

Heterotopic replantations in mutilating hand injuries, presentation of three cases

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Introduction

In cases where a mutilated hand with multiple digital amputations is concerned, an ideal replantation may not be possible depending on the type and severity of the trauma. In these cases, heterotopic digital replantations (HDR) may be considered in order to achieve the maximum functional outcome [1, 2].

In this article, hand restorations performed through heterotopic replantations in three hands that have undergone mutilating hand injuries have been put under the spotlight.

Case presentations

Case 1

A 27-year-old male patient presented to our clinic after his hand had been crushed between the chains of a cogwheel. During the examination, a crush injury in the left extremity, beginning at the level of the forearm and reaching to his

fingertips, was observed. There were also avascular subtotal amputations on multiple levels (Fig. 1a, b). The first finger of the right hand was also totally amputated (and the amputated portion was crushed), whereas the second, third, fourth, and fifth fingers had subtotal avascular amputations (Fig. 2a). Since the proximal part of the fifth finger in the patient's left hand was so severely damaged that a revascularization was impossible, it was decided to heterotopically implant this finger on the stump of the right thumb. The second, third, and fourth fingers of the right hand were revascularized, and the tendons and nerves have been repaired in fingers 2, 3, 4, and 5 (Fig. 2b–e).

Following the rigid fixation of the fragmented fractures in the radius and ulna and the application of myorrhaphy–tenorrhaphy on the tendon injuries of the patient, the multi-level radial–ulnar artery (and the variational median artery) and the median–ulnar nerve injuries in the forearm and within the hand were repaired. Subsequent to the multiple bone, tendon, artery, and nerve repairs in the hand, the bilateral digital arteries and nerves in the index and ring fingers were primarily repaired. The bilateral digital arteries and nerves in the thumb and middle finger were repaired using grafts (Fig. 1c, d).

When the blood flow in the third finger of the left hand degenerated on the eighth postoperative day, the patient was taken to reoperation. Since no reflow could be achieved, the finger was amputated on the PIP joint level, and the stump was repaired. On the 21st postoperative day, the necrotic tissue on the first web of the left palm and the forearm was debrided, and a subpectoral flap was applied.

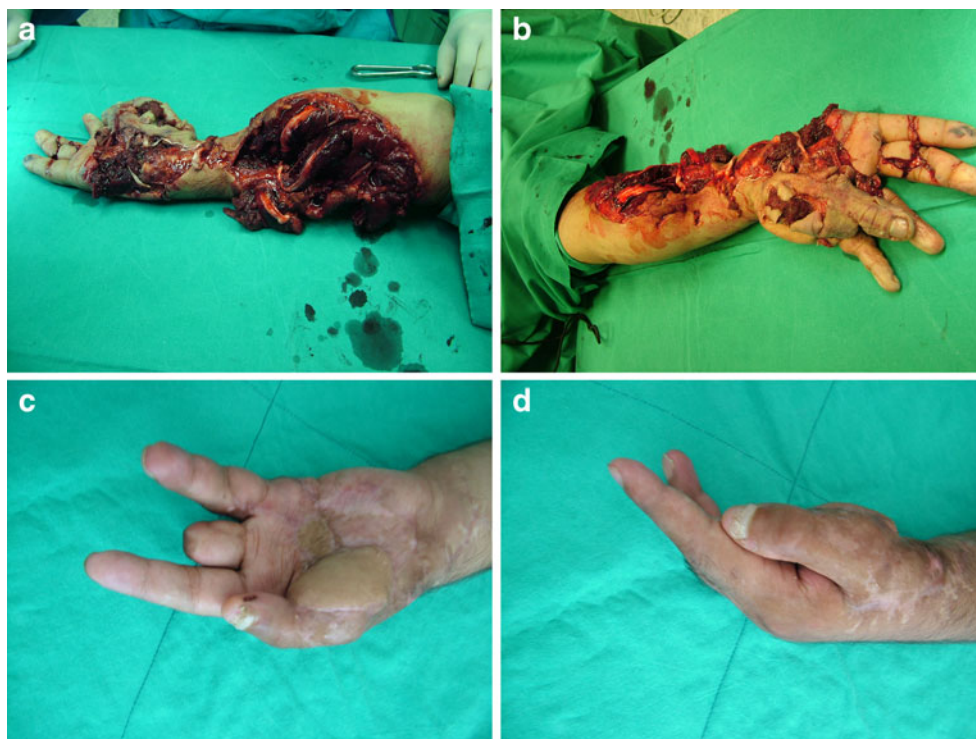
During the examination performed on the 15th postoperative month, the finger which had undergone a heterotopic replantation showed the following results in the Semmes–Weinstein test: thumb sensitivity: 3.61 mm; metacarpophalangeal (MCP) joint movement 15° (25–10°) and IP joint

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Fig. 1 (Case 1) **a, b** Crush injury in the left extremity beginning at the level of the forearm and reaching the fingertips; avascular subtotal amputations on multiple levels. **c, d** Non-ideal functional view after the repair



movement 30° (45–15°) on average; full opposition (opposition of all fingers); DASH Score: 18.18.

Case 2

A 29-year-old male patient presented to our clinic after a press injury. During the examination, crush amputations on the metacarpal level in the second, third, fourth, and fifth fingers of the right hand and a total crush amputation on IP level in the first finger were observed (Fig. 3a, b).

When the amputated portions were examined, it was observed that only the fifth finger was suitable for a replantation. For this purpose, a prosthetic hook was chosen as the appropriate solution. The stump of the thumb was repaired on the IP joint level. The fifth finger was replanted on the third metacarpal in a heterotopic manner and was set on the proximal aspect of the metacarpal instead of its normal position. During the control examination of the HDR finger on the postoperative 19th month, it was observed that no active interphalangeal joint movement could be performed and only a pulp to pulp pinch grip was possible with the stump of the thumb (Fig. 3c, d). In the Semmes–Weinstein test, the replanted finger tip sensitivity was found as 3.61 mm, and the thumb tip sensitivity was 4.56 mm, with a DASH Score of 20.45.

Case 3

During the examination of a 22-year-old male patient who also presented with a press injury, fractured subtotal

avascular amputations at the level of the metacarpophalangeal joints were observed in the second, third, fourth, and fifth fingers of the right hand (Fig. 4a, b). The exploration of the fingers revealed that the fourth finger was suitable for a replantation. This fourth finger was replanted to the metacarpal of the third finger at the level of the proximal interphalangeal joint (Fig. 4c, d).

When the finger subjected to the HDR was examined on the postoperative 24th month, it was observed that opposition of the thumb, as well as the pulp to pulp pinch grip, was possible with the thumb. The Semmes–Weinstein test showed a finger sensitivity of 2.83 mm. The DASH Score was 20.45.

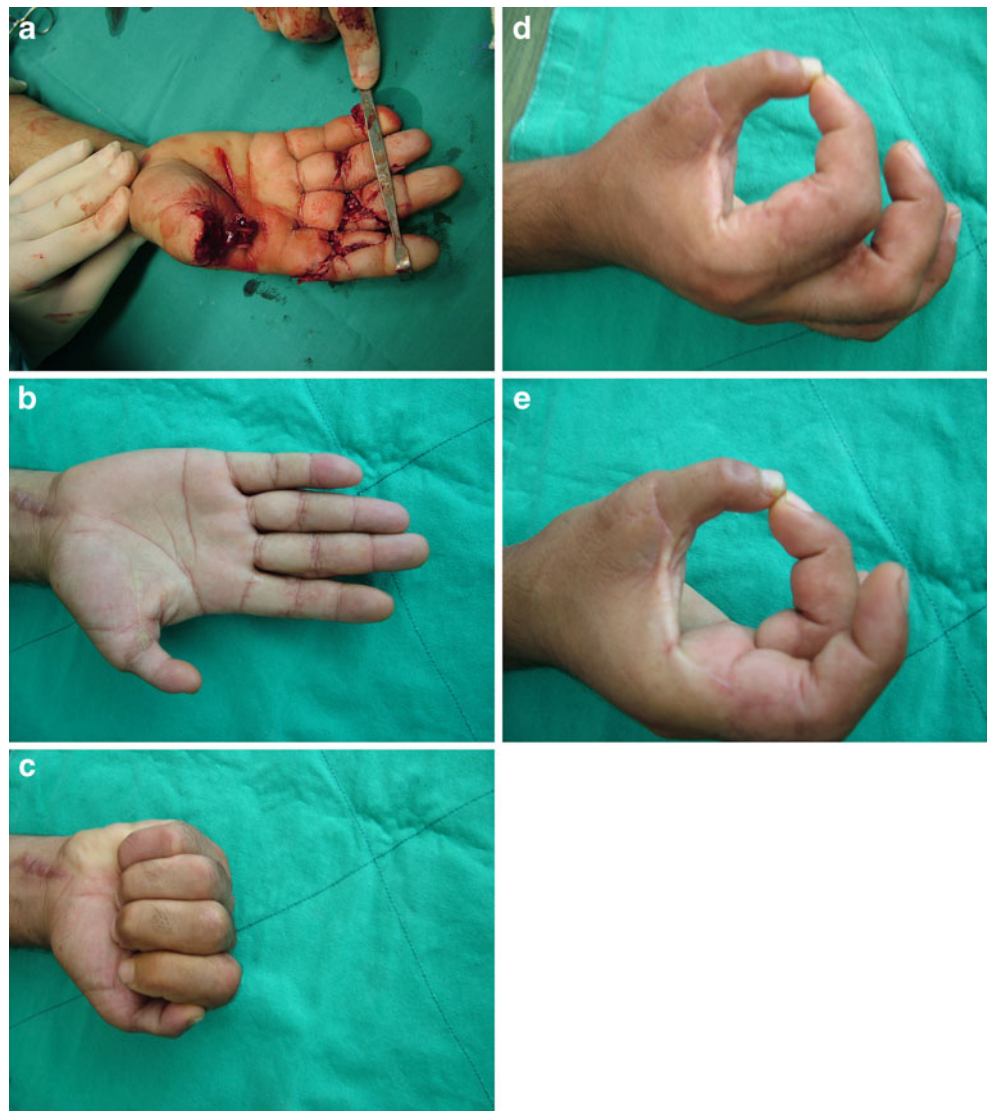
Discussion

For a functional hand, four basic components are required: a functional thumb, opposable fingers (at least two digits), enough web space, and the stability of the wrist [3, 4].

Since the thumb is responsible for 40–50% of the hand functions, the first and foremost step of hand restorations is maintaining a functional thumb. In the reconstructions of mutilating hand injuries, it is recommended to restore at least two fingers in order to maintain a strong and stable tripod pinch [5, 6].

Wei et al. [7] report that the restoration of the index and middle fingers leads to esthetically better solutions in mutilating hand injuries. But in fact, the restoration of the middle and ring fingers provides better outcomes in terms of the

Fig. 2 (Case 1) **a** Total amputation of the thumb; subtotal avascular amputations in the second, third, and fourth fingers; and vascular subtotal amputation in the little finger of the right hand. **b** Late postoperative view of the thumb following the heterotopic left-hand little finger replantation. **c–e** Functional view of the hand



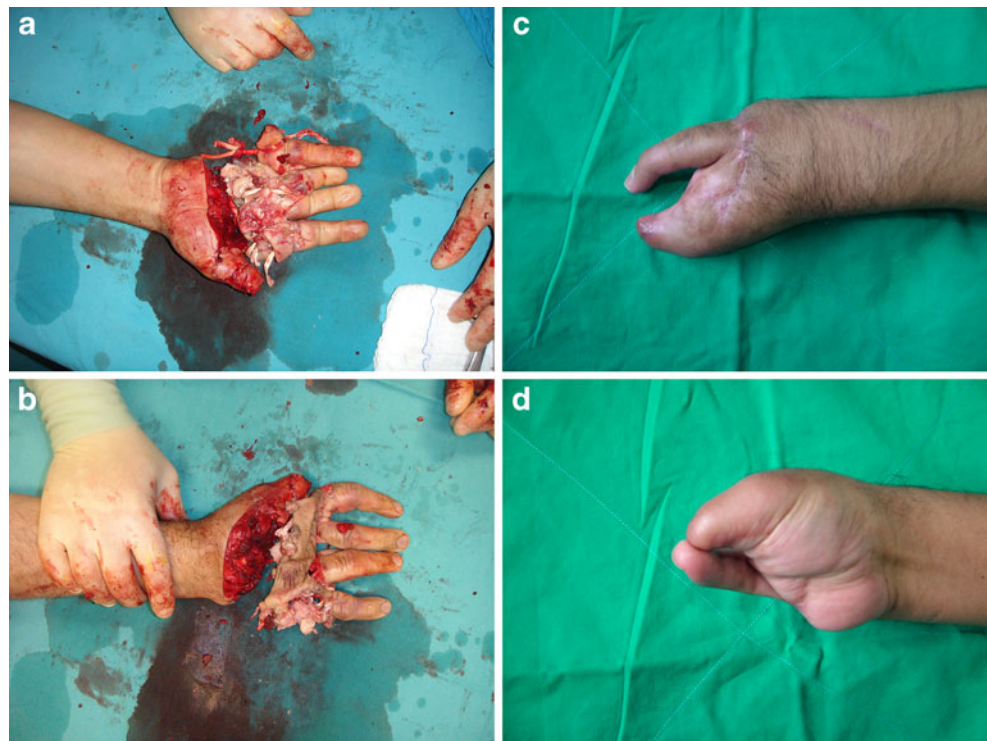
grasp and pinch functions. Although the restoration of the index and little fingers result in a wider hand, this hand will possess less power to pinch and grasp. Also, this hand that will have uncoordinated movements will experience difficulty in controlling small objects.

In multiple finger amputations, it is sometimes observed that the fingers or the stumps of the same fingers are unsuitable for a replantation. In these cases, HDR applications are an option. There is no fixed algorithm for HDR applications or any limits defined for such an algorithm in mutilating hand injuries yet [8]. In case the thumb is unsuitable for a replantation, using other fingers in place of the thumb may be the leading step of this algorithm. In fact, this has already become a routine clinical practice. Since amputations at the proximal interphalangeal and metacarpophalangeal joint levels lead to weak functional outcomes, the target in the rehabilitation of the other fingers involves shortening the amputated digits in such a way that they can be replanted to long receptive stumps. According to Soucacos et al. [1],

the indications for heterotopic or transpositional digital replantations and their classification can be listed as multiple digital amputations including the thumb, bilateral thumb amputations, bilateral symmetrical digital amputations, multiple digital amputations with the thumb intact, and the amputation of all five digits. Still, it is a fact that the identification of the type and content of the remaining tissue after the adequate debridement of the devitalized tissue plays the key role in achieving an ideal heterotopic replantation. In such injuries, one of the treatment targets is to preserve the residual hand functions together with an ideal wound healing [1, 2].

Although HDR was first performed in the early 1970s, reports on cases of HDR are rather limited in number [8–10]. Large-scale studies on heterotopic digit replantations originate from An et al. [2], Hoang et al. [10], Schwabegger et al. [6], and Soucacos et al. [2]. An et al. [3] have performed a total of eight heterotopic replantations in five patients. Two of these were on the thumb and

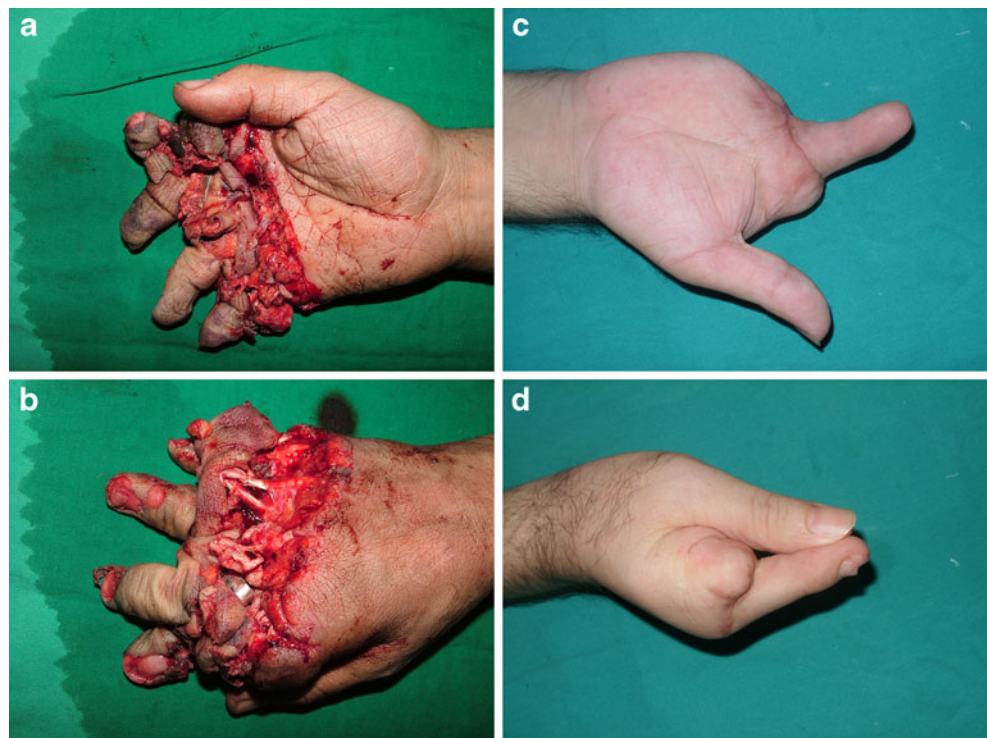
Fig. 3 (Case 2) a, b Crush amputations at the metacarpal level in the second, third, fourth, and fifth fingers of the right hand and total crush amputation on the IP level in the thumb. c Late postoperative view of the hand considered as a case of HDR (fifth finger replanted proximally to its normal position in the receptive metacarpal region) since it has been replanted proximally on its own metacarpal. d Functional view of the prosthetic hook



achieved ideal tripod pinch grip. Hoang et al. [10] have chosen to perform heterotopic digital replantations for thumb repairs in all of the six multiple digital amputation cases. In these patients, they have achieved 40% to 65% total active motion compared to the uninjured counterpart of

the thumb and 15 to 30 mm two-point discrimination values as functional results. Schwabegger et al. [6] have performed HDR in 13 patients out of 157 (146 replantations in 171 digital amputations). In two of these patients, three metacarpophalangeal joint transfers have been applied. The

Fig. 4 (Case 3) a, b Fractured subtotal avascular amputations on the level of the metacarpophalangeal joints in the second, third, fourth, and fifth fingers of the right hand. c Late view following the HDR. d Functional view



HDRs in the other 11 cases were performed to repair four thumbs, four index fingers, three middle fingers, and two little fingers. The authors are of the opinion that all the replanted fingers are acceptable from a functional and cosmetic point of view. Soucacos et al. [1] also performed transpositional digital replantations in 28 patients (82.3%) in their rather large-scale study including 34 patients and reported successful outcomes in terms of functional and cosmetic results. Including the patient (Case 2) that we classified as an application of HDR since we performed the replantation on a point outside (proximally from) the normal location in the receptive metacarpal region, we are of the opinion that we have reached—although not perfect—functionally acceptable results in all three of our HDR cases. In patients 2 and 3 where we could not maintain adequate hand function since we could only preserve one finger opposite to the thumb, we considered transferring a toe in order to increase the functionality, but the patients objected to these further treatment options.

In heterotopic replantations, the risk for impairment in sensation and the high incidence of cold intolerance are important problems or disadvantages [2]. Indeed, Schwabegger et al. [6] have observed cold intolerance independently of the objective in 10 cases out of 13. We have also observed cold intolerance in one of our patients. Another problem or disadvantage in HDR cases is the difficulty in the cortical adaptation. Still, it is obvious that these risks and problems should be undertaken in mutilating hand injuries necessitating HDR.

Although our knowledge on heterotopic replantations derives from a limited number of case and study reports, we know that this method is not limited to fingers. However, rare, heterotopic (cross-extremity) replantations of extremities are also applicable [11]. Besides, soft tissue or joint transfers to live fingers from non-replanted parts are also a possibility, and these can also be considered as partial HDR applications.

In conclusion, in order to restore an ideal pinch in a hand which has undergone a mutilating hand injury, at least two fingers must be restored. In such restorations, the thumb has always the precedence. These general principles also apply to the cases where an HDR is planned. In this respect, restorations to be performed using the HDR method should be borne in mind as an option in mutilating hand injuries.

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