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Case Report

Vacuum assisted closure as adjuvant therapy for a mangled upper extremity injury

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ABSTRACT

Injuries to the hand are frequent, with an incidence of 15 per 1,000 individuals per year. They occur in one third of industrial accidents, in one in five traffic accidents, and they are the cause of one in every 3 cases of disability. The term "catastrophic or mangled hand" has traditionally been used to define lesions that affect all or almost all of the tissues and functional systems of the hand (the skin, bones and joints, the arteries and veins, sensory and motor nerves and the muscles and ligaments) usually accompanied by the amputation of fingers. The first surgery is crucial to ensure good vascularity to the salvaged tissue, prevent infection and achieve bony stabilization. Re-look surgery and definitive reconstruction can then follow. The complexity of these injuries has led to the development of various surgical treatments and vacuum assisted closure. In this case, the initial surgery was performed at another institution. Therefore, upon accepting the patient at our institution, we carried out initial surgical management, followed by the placement of a vacuum-assisted closure, considering the possibility of performing a definitive surgical procedure aimed at restoring the functional capacity of the hand.

Keywords: Mangled hand, Reconstruction, Revascularization, Vacuum-assisted closure

INTRODUCTION

The definition of a mangled extremity is a limb with an injury to at least three out of four components - soft tissue, bone, nerves, and vessels. Mangling injuries to the extremity present a significant challenge to the hand surgeon. Optimal outcomes require capability of all the levels of the reconstructive elevator as well as bony fixation strategies, and secondary surgeries.[1] Injuries to the hand are frequent, with an incidence of 15 per 1,000 individuals per year. They occur in one third of industrial accidents, in one in five traffic accidents, and they are the cause of one in every three cases of disability.[2]

Upper extremity injuries are often devastating and result in profound functional and psychological impact on patients. Difficulties returning to work and performing the activities of daily living after an upper extremity injury are compounded by the poor quality of currently available upper extremity prosthetics.[3] Studies of functional recovery after mangled upper extremity injuries have demonstrated that salvaging sensate digits, even with only minor restoration of movement, is preferred to using a prosthesis.[3]

According to Del Piñal the criteria for an acceptable hand in aesthetic and functional terms are the presence of 3 fingers and the thumb. The minimum finger length is at the level of the middle phalange, which means that the proximal interphalangeal joint must be preserved. The minimum length of the thumb is at the level of the distal phalange, preserving the interphalangeal joint. The presence of 2 fingers (keeping the integrity of the proximal

interphalangeal joint) and the thumb constitutes what is known as the tripod pincer, which is considered to be the minimum requirement for satisfactory functioning. The presence of one finger with a complete proximal interphalangeal joint) and thumb constitutes the basic hand, which makes a very weak pincer motion possible with a mechanism that offers minimum grip.[4]

The complexity of these injuries has hindered the development of accurate scoring systems and treatment algorithms, with the result being treatment management individualized by patient and injury pattern.[3]

We will present a case that is extremely interesting due to its complexity, where multiple treatment variants for a mangled hand were employed. These included revascularization, finger amputations, and vacuum-assisted closure (VAC), as an adjuvant therapy for mangled forearm injuries with mangled extremity severity score (MESS) indicating amputation.

CASE REPORT

A 32-year-old female presented with a crush injury to her right hand due to a rollover accident, with 24 hours of evolution. Previously treated at another institution, notes mentioned that according to the MESS, the patient was at high risk of amputation. For this reason, they decided to perform damage control surgery, including surgical debridement, percutaneous reduction with Kirschner wire osteosynthesis from the first to the fifth metacarpal due to fractures, repair of the extensor and flexor tendons, and vascular exploration.

The patient was received at our institution, the primary survey revealed a patent airway with a respiratory rate of 16 breaths per minutes and oxygen saturation maintained in room air. Blood pressure was 116/64 mm Hg; pulse rate was 69 beats per minute. Her Glasgow coma scale was 15/15; with round, regular, reactive pupils. On local examination a circumferential blunt and penetrating wound in the right hand, from flexor zone III to extensor zone VI, involving the first to the fifth finger, affecting skin, subcutaneous tissue, muscle, tendons, bone, superficial and deep palmar arches, and nerves. The hand was congested from the 1st to the 5th finger, ischemic in the distal portion, cold with slow capillary refill in the 2nd and 3rd fingers, and no capillary refill in the rest (Figure 1). The X-ray of the patient's hand showed fractures of the 1st to 5th metacarpals with percutaneous reduction using Kirschner wire osteosynthesis material. The angiotomography of the right upper extremity showed vascular tracts with partial distal enhancement beyond the palmar arch, suggesting the need for further studies, as well as fractures of the trapezium and trapezoid bones (Figure 2).

The patient was immediately shifted to the operating room. Debridement was done, and the patient underwent a revascularization procedure. The dorsal vein of the right first finger was identified as thrombosed at the distal end and sectioned, with the proximal end thrombosed and ligated with suture material from the first surgery. The suture material was removed, and both ends of the vein were cleared until venous return was achieved. Microvascular anastomosis was performed using 9-0 Nylon. Post-procedure, capillary refill was established in all fingers, the wound was closed, and a plaster splint was applied (Figures 3 and 4).

At 24 hours post-operation, the patient showed poor evolution. On physical examination, the distal parts of the first to fifth fingers were ischemic, cold, with delayed capillary refill in the second and third fingers, and no capillary refill in the rest. Blisters were present on the fourth and fifth fingers, and digital pedicles were not audible with Doppler application (Figure 5). Carpal tunnel and Guyon's canal release were performed, along with volar and dorsal fasciotomies (Figure 6).

Figure 1: Patients' hand on arrival at emergency.

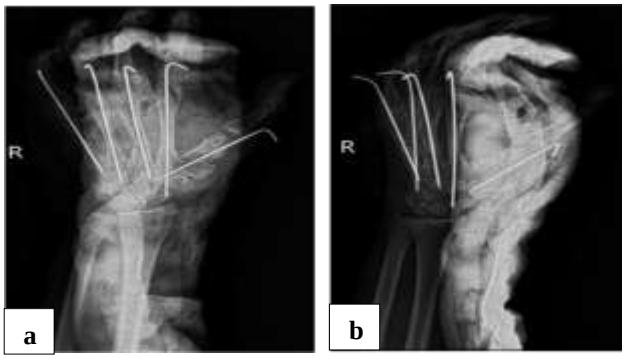

Figure 2 (a and b): Initial X-ray of the patients' hand.

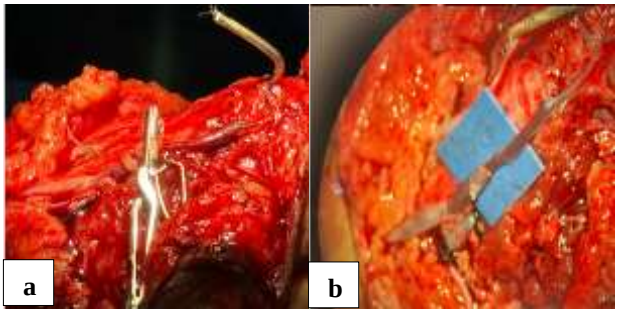

Figure 3 (a and b): Dorsal vein of the right first finger microvascular anastomosis.

Figure 4 (a and b): Postoperative right hand.

Figure 5 (a and b): 24 hours postoperative right hand.

Figure 6 (a and b): Carpal tunnel and Guyon's canal release + fasciotomies.

On the twelfth post-operative day, we observed signs of necrosis on the dorsum of the hand, absence of capillary refill in the first and fifth fingers, and adequate capillary refill with adequate temperature in the third, fourth, and fifth fingers (Figure 7).

The patient underwent debridement and amputation of the first and fifth fingers along with the metacarpal bones, edge remodeling, and closure of the flexor zone with 3-0 Prolene suture. A permeable adhesive layer (collagen-elastin template) was placed to cover the part of the wound not covered by the skin (Figure 8). We used VAC and set the machine to provide a pressure of −120 mm Hg in intermittent mode, as the intermittent mode would result in twice the amount of granulation tissue. In this patient, the dressing was replaced every 5 days (Figure 9).

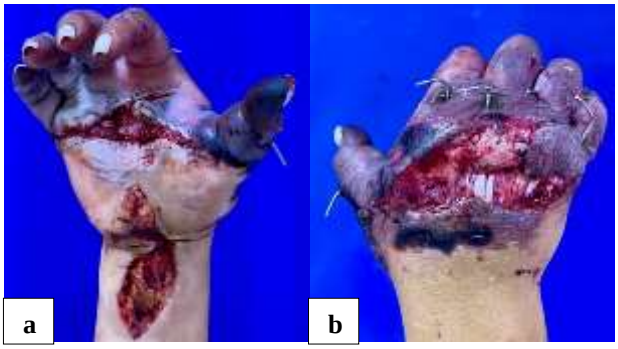

Figure 7 (a and b): Hand twelve post-operative day.

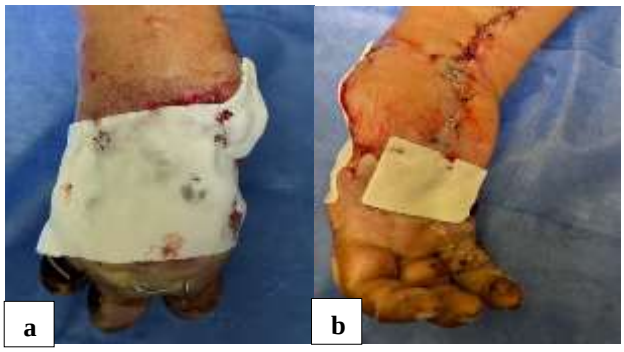

Figure 8 (a and b): Postoperative collagen-elastin template.

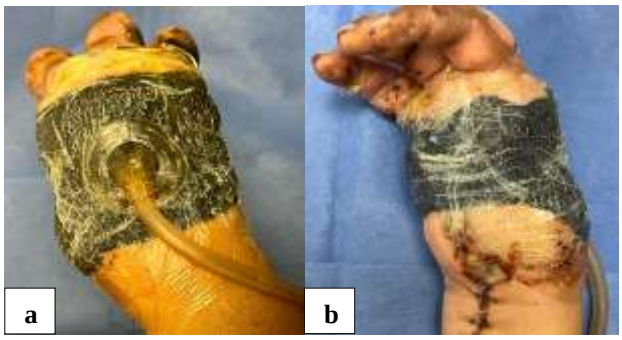

Figure 9 (a and b): Postoperative vacuum-assisted closure.

On the fourteenth day after the placement of the VAC, optimal granulation was achieved (Figure 10).

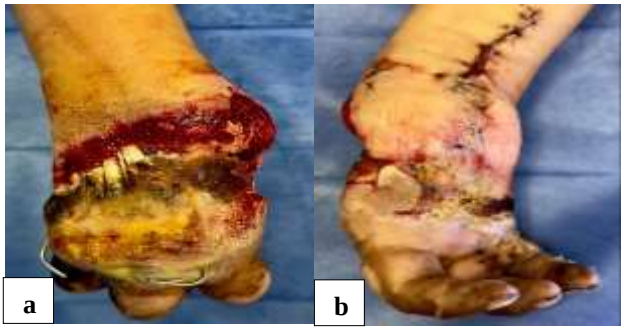

Figure 10: Clinical picture of right hand, fourteenth day of VAC follow-up.

The VAC will be removed, and the patient will be maintained with the permeable adhesive layer (collagen-elastin template). X-rays showed that metacarpal fractures were still present, so the Kirschner wire osteosynthesis will be retained until complete consolidation. Subsequently, additional procedures may be considered to perform functional reconstruction as an additional step in reconstructive therapy for this case, along with physiotherapy.

DISCUSSION

Mangled injuries can result in extensive tissue damage and infection risk and often lead to amputation. Consequently, managing mangled injuries is still challenging. Despite a clear indication for amputation with MESS greater than seven, other factors such as the patient's preferences and the availability of resources often alter the decision.[5]

MESS has been designed to decide on amputation of the lower limb for severe injuries; with the score being seven or higher as an indication for amputation. Unlike the lower limb, the upper limb does not have a scoring system to choose between amputation or repair procedures.[6] However, MESS is used in upper extremity cases without proper validation. Due to recent advances in the treatment, the diagnostic accuracy of MESS for the need of amputation has decreased. Furthermore, the management of such injuries should not be solely based on these scoring systems as they provide only general guidelines for treatment.[6]

The priorities for a mangled hand reconstruction are a stable and opposable thumb of adequate length (at least up to interphalangeal joint), at least one, and preferable two digits for pinch with the thumb, the digits should have adequate length and mobility to reach the thumb, good sensation of the reconstructed hand, good skin and soft tissue cover that is durable and facilitates further reconstruction.[7]

Recently, vacuum-assisted closure has proven to be a highly beneficial innovation in wound care. VAC enhances blood supply, reduces congestion, triggers angiogenesis, eliminates debris, and significantly decreases bacterial counts in wounds. Additionally, it is reported to be effective in promoting tissue granulation, thereby improving the success rate of flap procedures and enhancing flap viability.[5]

Postoperative management is equally important as the intra-operative management, early and proactive physiotherapy is important to quickly regain the function and range of motion of the hand.[8] The hand therapist is a key player in the management of the mutilating hand injuries.[8] Therapy contributes much to the outcome. Referral is made immediately after the first surgery.[7] This allows an early assessment by the therapist, and early mobilization of the unaffected joints to prevent stiffness.[7]

Following a mutilating injury, the option for provision of a prosthesis after final surgical reconstruction is an important and often overlooked aspect of treatment. In the upper limb, the prosthesis can provide function in terms of grasp, and help restore the patient's body image.[7]

CONCLUSION

These complex injuries are highly variable in nature. Factors such as the mechanism of injury, the specific region of the hand involved, the length of ischemia, and the coexistence of multiple regions of injury, all affect the outcome. This represents a challenge for the surgeon, with the primary objective being to achieve a functional hand. We present the successful management of a mangled hand, complicated by the need to adapt to prior initial surgical management performed at another institution. Our aim was to achieve a functional hand despite the complexities involved. Given the complexity of the condition, the surgeon has several therapeutic options, including debridement, revascularization (early intervention with the restoration of vascular anastomosis plays a key role in preventing further damage), skeletal stabilization, vascular reconstruction, musculotendinous and nerve reconstruction, skin and soft tissue reconstruction, along with VAC, which has played an important role in recent years in achieving optimal outcomes for these types of conditions and has yielded satisfactory outcomes in the management of patients with mangled injuries, though its use is still rare due to financial constraints, especially in developing countries. Subsequent early rehabilitation has consistently shown good results in the management of mutilated hands.

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