Mangled upper extremity. Case report

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ABSTRACT
We present the case of a patient with a mangled upper extremity due to a shotgun wound. Patient was initially managed with multiple surgical debridements and an AO external fixator. Final treatment was performed with a unilateral external fixator, in addition to an iliac crest structural bone graft. During initial management, a radial nerve injury was observed; the nerve was intact, though blood-deprived. Due to scarring and soft tissue-infection, treatment was performed during the acute phase of the injury. Subsequently, tendon transfers were made to treat a radial nerve injury. Patient evolved favorably and regained adequate function of the upper extremity.
This case is presented due to its complex management resulting from bone, neurovascular, skin, and soft-tissue involvement.
Key words: Extremity; mangling; external fixator; tendon transfers.
Level of evidence: IV

Extremidad superior gravemente lesionada. Reporte de un caso clínico

RESUMEN
Se presenta un paciente con una extremidad superior gravemente lesionada por arma de fuego. Inicialmente fue tratado con múltiples limpiezas quirúrgicas y colocación de tutor externo AO. El tratamiento definitivo consistió en tutor externo monolateral, además de injerto estructural de cresta ilíaca. Durante el manejo inicial, se detecta lesión del nervio radial, con nervio en continuidad. Dado el proceso cicatricial y la infección de partes blandas, no se logra manejar en la etapa aguda. Posteriormente se realizan transferencias tendinosas para nervio radial. La evolución fue favorable y la función de la extremidad superior resultó satisfactoria. Se comunica este caso debido a su complejo manejo a causa de las lesiones óseas, neurovasculares, cutáneas y de partes blandas.
Palabras clave: Extremidad; lesión grave; tutor externo; transferencias tendinosas.
Nivel de Evidencia: IV

INTRODUCTION

A mangled limb is defined as an injury involving at least three of the four major systems (skin and soft-tissue, bones, nerves, and blood vessels)[1-3].

There are two treatment options for a mangled limb: amputation and salvage therapy. With time and improvements in surgical approaches, soft-tissue management, as well as functional and early rehabilitation, reconstruction and salvage of the limb is more of a possibility, whether immediate (during the acute phase of the injury) or delayed[1-4].

This kind of injuries occurs after a high-energy trauma and, in general, is associated with other injuries; management always prioritizes life over limb.

The management of these patients is complex, mostly due to the loss of soft-tissue and skin, in addition to vascular injuries that further compromise tissues and promote infections[1-4].

We present the case of a patient with a mangled limb, and discuss both the management during the acute phase of the injury and the delayed reconstruction to achieve a cosmetic and functional limb.

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CLINICAL CASE

A 22-year-old patient without any relevant history suffered a gunshot wound to his left arm. The gun was shot one meter away from the patient. He was admitted with a diagnosis of left humeral fracture and possible brachial artery and radial nerve injury (Figure 1).

Figure 1. X-ray of the patient upon presentation at the Emergency Department.

In the Emergency Department, debridement was performed, after which a large 10 cm-soft-tissue laceration was observed (Figure 2). In the second stage, another debridement was performed at the Department of Orthopedics and Traumatology. The brachial artery was intact, and there was continuity of the radial nerve, though it appeared to be blood-deprived. The injury was classified as an open left humeral fracture (Gustilo Open Fracture Classification type IIIA and AO Classification of Fractures type 12-C3). AO fixators were placed (Figure 3), and the wound was treated by vacuum-assisted closure. The patient started using a radial nerve dynamic splint and received empirical antibiotic treatment.

Due to an infection by *Serratia marcescens*, ertapenem was administered. Six weeks after the injury, a dermoepidermal skin graft was performed, and wound closure was successful. Patient was discharged two months later.

We scheduled a definitive surgical management of the fracture with compressive unilateral external fixation, which took place three months after the initial injury. Open reduction and stabilization were performed with iliac crest autogenous bone grafting and platelet aggregation (Figure 4). The assessment by the upper limb surgeon ruled out a radial nerve repair due to significant fibrosis of approximately 20 cm, resulting from scarring and infection. The patient evolved favorably, with adequate soft-tissue coverage.

Figure 2. Debridement. Skin and soft-tissue injury can be observed.

Figure 3. Fracture initially fixed with external AO fixators.

Figure 4. Fixation with unilateral fixator and iliac crest grafting.

Continued compression of the fracture site was performed at a rate of 0.25 mm/day, for 10 days, resulting in progressive consolidation (Figure 5).

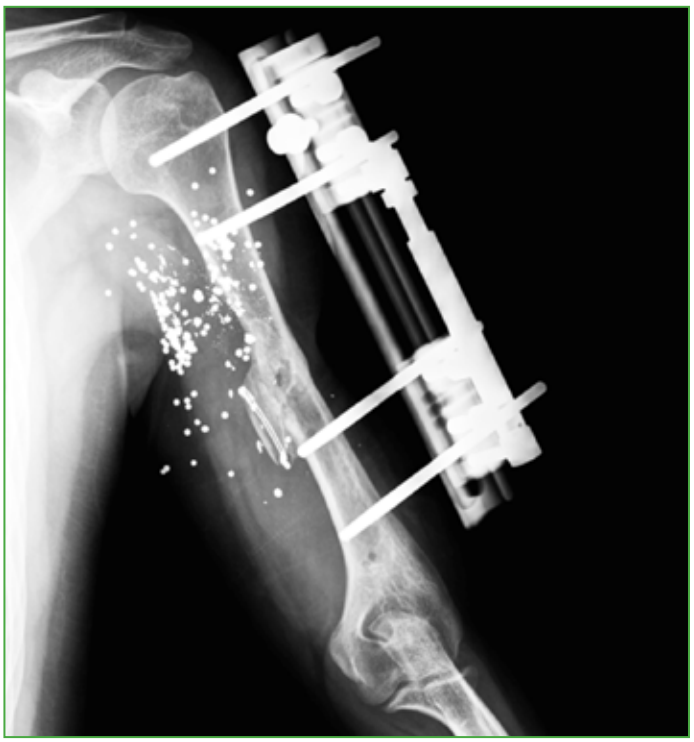

Figure 5. Final result achieved with external fixators. Consolidated fracture.

After six months of use, the external fixator was removed without complications. The hand surgery team began postoperative management of the radial nerve lesion, which was planned to be carried out by tendon transfers.

Three years after the initial trauma, tendon transfers were performed after a surgical waiting list. Before the surgery, we confirmed correct flexion-extension of the elbow; loss of wrist, thumb and fingers extension; and lack of sensation through the anatomical course of the radial nerve.

Tendon transfers were performed from the round pronator tendon to the extensor carpi radialis longus tendon; from the flexor carpi ulnaris tendon to the common extensor and the extensor digiti minimi tendons; and, ultimately, from the palmaris longus to the extensor pollicis longus tendons.

Treatment was started with aggressive motor physical therapy and occupational therapy. Patient evolved favorably, regaining adequate function on the upper limb. In later multidisciplinary follow-ups, patient presented adequate function and resistance extension of the wrist, thumb and fingers (Figura 6).

Figure 6. Functional results after tendon transfers and physical therapy.

DISCUSSION

Humeral shaft fractures account for 1% to 5% of all fractures, and 20% of upper limb fractures, showing a bimodal distribution: younger people suffer high-energy injuries, while the elderly suffer low-energy injuries[5].

The incidence of these fractures due to gunshot wounds increases every day. Up to 10% of gunshot wounds compromise the humerus[6]. In general, they are associated with extensive soft-tissue involvement and, in up to 60% of cases, secondary neurovascular injuries are observed, 70% of which are radial nerve injuries. Another serious related injury is the brachial artery injury (up to 20% of cases)[4-6].

Treatment with an external fixator is indicated in patients with open fractures and segmentary bone loss, open neurovascular injury, lack of consolidation due to infection, and multiple trauma[7].

The external fixator approach achieves better stability and compression of the fracture site, which facilitates early mobility and achieves higher consolidation rates, unlike modular AO fixators, which have higher instability and a high rate of loosening of the nails[7].

The most commons complications are infection of Schanz screws (12-50%), discomfort and lack of cosmetic results resulting from the device[7].

In patients with open humeral fractures due to gunshot wounds and radial nerve injuries, treatment is always surgical, with initial surgical exploration to determine whether the nerve is intact and to assess the possibility of a primary repair[8, 9].

In cases of complex peripheral nerve injuries, there are treatment options to restore the balance and function of the limb, such as nerve and tendon transfers, and allografts. Tendon transfers are reconstruction procedures to recover function after different types of injuries, both central and peripheral[8-10].

Our patient underwent debridement and surgical exploration during the acute phase of the injury. The radial nerve was intact, but blood-deprived. We decided to wait three months for observation, but during this period, the patient developed an infection that resulted in scarring and severe fibrosis, which excluded a new exploration and subsequent repair.

It has been reported that tendon transfers should be considered or planned if extension is not regained after six months, although studies show that it could be beneficial to perform it before the six month-period, mainly to improve extension of the wrist[8-10].

The aim of a tendon transfer for radial nerve injury is restoring wrist, thumb and finger extension. There are different approaches and transfers to this end. The main advantage of tendon transfers is that they can be performed despite degeneration of the motor plate, the operating time is shorter and, in general, function is regained shortly after[8-10].

The incidence of fractures by gunshot wounds is increasing worldwide. This type of fracture results in severe secondary injuries, such as soft-tissue injuries, skin defects and neurovascular damage. Medical teams in charge of treating these injuries must be familiar with different approaches and treatment options in order to offer the patient a tailored treatment by a multidisciplinary team.

In this paper, we presented the case of a patient with a mangled limb. An initial salvage therapy was performed, with soft-tissue management and fracture stabilization. The development of soft-tissue infection forced us to delay management of the radial nerve injury, which was ultimately performed via tendon transfers, with adequate functional results.

Conflict of interest: Authors claim they do not have any conflict of interest.

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