

## Digit Replantation

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### Introduction

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The focus of replantation of any part of the upper extremity is maximizing functional outcome rather than simple survival of the amputated part. Functional outcomes are dependent on anatomical characteristics of the injury as well as patient-specific factors. Anatomical considerations include the level of amputation and the degree injury to the arterial intima and other soft tissue structures. Other considerations must be given to patient factors such as age, occupation, and cultural significance attributed to the hands.

### Anatomy

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The level of amputation is stated as related to the zone of flexor tendon injury. Zones of flexor tendon injury are labeled in relation to insertion of the flexor digitorum profundus, the level of the digital pulley system, and the location of the carpal tunnel. Zone 1 injuries comprise those injuries in which the transection occurs distal to the origin of the flexor digitorum superficialis tendon. Zone 2 injuries lie between the distal insertion of the flexor digitorum superficialis and the A1 pulley, located just proximal to the metacarpophalangeal joint. Zone 3 flexor tendon injuries and amputations occur between the A1 pulley and the distal edge of the carpal tunnel. Injuries through the carpal tunnel are referred to as Zone 4 injuries. Zone 5 amputations and flexor tendon injuries occur proximal to the carpal tunnel.

Zone I amputations involve only the flexor digitorum profundus tendon, leaving motion intact at the proximal interphalangeal joint (PIP). Amputations at this level portend a favorable outcome, however, if the amputation occurs at the distal aspect of the middle phalanx or past the distal interphalangeal joint (DIP) the small diameter of the digital vessels may preclude replant. Amputations at this level have classically had a very poor outcome due to the inability of the repair to pass between the complex digital pulley system. However, Zone 2 amputations are not absolute contraindications to replantation and should still be considered in the properly selected patient. In general, outcomes of replantation in Zones 3 to 5 depend on other patient and injury factors, such as ischemia time, mechanism of amputation and patient comorbidities, then on the level of amputation.

### Indications

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General indications for upper extremity replantation are thumb amputation, multiple digit amputation, mid-palm (transmetacarpal) amputation, single-digit amputations distal to the insertion of the flexor digitorum superficialis tendon (Zone 1), sharp amputations at the hand, forearm, or elbow level, and any amputation in a child. Any patient that is transferred to a Level 1 trauma center or replant capable facility should be done after consultation with the hand surgeon at that facility to ensure the transfer is appropriate.

### Contraindications

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General contraindications are severe crush or avulsion injuries, multiple level injuries, single finger amputation proximal to the insertion of the flexor digitorum superficialis tendon (proximal to Zone 1), prolonged ischemia time, and mentally or physically unstable patients. Patients with absolute contraindications to replantation do not need emergent transfer to a replant capable facility if their wounds can otherwise be managed at the facility of initial presentation.

### Equipment

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Digit replantation requires the use of an operating microscope as well as appropriate microsurgical instruments and suture. If this equipment is not readily available at the treating facility, the patient may need transfer to a facility with the proper resources.

### Personnel

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Any surgeon trained in microsurgical technique and hand replantation may perform digit replantation. This includes any attending orthopedic or plastic surgeon. However, this procedure requires specialized equipment and personnel that are familiar with that equipment. These resources may not be available at all institutions. Orthopedic, plastic, or general surgeons with the Certificate of Added Qualifications (CAQ) in hand surgery are the best resources for performing replantation or referring to facilities where replantation is possible.

### Preparation

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### Handling of Amputated Extremity Parts

Transportation of the amputated part is paramount in preserving viability. The most widely utilized and effective method of preservation is wrapping the amputated extremity in gauze moistened with a physiologic solution (normal saline or lactated ringers), placing the wrapped amputated part in a plastic bag, then placing this plastic bag on ice. Alternatively, the part may be immersed in a physiologic solution in one bag which is then placed on ice. Amputated extremity parts should never be placed directly on ice, as this may cause frostbite or other soft tissue injuries to the amputated part. Such injury may preclude replantation altogether or compromise the achievable functional result of replantation.

### Ischemia Time

Timing is critical in replantation surgery. The amount of muscle in the amputated part determines the amount of ischemia time each part will tolerate. Digits contain no muscle, and the bone and soft tissue present in each digit have a relatively low metabolic rate and formation of toxic byproducts of ischemia. Therefore, digits amputated in Zone 1 and Zone 2 may tolerate up to 12 hours of warm ischemia time and up to 24 hours of cold ischemia time. In general, muscle makes up a substantial portion of the soft tissue in Zone 3 to 5 amputations. Extremities amputated at this level will tolerate no more than six hours of warm ischemia time or 12 hours of cold ischemia time. Because of this, vascular shunting to the amputated part may be necessary for forearm or elbow amputations before surgical repair may be initiated.

## Technique

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### Sequence of Repair

When possible, the amputated part should be taken to the operating room before the patient for thorough debridement and examination under the microscope. The quality of the tissue, specifically the nerves and blood vessels, are examined before committing to the replantation. Identifiable structures should be tagged with suture or microclips. The first step in replantation is bone shortening and fixation. Bone should be shortened enough to take all tension off of the subsequent soft tissue repairs. In the pediatric population, any bony shortening should take care not to sacrifice the physis. Bony fixation is followed by extensor tendon then flexor tendon repair. Arterial repair should then be undertaken. No matter what the level of amputation, anastomosing intact and healthy arterial intima on each side of the repair is paramount to success. If this requires excessive debridement, vein grafts must be taken. Ample vein grafts are typically available from the ipsilateral extremity in the cephalic or basilic vein. However lower extremity vein grafts may be necessary. Nerve repair is then completed followed by vein repair. Lastly, soft tissue coverage of the repair is completed.

In short:

1. Bone
2. Extensor Tendon
3. Flexor Tendon
4. Artery
5. Nerve
6. Vein
7. Soft tissue

## Complications

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Complications of flexor tendon injury can include bleeding, infection, replant failure, and finger stiffness. Venous congestion of the finger is a common problem as anastomosis of damaged dorsal veins is often difficult. Various strategies to prevent or treat venous congestion exist, including removal of the nail plate, fishmouth incisions over the fingertip with heparin pledget application, or application of leeches. Any patient begun on leech therapy should also be placed on Ciprofloxacin therapy to prevent infection from *Aeromonas hydrophilia*.

## Clinical Significance

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If performed by an experienced hand and microsurgeon, viability rates of replants should be at least 80% following replantation. Motion at the affected joints depends on the level of amputation, mechanism of amputation, and compliance with postoperative therapy. Patients should be advised before surgery that the motion in replanted digits averages only approximately 50% of normal. Furthermore, patients undergoing replantation average ten days in the hospital and approximately seven months of time off of work. In general, the best results come from replantation of the thumb, hand, distal forearm, and fingers distal to the insertion of the flexor digitorum superficialis (Zone 1).

## Questions

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To access free multiple choice questions on this topic, [click here](#).

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## Publication Details

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