

## Review Article

# Heterotopic digital replantation for restoring hand function

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### ABSTRACT

Heterotopic digital replantation is a specialized reconstructive microsurgical technique used when an amputated digit cannot be replanted to its original site due to extensive local damage or multiple amputations. Instead, the viable digit is transferred to a non-anatomic position-most often to reconstruct the thumb or restore opposition-aiming to maximize functional outcome rather than anatomic accuracy. This approach is particularly indicated in cases of irreparable thumb loss, multiple non-replantable digits, or severe joint destruction where restoring prehension is the primary goal. The procedure requires precise microsurgical anastomosis of vessels and nerves and may be combined with free tissue or joint transfers. Reported outcomes show satisfactory sensory recovery, range of motion, and grip strength when careful surgical planning and rehabilitation are applied. However, potential complications include vascular thrombosis, infection, wound healing disorders, and long-term stiffness or sensory deficits. Despite these challenges, heterotopic replantation remains a valuable option for restoring meaningful hand function in complex injuries where traditional replantation is not feasible.

**Keywords:** Heterotopic digital replantation, Thumb reconstruction, Finger transplant, Microsurgery, Hand trauma, Functional restoration

### INTRODUCTION

In heterotopic digital replantation, an amputated finger or thumb that cannot be replanted to its original anatomical site-due to extensive local damage, loss of recipient structures, or other contraindications-is instead transplanted to a different position on the hand to maximize functional outcome. For example, a non-salvageable thumb may be reconstructed by transplanting an amputated finger (such as the index or ring finger) to the thumb position, thereby restoring oppositional and prehensile function.<sup>1,3</sup> This approach prioritizes restoration of a functional thumb and at least two opposable fingers, which are critical for hand function.<sup>3</sup>

The procedure involves microsurgical anastomosis of vessels and nerves, and may be combined with other reconstructive techniques such as free tissue transfer or joint transfer, depending on the extent of injury and available "spare parts".<sup>2,4</sup> Long-term outcomes, including

range of motion, grip strength, and sensory recovery, have been reported to be comparable to those achieved with in situ replantation, provided that careful patient selection and surgical planning are undertaken.<sup>1,2</sup>

In summary, while "heterotopic finger transplant" is not a recognized term, heterotopic digital replantation is a validated reconstructive strategy for hand injuries, involving transplantation of a digit to a non-native position to optimize hand function.<sup>1-3</sup>

### INDICATIONS FOR HETEROTOPIC FINGER TRANSPLANT

The typical indications for heterotopic finger transplants-defined as the transfer of a digit or joint to a non-anatomic position on the hand-are primarily encountered in the context of complex, mutilating hand injuries where restoration of prehensile function is the primary goal and

direct replantation is not feasible due to the extent or pattern of injury.<sup>5-8</sup> The most common scenarios include:

#### ***Irreparable loss of the thumb or multiple digits***

Restoration of a functional thumb is prioritized, often by heterotopic transfer of a salvageable finger (e.g., ring or middle finger) to the thumb position when the native thumb is nonviable. This is critical for enabling opposition and tripod pinch.<sup>8,9</sup>

#### ***Multiple digital amputations with limited viable parts***

When several fingers are lost and some amputated parts are nonreplantable at their original sites, heterotopic transplantation is used to redistribute available tissue to maximize hand function, typically aiming to restore at least two opposable fingers and a thumb.<sup>10,11</sup>

#### ***Severe joint destruction***

In cases of extensive metacarpophalangeal (MPJ) or proximal interphalangeal joint (PIPJ) damage, heterotopic vascularized joint transfer is indicated when a salvageable joint from an amputated or redundant digit can be transferred to a more functionally optimal position, especially when prosthetic replacement or arthrodesis is contraindicated.<sup>1,4</sup>

#### ***Congenital absence or deficiency of digits***

Although less common, heterotopic transfer (including toe-to-hand transfer) may be considered in select cases of congenital hand differences to reconstruct absent or deficient digits, particularly when aiming to restore growth potential and function.<sup>5</sup>

In all cases, the decision to perform heterotopic transplantation is individualized, based on the pattern of injury, availability of salvageable tissue, and the functional requirements of the patient. The overarching principle is to optimize hand function by reconstructing a thumb and at least two fingers capable of opposition, using available autologous tissue in the most strategic configuration.<sup>2,3</sup>

### **COMPLICATIONS**

In patients undergoing heterotopic digital replantation for complex hand reconstruction-typically following mutilating hand injuries with multiple non-replantable digits-the postoperative period requires vigilant monitoring for both general surgical and procedure-specific complications. The most critical complications to monitor include the following.

#### ***Vascular compromise***

Early detection of arterial or venous insufficiency is essential, as microvascular thrombosis or vasospasm can

lead to partial or complete loss of the transplanted digit. This is a leading cause of reoperation in microsurgical hand reconstruction.

#### ***Infection***

Surgical site infection, including deep tissue infection and osteomyelitis, is a significant risk, particularly in the context of traumatic injuries and extensive soft tissue damage. Infection can compromise both the viability of the transplant and overall hand function.

#### ***Wound healing disorders***

Delayed wound healing, dehiscence, and necrosis of skin flaps or grafts are common in complex hand trauma, especially when local tissue perfusion is suboptimal or when there is significant contamination.

#### ***Major bleeding and hematoma formation***

Postoperative bleeding can threaten both the survival of the transplanted digit and overall patient stability. Major bleeding is independently associated with increased 30-day mortality after general surgery and should be closely monitored.<sup>12</sup>

#### ***Sepsis***

Systemic infection is a major concern in patients with extensive traumatic injuries and is strongly associated with postoperative mortality.<sup>12</sup>

#### ***Thromboembolic events***

Deep vein thrombosis and pulmonary embolism are risks in the perioperative period, especially in patients with prolonged immobilization or additional comorbidities.<sup>13</sup>

#### ***Acute kidney injury and other organ dysfunction***

Although less common in isolated hand surgery, perioperative organ dysfunction-including acute kidney injury, myocardial injury, and stroke-can occur, particularly in patients with significant comorbidities or those undergoing prolonged or complex procedures.<sup>12,14</sup>

#### ***Pulmonary complications***

In patients with underlying pulmonary disease (e.g., COPD), postoperative pulmonary complications such as pneumonia, atelectasis, and acute respiratory failure should be anticipated and managed proactively.<sup>15</sup>

#### ***Functional complications***

Stiffness, joint contracture, and poor sensory recovery are longer-term risks that can compromise the functional outcome of the reconstruction.

### Psychological and rehabilitation issues

Delirium and postoperative cognitive dysfunction, while less common in hand surgery, may occur in older or medically complex patients and are associated with poor long-term outcomes.<sup>12</sup>

Patients with advanced age, significant comorbidities (e.g., cardiac, pulmonary, renal), or poor preoperative status are at increased risk for these complications and may require more intensive monitoring and multidisciplinary management.<sup>12,14</sup> Early identification and intervention for these complications are critical to optimizing both digit survival and overall patient outcomes.

### CONCLUSION

Heterotopic digital replantation represents a valuable reconstructive strategy in the management of complex hand trauma, where traditional anatomic replantation is not feasible. By redistributing viable amputated parts to functionally optimal positions—most notably to reconstruct the thumb and at least two opposable digits—this approach prioritizes restoration of hand function over anatomical fidelity. Successful outcomes rely on meticulous microsurgical technique, precise vascular and neural anastomosis, and individualized surgical planning that takes into account the pattern of injury, availability of salvageable tissue, and patient-specific functional needs.

Despite its potential to achieve excellent functional recovery, heterotopic replantation carries significant risks, including vascular compromise, infection, wound complications, and long-term stiffness or sensory deficits. Therefore, optimal management requires careful patient selection, vigilant postoperative monitoring, and coordinated rehabilitation to preserve motion and maximize dexterity.

In conclusion, when applied judiciously, heterotopic digital replantation can yield outcomes comparable to conventional replantation, offering patients with devastating hand injuries the possibility of meaningful restoration of prehension, grip strength, and independence.

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