Finger Replantation in Sanglah General Hospital: Report of Five Cases and Literature Review

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Background: Replantation is the prime treatment for amputated hands and fingers due to functional and aesthetic advantages. The absolute indications for replantation are amputations of the thumb, multiple fingers, trans metacarpal or hand, and any upper extremity in a child, regardless of the amputation level. A fingertip amputation distal to the insertion of the flexor digitorum superficialis (FDS) is also a good indication. Indications have been expanded to include amputation at nail level, and when there is a request from the patient, replantation is attempted even for a single finger amputation regardless of the amputation level. Based on the mechanism of injury, a clean-cut sharp amputation is more likely replanted compared to crush and avulsion injuries. With a proper management of the amputated finger, replantation can be attempted even after 24 hours. This report was written to provide examples of finger replantation cases and the measures that can be taken in a resource-limited hospital in order to conduct a replantation. Case Series: We reported five out of nine digital replantation cases in Sanglah General Hospital between January and July 2014. Two patients were six and eleven years old boys who accidentally cut their finger while playing, the rest were male labors between 20-30 years old whose amputations due to machine injuries. Result: A 100% replant survival was achieved. After a period of follow up with occupational therapy, all patients regain good functional and cosmetic results.

Keywords: finger amputation, digital replantation, finger replantation

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INTRODUCTION

The history of digital replantation started around 1960 when the first successful thumb replantation reported by Komatsu and Tamai.¹ Finger replantation and microsurgery have evolved at a rapid pace, they now include amputations of the hand, thumb, multiple digits, and amputations in children. Indications include the amputation of the thumb, multiple digit amputations, mid-palm/hand amputations, single finger amputations distal to the flexor digitorum superficialis (FDS) insertion, or any amputation in a child.² The indications have also been expanded to when there is a request from the patient. The contraindications are severe crush injuries, multilevel amputations, concomitant life-threatening injuries, single finger amputations proximal to the flexor digitorum superficialis insertion, patients unable to comply with a rehabilitation program, prolonged normothermic ischemia time.³

Good communication between the replantation center, microsurgeon, and the referring physician is important to achieving appropriate, fast, and correct transport of the amputated parts. Communication with patients is also significant where the possible candidates for replantation must be informed of the likely outcomes of replantation, revision of the amputation procedures, and the different postoperative regimens for each patient. Although replantation surgery has become a routine procedure, it is still a delicate and
demanding surgery, requiring experts in microsurgical techniques.

Even though replantation procedures have been simplified, a second surgical team can save valuable surgical time by debriding and identifying the vessels in the amputated part, harvesting microvenous grafts, and performing bone fixation or tendon repair among other things, while the chief surgeon focuses on revascularization. The main goals in the management of a mutilated hand are form and function restorations. Ideally, the injured parts are to be restored to their pre-traumatic state. Although replantation of sharply severed parts may not restore function and some more precise activities.

CASE SERIES
Patient 1
A 30-year-old right-handed male labor accidentally cut his left thumb while slashing a coconut, sustained amputation at the first metacarpal of left digitus I manus. The patient was transferred to the hand unit following a resuscitation in the accident and emergency unit. The replantation was performed 6 hours after the accident. Two teams worked to prepare the vessels and nerves, and other structures. During the operation, we found a rupture of the superficial branch of the radial artery and the princeps pollicis artery. We did an end-to-end anastomosis under a high-power microscope. We also anastomosed one of the ruptured veins. The fractured bones were fixed with K wires. Flexor and extensor tendons were reinserted to appropriate muscles. Five months after the replantation, after a period of occupational therapy the patient regain a good cosmetic and functional results.

Figure 1.
A. Patient 1 Clinical examination: traumatic amputation of left 1st shaft metacarpal. B. Post-operative appearance (after replantation). C. Pre-operative x-ray: traumatic amputation of left 1st shaft metacarpal. D. Post-operative x-ray.

Patient 2
A six-year-old boy who accidentally cut his left thumb while playing with an ax sustained an amputation at the distal interphalangeal articulation of left digitus I manus. The patient was transferred to the hand unit following a resuscitation in the accident and emergency unit. The replantation was performed 3 hours after the accident. 3 months later, the patient could use the replanted thumb in every day basic activities and some more precise activities.

Figure 2.
A and B. Shows Patient 2 pre-operative clinical findings: traumatic amputation on left base distal phalanx of the thumb. C and D. Postoperative clinical appearance.

Patient 3
A 21-year-old right-handed male labor accidentally cut his left ring finger while cleaning a machine. He was amputated at the medial phalanx of left digitus IV manus. The patient was transferred to the hand unit following a resuscitation in the accident and emergency unit. The replantation was performed 5 hours after the accident. Two teams worked to prepare the vessels and nerves, and other structures. During the operation, we found a rupture of the ulnar and radial side of arteriae digitales palmares propriae, and the ulnar and radial side veins. We did an end-to-end anastomosis under the high-power microscope of the radial side of arteriae digitales palmares propriae and both veins.

Fractured bones were fixed with K wires. Four months later, after another operation to repair the tendons and nerves and a period of rehabilitation for three months, the patient was back to his previous work.

Patient 4
A 29-year-old right-handed male labor accidentally cut his right index finger while working with an emery wheel and sustained an
amputation at the proximal phalanx of right digitus II manus. The replantation was performed 6 hours after the accident.

The patient was transferred to the hand unit following a resuscitation in the accident and emergency unit. Two teams worked to prepare the vessels and nerves, and other structures. During the operation, we found a rupture of the ulnar and radial side of arteriae digitales palmares propriae, and the ulnar and radial side veins. We did an end-to-end anastomosis under a high-power microscope of the ulnar side of arteriae digitales palmares propriae and both veins.

The fractured bones were fixed with k wires. Four months later, after another operation to repair the tendons and nerves, the patient could use the replanted finger in every day basic activities and some more precise activities. Moreover, he was back to his previous work.

![Figure 3](image)

**Figure 3.**
A and B. Patient 3 clinical examination: dorsal and volar aspects of the traumatic amputation of the left ring finger. C and D. The amputated left ring finger. E and F. Postoperative appearance.

**Patient 5**
An eleven-year-old boy who accidentally cut his left index finger while playing with a motorized grass cutter sustained amputation at the distal part of the proximal phalanx of left digitus II manus. The patient was transferred to the hand unit following a resuscitation in the accident and emergency unit. The replantation performed 3 hours after the accident. Two teams worked to prepare the vessels and nerves, and other structures. During the operation, we found a rupture of the ulnar and radial side of digitales palmares propriae artery and the ulnar and radial side veins. We did an end-to-end anastomosis under a high power microscope of the radial side of digitales palmares propriae artery and both veins. The fractured bones were fixed with k wires. Two months after the replantation, the patient could use the replanted thumb in every day basic activities and some more precise activities.

![Figure 4](image)

**Figure 4.**
A and B. Patient 4 clinical examination: dorsal and volar aspects of the traumatic amputation of right index finger. C and D. The amputated right index finger. E and F. Postoperative appearance.

**DISCUSSION**
Based on our experience, one of the most important parts of handling the amputation victims is the pre-hospital part. In handling an amputated extremity victim, we should always remember to perform the initial assessment and not only focused on the amputated parts of the body. The patient’s vital sign, general health assessment, and general physical examination should be assessed and addressed first. The amputated parts should be dressed in sterile gauze. Bleeding should be dressed with compressions, not using a tourniquet. We found that some of the amputation cases cannot undergo a replantation process because of inappropriate handling of the amputated parts. The amputated parts should be wrapped in gauze and kept in a plastic package, chilled with ice, and be carried as soon as possible to the microsurgery and replantation center. The amputated parts should not be placed inside an ice-filled bag because the hypotonic water may cause water intoxication and cell damage. Digits may be routinely replanted with up to 24 hours of cold ischemia time and 12 hours of warm ischemia time.
The description of the mechanism of the injury is important. A patient with amputations resulting from sharp objects is an ideal candidate for replantation because the zone of injury is largely confined to the amputated site. In contrast, a victim of a broad crush or an avulsion injury is a poor candidate for replantation. Sufficient bone is necessary for a stable fixation. The lacerated vessels, although frequently requiring interposition grafts, have to retain the distal capillary integrity. The patient medical history has to be obtained. Cardiac, pulmonary, and neurologic status must be weighed against the stress of transport and subsequent surgery. For example, a recent myocardial infarction or dementia would serve as an absolute contraindication for replantation surgery. Tetanus prophylaxis and broad spectrum antibiotics should be given to the patient to prevent undesirable infection.

Upon arrival at the microsurgery and replantation center, preparations of the amputated segment and the hand should be done simultaneously and as soon as possible. The preparation of the amputated fragment begins in the operating room, even before the patient is anesthetized or taken to theater. This is a great timesaver. Once prepared, the amputates part is placed on a sterile glove or plastic bag filled with ice. Two lateral digital incisions are used for exploration. The vessels are rinsed with heparinized saline. All vessels and nerve edges are trimmed and marked using 10/0 sutures. We do not recommend immediate dissection of dorsal veins at this stage, as manipulation during fixation and a possibly prolonged palmar phase of the replantation may cause their damage. We recommend the preparation to be done during the dorsal phase. The bone is cut clean with an oscillating saw and two 1.0 K-wires are placed using the ‘in-and-out’ method. The flexor digitorum profundus (FDP) tendon to be repaired is mounted on a Tsuge 4/0 suture.5

In preparation of the hand, the digital stump is likewise trimmed. The bone is cut with an oscillating saw. The neurovascular structures are dissected. Nerves marked with methylene blue or using a 10/0 suture. The arteries are cut beyond the zone of injury and are rinsed with heparinized saline and set on a microvascular double clamp.

It is sometimes difficult to retrieve the retracted proximal flexor tendon stump, especially for the thumb. Therefore, an approach in zone 3 or 4 may be necessary. A Tsuge suture (4/0 PDS loop) is mounted on the tendon, which can then be returned to its sheath, back to the cut edge.5 The best results will always be achieved in a clean amputation with limited dissection.

The patient should be kept warm, regional anesthesia should be administered, and a tourniquet...
should be applied but not initially inflated. Under a high-power microscope magnification, the vessels can be repaired using 11-0 suture with a 50-μm needle. The K-wire (usual size 10/10) is passed retrograde into the proximal bone end, ensuring a firm grip on the replanted part to prevent spinning as the wire turn. For tendon repairs, we prefer the Kessler suture modified by Tajima (PDS 4/0) as well as the Tsuge (PDS 4/0 loop suture), which are faster to perform. To repair the nerves, two or three 9/0 or 10/0 stitches are done. In a case of nerve defect, our first choice is a nerve graft from the not salvageable or the ‘spare part’ finger. Alternatively, the lateral antebrachial cutaneous nerve is the most appropriate.

After surgery, the patient is kept in a warm room to promote vasodilation for 3 to 5 days. Hematocrit as parameters for disseminated intravascular coagulopathy (DIC) and electrolyte balance are carefully monitored. A hematocrit of 20 to 25 is ideal. The electrolyte balance is kept close to normal. Intravenous fluids are delivered at a rate of twice maintenance rate for 3 days, followed by routine maintenance rates. Heparin 5000 units are given twice to prevent potential lower extremity deep venous thrombosis associated with bed rest. Hourly monitoring with pulse oximetry and capillary refill is conducted until the patient is discharged. In 48 to 72 hours, the patient underwent a dressing change and further debridement if necessary, and definitive soft tissue closure which may require skin grafting or the use of flaps. The patient is returned to the ward and monitored for 3 to 4 days if no graft or flap necessary, or 6 to 10 days if flaps are required.

Along with the development of surgical microsurgical and scientific technology, the field of replantation has become more refined. Specific indications and contraindications for replantation, preparation protocols, efficient techniques to ultimately minimize ischemia times and improve survival rates, guidelines for postoperative care, strategies for treating complications, and goals for outcomes have been established. Patient satisfaction is various depends on their level of expectation as defined and explained in the preoperative discussion and the process of informed consent. When considering multiple-finger replantation, the finger with the best chance for successful replantation, best-expected recovery, and most significant contribution to function should be repaired first. If all the fingers are injured equally and have the same chance for successful repair, the authors prefer to repair the middle, then index, then ring, and, lastly, the small finger.

The amputated fingers should be brought to the operating room as soon as possible because the digital vessels, nerves, and tendons can be identified and tagged with sutures or clips, which saves time and minimizes ischemia. The order for repairs can be improvised with multiple replantation. Initially, the osteosynthesis, extensor tendon, one dorsal vein, and one digital artery can be repaired for each finger to minimize overall ischemia time, then another dorsal vein, the digital nerves, and the flexor tendon core sutures can be repaired later, once blood flow has been reestablished to the fingers. Resection of the avulsed digital artery and vein is the most crucial part of the procedure, vessels reconstruction can be performed using various methods, but vessel transfers from the middle finger appear to be the most reliable solution.

Successful replantation is no longer measured by survival of the amputated or devascularized part, but rather by the function of that part. Although numerous reports attest to successful replantation and revascularization in the upper extremity, there has been only a little discussion of the functional outcome. Sears et al found that functional outcomes of sensibility and range of motion after replantation of finger avulsion injuries are better than what is historically cited in the literature. The results the systematic review challenges the practice of performing a routine revision amputation of all complete finger avulsion injuries.

**CONCLUSION**

Even though the functional outcome of replanted fingers will never be equal to that of the normal healthy counterpart, a replantation has major functional, cosmetic, and psychological benefits. Our patients were very satisfied with their replanted fingers, which had helped them to do their daily activities.

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