/10, “pins and needles” and a burning sensation over the palmar and volar aspect of his left hand. The patient managed his pain with over-the-counter Tylenol® due to experiencing adverse side effects with prescribed pain medication. After the replantation, the patient was limited with all ADLs utilizing his left hand. The patient reported requiring assistance from his wife with most ADL activities (e.g., bathing, dressing, eating).

The left extremity was first carefully palpated for tenderness and inspected for temperature, color, odor, unusual drainage, and edema. There was minimal edema noted in the digits, and there were no signs of tissue rejection (rash, red discoloration, or swelling). Active range of motion (AROM) was assessed for the hand (measures obtained in the orthosis), and shoulder (see Table 1). The orthosis was monitored to insure correct fit, observing for any pressure points. Formal sensory evaluation was not performed since gross sensory assessment demonstrated an insensate hand, and due to nerve injury and repair, sensation distal to the wrist would not be anticipated for 3–6 months. Resistive strength testing of the hand and wrist were contraindicated secondary to the surgical repair of the tendons. Rehabilitation potential for this patient was fair + to good, based on factors that delay healing such as advanced age, severity of trauma with the initial amputation, and past medical history.

The patient was initially seen in the clinic twice weekly; a plan of care was developed following Kleinert Institute Rehabilitation Treatment Guidelines for Distal Forearm to Transmetacarpal Level Replant/Transplant (see Table 2). The plan of care consisted of gentle soft-tissue mobilization (STM), debridement of volar forearm wound, scar massage, electrical stimulation (ES), ultrasound (US), therapeutic exercise, neuromuscular re-education, and a home exercise program (HEP). Primary treatment rationale was to promote active motion of the digits without placing the tendons at risk for gapping and/or rupturing.

Intervention

The patient was treated in hand therapy over a 13-month period, with a total of three episodes of care due to new surgical interventions (see Fig. 2). The second episode of care, which began seven months post-replantation, followed a second surgical procedure to address distal radius non-union with wrist stiffness, using a bone graft and skin graft extension. The third episode of care occurred approximately 12 months post replantation following a

Table 1
Active range of motion of left upper extremity

Left UE	EOC1 initial	EOC1 discharge	EOC2 initial	EOC2 discharge	EOC3 initial	EOC3 discharge
Digit AROM	30–40° of PIP flexion; –20° PIP extension	Lack ½ inch from PFC for full composite flexion	Full comp flex; lacks 15° PIP composite extension	Full composite flexion	Full flex, index lacks ½ inch flex PFC; lacks 15° PIP ext	Full composite flexion
Wrist flexion	25°	25°	25°	40°	30°	60°
Wrist extension	10°	30°	30°	45°	20°	45°
Radial Deviation	5°	15°	0°	5°	5°	20°
Ulnar Deviation	10°	30°	15°	25°	20°	22°
Supination	80°	80°	80°	85°	75°	75°
Pronation	80°	80°	70°	80°	65°	80°
Shoulder flexion	130°	165°	170°	170°	170°	170°
Shoulder abduction	130°	170°	165°	170°	170°	170°
Shoulder IR	70°	85°	85°	85°	85°	85°
Shoulder ER	65°	80°	80°	85°	85°	85°

EOC = episode of care; AROM = active range of motion; PIP = proximal interphalangeal joint; PFC = proximal flexion crease; IR = internal rotation; ER = external rotation.

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