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CASE REPORT

Salvage of the Thumb using the Masquelet Technique after Crush Injury

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Authorship and Contribution Declaration
Each author of this article has encountered all 04 criterions of authorship:

1. Commencement and design of the study, attainment of data, or analysis and interpretation of information.
2. Drafting the manuscript or rewriting it censoriously for important intellectual content.
3. Providing concluding endorsement of the version for publication.
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ABSTRACT

Traumatic crush injury of the thumb can be devastating, often leading to poor functional outcomes. Various reconstruction options exist, dependent on surgical expertise. The Masquelet technique, well-established in the reconstruction of long bones in the lower limbs, has been scarcely reported for thumb injuries, with no documented cases in the Asia region. We present a case of a traumatic crush injury to the right thumb, initially managed with an antibiotic spacer, followed by reconstruction using a tricortical iliac graft in a two-stage Masquelet technique. This technique proved to be versatile, providing satisfactory functional and aesthetic outcomes.

Keywords: Thumb reconstruction, Masquelet technique for thumb, thumb crush injury, thumb salvage surgery, two-stage technique for thumb

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INTRODUCTION

Crush injuries of the hand often involve significant bone and soft tissue loss, threatening both the viability of the fingers and the overall function of the hand, particularly when the thumb is involved. As John Napier famously stated, "The hand without a thumb is, at worst, nothing but an animated spatula"[(1)]. The treatment of thumb injuries is complex, determined by factors such as the extent of bone and soft tissue damage, vascularity, the surgeon's expertise, and the patient's expectation[(2)]. Surgical decisions must prioritize thumb salvage whenever possible, with the goal of maximizing function in the shortest time and with the fewest surgeries[(3)]. While there have been few reports of thumb reconstruction using the Masquelet technique, we describe our experience with this approach.

A 60-year-old right-hand dominant male presented after a fall from a height of 12 feet while performing plumbing work at home. Upon landing, his right hand struck a metal plate on the ground, resulting in an open crush injury to the thumb. No other injuries were noted, and the patient remained hemodynamically stable, presenting to the emergency department.

On examination, an open wound was noted over the dorsum of the first webspace, exposing torn muscles, tendons, and bone fragments (Figure 1a). Distal circulation was intact, and sensation to the volar aspect of the thumb was preserved. Radiographs showed significant bone loss (Figure 1b, c).

After discussing surgical options with the patient, we decided to attempt thumb salvage rather than primary amputation with delayed reconstruction, based on the clinical findings and the patient's preferences.

The wound was debrided, and an antibiotic cement spacer was placed to fill the defect, followed by the application of an external fixator (Figure 1d, e). The wound was primarily closed. Postoperatively, the thumb remained viable and patient was discharged after one week of hospitalization.

At the eight-week follow-up, the wound had healed, pin sites were healthy, and blood tests showed no signs of infection. We proceeded with the second-stage surgery, performing a reconstruction

using a tricortical iliac graft and reverse radial forearm flap. The bone defect measured 4 cm from both ends of the first metacarpal distally and scaphoid proximally. The iliac crest graft was harvested, resized, and stabilized with wire fixation (Figure 1f, g). The wound was covered with a reverse radial forearm flap.

At the four-week follow-up, the graft showed signs of fusion at both ends, with preserved height and alignment. Subsequent follow-ups at three and six months showed continued bone incorporation (Figure 1h, i, j, k). Hand function was assessed and demonstrated good grip strength, including pad-to-side, three-jawed chuck, five-jawed cradle-chuck, and hook grip (Figure 2a, b, c, d). The patient was pleased with the outcome and was able to return to work as a factory operator.

Figure 1: (a) Clinical photograph upon presentation. (b) (c) Initial hand radiographs AP and lateral showed severe comminution of first metacarpal, trapezium and scaphoid. (d) (e) After primary surgery, the bone loss was temporarily filled with antibiotic cement and stabilized with external fixator. (f) (g) After definitive surgery, the iliac bone autograft was implanted and transfixed with three k-wires. (h) (i) Radiographs taken at three and (j) (k) six months post-surgery showed progressive integration and union of the autograft.

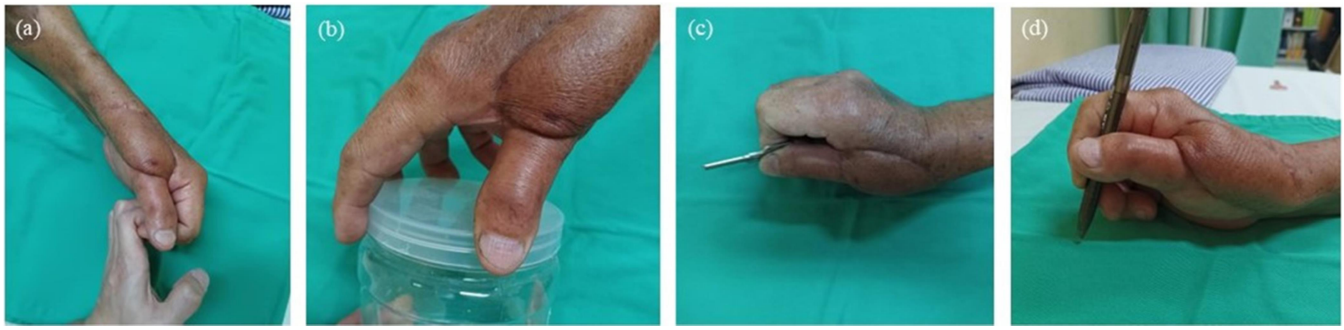

Figure 2: Clinical photographs at six months showed preservation power grip: (a) hook grip (b) five-jawed cradle-chuck and precision grip; (c) pad-to-side (d) three-jawed chuck for activities of daily living.

DISCUSSION

Crush injuries to the hand are common in newly industrialized countries. Thumb involvement often results in disappointing functional outcomes, and reconstructive efforts should prioritize restoring as much function as possible in a single procedure[3]. Early assessment is crucial to determining the optimal treatment pathway. Salvage of the thumb should be pursued when feasible, with amputation and secondary reconstruction reserved for cases where function cannot be preserved.

Various reconstructive options, including toe-to-thumb transfer or index pollicization, can provide good functional outcomes but come with limitations in terms of appearance and donor-site morbidity[2]. In this case, the soft tissue condition and distal vascularity were preserved, allowing us to proceed with thumb salvage.

Initial debridement must be thorough to avoid the need for repeat surgeries. In this patient, the bone defect was 4 cm, which posed a challenge in terms of initial stabilization and subsequent reconstruction. Stabilization was based on the level of contamination, with an external fixator and K-wire fixation chosen to minimize infection risk[3]. In cases of mild contamination, mini-plate fixation may be considered. Primary wound closure should be attempted when possible to cover implants and protect vital structures.

The secondary procedure focused on restoring function and appearance. Reconstruction options for bone defects depend on soft tissue conditions (septic vs. aseptic), the size of the defect, and the surgeon's experience[2]. While distraction osteogenesis is a well-established technique for long bones, it is less commonly used in metacarpal reconstruction due to its complexity.

The Masquelet technique has gained popularity for metacarpal reconstruction in the Western world. Initially developed for long bone defects with excellent union rate[4], it is applicable in both septic and aseptic conditions. The first stage involves the use of a cement spacer to fill the defect and deliver local antibiotics, while also creating an induced membrane that facilitates bone graft incorporation. This biological chamber supports bone healing and corticalization[5].

Functional recovery of the thumb is critical for both power and precision grip. Sollerman et al. (1995) classified hand grips[6], emphasizing the importance of functional grip for daily routines. On the other hand, aesthetic outcomes play a crucial role in the psychological well-being of the patient[7]. Rehabilitation should also address the mental and emotional impact of the injury, making it an essential component of the recovery process during follow-up.

CONCLUSION

In summary, a thorough initial hand assessment following a crush injury is essential to determine the direction of treatment, whether salvage or amputation. Key factors include vascularity, soft tissue contamination, bone defect size, surgeon expertise, and patient preferences. Primary surgery should aim to remove all devitalized tissue, while secondary surgery focuses on improving function and appearance. The Masquelet technique is a versatile and effective approach for addressing critical bone loss in metacarpals, with favourable clinical outcomes and aesthetic results.

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