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Case report

A functional "metacarpal-hand" after a firework injury obtained without any flap or toe-transfer

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Abstract. A 37-year old male patient with a right-hand firework injury. An extreme hand reconstruction was performed. The second and third rays were sacrificed enlarging the first space. The diaphysis of the second metacarpal bone became a tubular graft to reconstruct the fourth metacarpal. The thumb consisted only in the first metacarpal bone. The result was satisfactory, according to the wishes and needs of the patient, a three-finger hand with an opposable thumb, obtained in only one surgical treatment and without using free flaps. The concept of an "acceptable hand" is related to the surgeon's and patient's opinions. (www.actabiomedica.it)

Key words: Fireworks, mangled extremities, hand, reconstructive surgery, bone graft

Introduction

Mangled hands are always a challenge even for the most expert surgeon. Each case is different, and a combination of effort, imagination and skill are needed to reach an acceptable result (1,2). An acceptable hand has "three fingers of near normal length, with near normal proximal inter-phalangeal joint motion, and good sensibility, plus a functioning thumb" (3). Obtaining this ideal result can be very difficult in challenging cases (1,2). Firework injuries are very severe, because a combination of fractures, joints dislocations, traumatic amputations, and soft tissue injuries simultaneously occur, and the chance to obtain an acceptable outcome without free flaps is very low. The present article describes a case of a complex hand reconstruction with a satisfactory result according to the patient's wishes and needs, despite the lack of an "acceptable hand".

Case report

A 37-year old male patient, got access to our institution with a right-hand firework injury. The blast resulted in the left hand splaying at metacarpal level with bone, neurovascular, tendons and soft tissues loss and multiple fractures-dislocations (grade 4 according to Matheron) (4). The most significant clinical and radiographic findings were (Figure 1):

- Distal metacarpal amputation associated with dislocation at trapeze-metacarpal joint of the thumb.
- Trans-metacarpal amputation of the second, third and fourth ray.
- Amputation at middle phalanx associated with fracture-dislocation at carpal-metacarpal joint of the fifth ray.

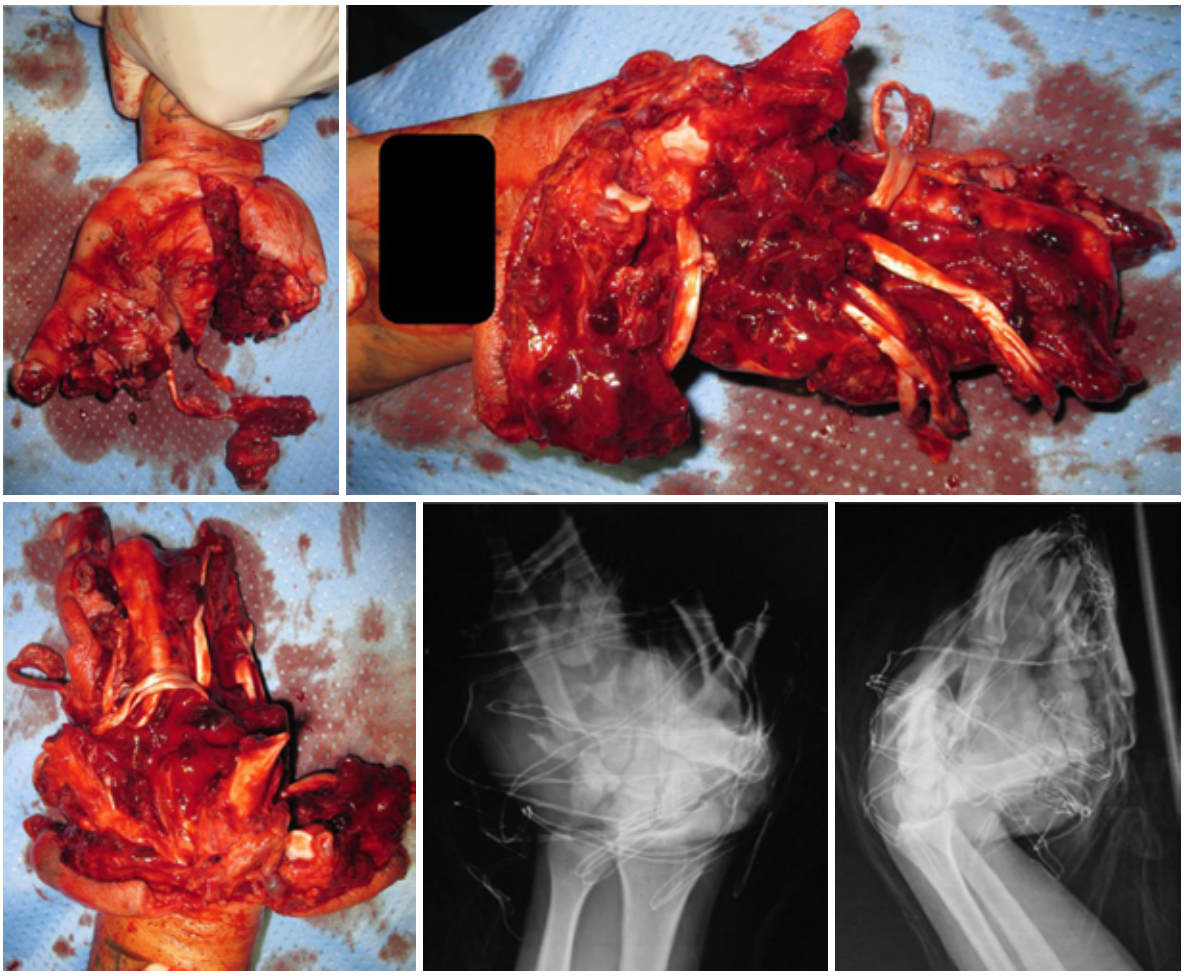

Figure 1. Mangle hand before surgery.

- Complete degloving on dorsal and volar side of the hand.
- Neurovascular lesions and tendon lesions (both flexor and extensor) of all the five rays.

Reconstruction strategy resulting in an acceptable "metacarpal hand" involved the following steps (Figure 2):

- Reduction and fixation of fracture and dislocations of the first and fifth ray with k-wire.
- A storage of thenar muscles and first web muscles and a sacrifice of the second and third ray amputation at level of the proximal epiphysis.
- Use of the shaft of the second metacarpal bone like as a tubular graft to reconstruct the fourth metacarpal, stabilized by k-wire.
- Repositioning of the thenar muscles on the first ray.
- Repositioning of the first web muscles on first and fourth metacarpal bones.
- Repair of nerves and tendons on the first, fourth and fifth ray.
- Skin closure using residual vital tissues from the trauma.

Oral supplementation therapy with neurotropic nutraceuticals was administered during the first two

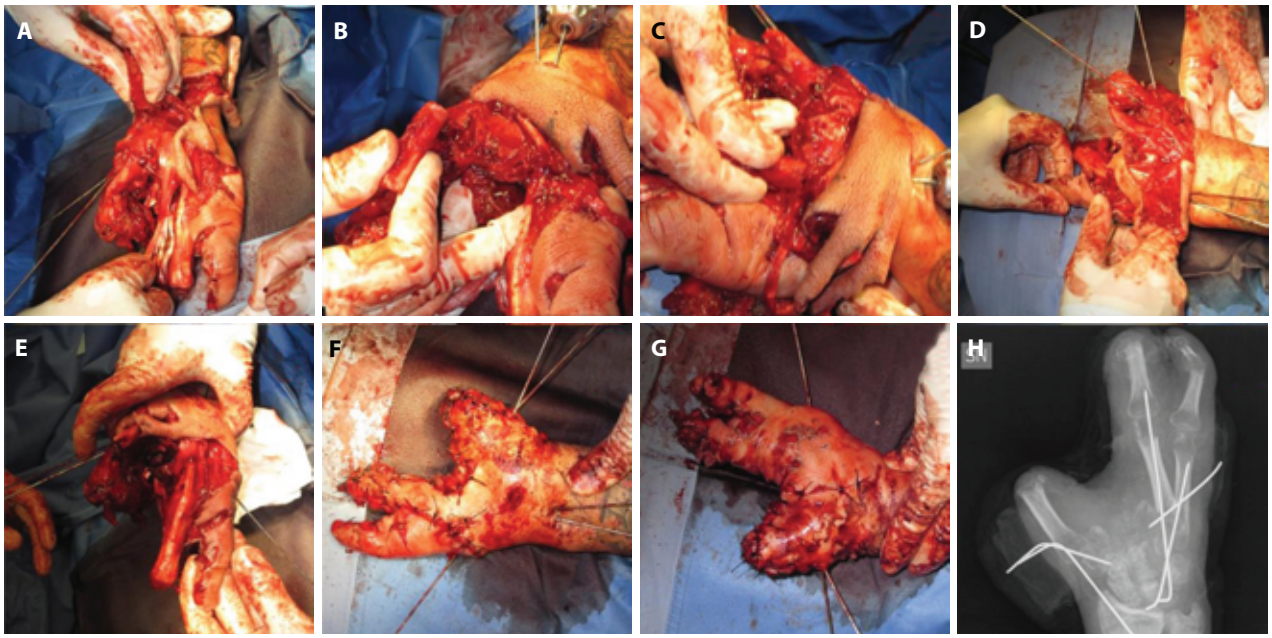

Figure 2. Reconstructive surgery. A: first ray stabilization (trapeze-metacarpal joint). B: the second metacarpal bone was harvested. C: the second metacarpal bone reconstructed the forth ray (non-vascularized bone graft). D: osteosynthesis of the ulnar metacarpal bones. E: Final appearance before skin closure. F: Dorsal view. G: palmar view. H: post-operative X-ray.

months (5,6). Skin and radiological healing occurred in 90 days with silver hydro-fiber dressings every five days and k-wires removal. There was a malunion of the fourth ray and two scar retractions, one on the first web space and the other between the fourth and fifth ray. We proposed to the patient a Z-plasty or a flap to enlarge the first web space and to separate the fourth and fifth ray, but he refused. After 9 years (last follow up), the patient was satisfied of the result according to his good adaptive pinch function and his skill to perform daily actions such as grabbing, taking the cap off of a bottle, and tying his shoelaces (Figure 3). Patient reported outcome measures (PROMs) were as follow: Michigan Hand Questionnaire (7) score: 51,8%; Disabilities of the Arm, Shoulder and Hand (DASH) (8) score: 27,5%.

Discussion

A guideline about an "acceptable hand" in a mangled hand's reconstruction is, in our opinion, not reliable, and each patient has to be considered as a different case (1–3). An "acceptable hand" is generally defined as a hand with three fingers, near-normal length, near-normal sensation, and a functional thumb. Aesthetic outcome is often seriously compromised; the acceptable hand should ensure grip and pinch strength (3). The concept of an "acceptable hand" should be related to the surgeon's opinions, related to the individual case, as well as patient willingness. In our case, we obtained a functional reconstruction of a three-finger hand with an opposable thumb with one-step surgery, without donor site impairment, such as in cases of a toe transfer or free or pedicle flap harvesting. Advanced dressings as negative pressure wound therapy and fixed internal osteosynthesis were not necessary. This case report explains that it is not critical to achieve a near-normal anatomical condition, but a near-normal functional hand. In mangled hands, bank tissues should be taken into consideration first delaying coverage with free flaps (9–12). The goal is to create the first web space as wide as possible related to the length of the first ray and trapeze-metacarpal mobility (1–4,9,10–14). The ideal hand is a functional hand able to pinch. In a pinch it is important not only tip-to-tip but also how much the gripper arms can be opened. Moreover, the aesthetic result is unsatisfactory; however, the possibility

Figure 3. Clinical result at the last follow-up (9 years).

for further surgery such as a toe transfer or first web space reconstruction with free flaps was not impaired. In spite of the first ray's shortness, a toe transfer is not an optimal solution, because of the resulting stiffness (3,11). Hence, a further surgery may undermine an already satisfying result. Both surgeon and the patient must not overlook this latter issue.

Conclusion

A firework-related hand injury is a surgical challenge, due to the combination of burn and blast forces, but with appropriate surgical measures, an apparent unsalvageable hand can be reconstructed reaching a functional result. In firework-related hand injuries, we have to turn the concept of an "acceptable hand" into a "functional hand". The most important phase in the reconstruction of a "functional hand" is the creation of a large first web space related to the length of the thumb and to ensure a base-thumb mobility. A large first web space, associated with a good base-thumb mobility, ensures an effective pinch even though it is not possible to restore a satisfactory length of the thumb. Toe-transfer is not the primary solution because of frequent postoperative stiffness (3,11). Flaps may not be necessary if a primary skin closing could be reached thanks to vital surrounding tissues residual from the trauma.

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