

The Functional Results of Forearm and Upper Arm Replantation: Report on Two Cases

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Upper extremity replantation is relatively less commonly performed than finger or hand replantation. We have experienced one case of forearm replantation and one case of upper arm replantation. After the replantation, limb volume at the biceps brachii muscle level below the replantation level appeared to be appropriate, however, the motor function of the muscles and the sensitivity were disappointing. For replantation of forearm and upper arm, restoration of the motor function and sensitivity of the extremity below the amputation level as well as the morphologic reconstruction have to be considered.

Key Words: Upper extremity, Replantation, Evaluation studies

Forearm or upper arm replantation occurs relatively less commonly than finger or hand replantation. With advancement of microsurgical technique, surgical success rate in forearm, upper arm, finger and hand replantation was improved recently. The morphologic recovery with the replantation is important in the psychologic aspects of the patients, and the recovery of the motor function and sensitivity of the extremity below the amputation level is also very meaningful.

Surgical indications for forearm or upper arm replantation are similar to those of finger replantation, but as many cases may have postoperative limited expectations in the recovery of the extremity function and complications, such as postoperative toxemia and failure of revascularization, the procedure should be performed in relatively isolated amputatee who well understands the surgical problems.

We have experienced one case of forearm replantation and one of upper arm replantation, and we investigated the

morphologic restoration and the functional recovery of motor and sensitivity of the extremity below the amputation level.

CASE REPORT

Case 1

A 44-year-old male had a complete amputation at distal 1/3 of left upper arm combined with fractures of the right femur and both tibias, which was caused by fall from reconstruction building of 25-m height. When he arrived in the emergency department of Chonbuk National University Hospital, the left humerus had a transverse fracture in its distal 1/3 with a clean divided margin, including divided muscles, arteries and nerves (Fig. 1A). Surgery was performed under the general anesthesia. Wound margin was more cleaned with a minimal debridement and the fractured humerus was fixed with a plate and screws. The divided brachial artery, median nerve, triceps and other



Fig. 1. (A) A 44-year-old man sustained upper arm amputation. (B) Immediate replantation state. (C) Immediate post replantation fasciotomy. (D) Immediate after replantation. (E) Follow-up 5.4 years after replantation.

Table 1. Subjective questionnaire

(1) How long were you off work/school?
(2) What things can you not do following surgery?
(3) Do you think your extremity is better than an amputation or a prosthesis?
(4) Would you recommend this procedure to others with a similar injury?
(5) Can you use your extremity for the activities of daily living?
a. not at all
b. little
c. for many activities
d. for most activities
e. for all activities
(6) How satisfied are you with the results of your surgery?
a. not satisfied
b. somewhat satisfied
c. satisfactory
d. better than expected
e. no difference than before surgery

Cited from Russell et al. J Hand Surg Am 1984;9:623-33.¹

muscles, ulnar nerve, radial nerve and basilic and cephalic veins were anastomosed in order (Fig. 1B), and at last the fasciotomy was made in the palmar hand and forearm (Fig. 1C) to prevent the compartment syndrome to improve the healing process of the part (Fig. 1D). At postoperative years 5.4, the motor function of the left fingers, wrist, and elbow got a score of 2 points only on 'write-name' by the Carroll's qualitative test. The two-point discrimination was poor. The circumference of the left arm was a little small as 22 cm compared to the right upper arm (25 cm) that is non-injured side (Fig. 1E). He was satisfied with only 2 items, which were two questions 'the postoperative

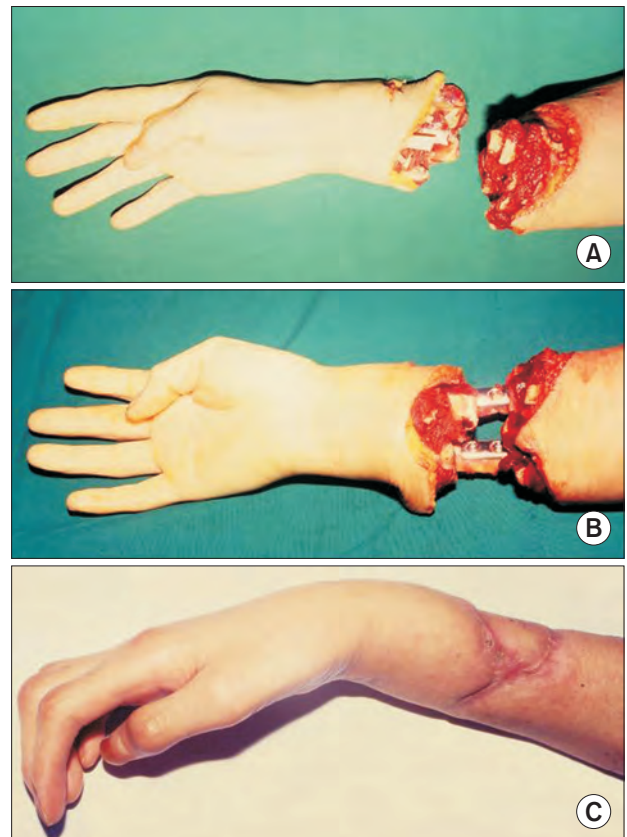


Fig. 2. (A) A 53-year-old man sustained amputation at distal 1/3 of forearm. (B) Forearm both bone was fixated followed by replantation. (C) 3.7 years after replantation.

extremity condition is better than an amputation or prosthesis?' and 'would you recommend this procedure to others with a similar injury?' among 6 subjective patient evaluation questionnaire (Table 1).¹

Case 2

A 53-year-old male had an amputation injury at the distal 1/3 of the right forearm, which was caused by a press machine (Fig. 2A). Two bones of the right forearm were fixed with two plates and multiple screws, and then the divided radial and ulnar arteries, muscles, three nerves and superficial large two veins were re-anastomosed (Fig. 2B). At postoperative years 3.7, the motor function of the right fingers, and wrist got a score of 10 points by the Caroll's qualitative test. The two-point discrimination was poor (Fig. 2C).

DISCUSSION

Advancements in replantation surgery, paralleled by improvements of microsurgical techniques, have led to an increasing success rate of replantation of the upper extremity with an overall viability rate greater than 80%.^{2,3} The absolute contraindications of replantation for the upper extremity amputation include any life-threatening injury, a patient condition with chronic debilitating illness, impaired function of the extremity from a previous injury or disease, profuse contamination of the extremity, and prolonged warm ischemia of the amputated tissue.^{4,5} For the past pioneers of microsurgery, tissue success with functional failure was acceptable, but nowadays function must predominate as the goal, requiring restoration of skeletal stability, joint mobility, power and sensibility.^{6,7}

Replantation of the amputated upper extremity parts should be performed by surgeons who are well trained in the surgery part of the hand and upper extremity. When an amputation patient arrives at the department of emergency with an amputation stump, an orthopedic micro-surgeon was first called to evaluate general physical and amputation conditions in the upper extremity and to determine whether microsurgical replantation is available or not with expected survival rate. Amputation stumps of the two above patients at the department of emergency were in a good condition for replantation and replantation was performed under general anesthesia.

The fractured bone should be first stabilized with a plate and screws, and the divided muscles were repaired layer by layer, and then the epineuria of the injured median, ulnar and radial nerves were sutured without tension, and at last the injured

cephalic and basilic veins were anastomosed. Additionally, fasciotomy was performed in the forearm distal to the amputation level to prevent compartment syndrome.

Replantation toxemia, which might be induced by serum myoglobinemia, metabolic lactic acidosis, hyperkalemia and hypoproteinemia,⁸ was not observed in our patients, probably due to a relatively short warm ischemic time. Two large superficial veins were repaired and fasciotomy was performed to prevent compartment syndrome.

Before surgery, patients with an above-elbow amputation should be medically and psychologically stable and understand the limited expectations in postoperative functional recovery. Postoperative functional recovery of the upper extremity was evaluated by the qualitative test suggested by Carroll.⁹ Each activity is given a score from 0 to 3, and a total of 33 such activities produce numerical scores. The hand of the patient with the upper arm replantation had no score in grasp, grip, pinch, placing, supination/pronation, and write name. Two-point discrimination test¹⁰ was performed and the extremity had no sensitivity. Limb-volumes were also measured.¹ The circumference of the biceps brachii was slightly decreased compared to the non-injured side. Subjective questionnaire was asked and 2 of the 6 were satisfactory.

Replantation of the upper extremity could maintain the limb intact with revascularization, but more tedious surgical skills and lots of therapeutic experiences are required to restore the motor and sensory function of the extremity.

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