Medical and Research Publications
International Open Access

Case Report **Journal of MAR Orthopedics (Volume 5 Issue 2)**

High Velocity Gunshot Injury to the Elbow: Case Report & Review of the Literature

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Received Date: May 30, 2023

Published Date: June 15, 2023

Abstract

Gunshot injuries to the distal humerus are rare and decision-making is critical especially with articular involvement, bone loss, neurovascular injury and skin loss.

Early wound debridement, IV antibiotics, and provisional fixation with external fixator and early soft tissue reconstruction is gold standard in treatment of complex open fractures of the distal humerus.

Wound infection, stiffness, malunion and nonunion are potential complications for these devastating injuries. Treatment options include open reduction and internal fixation, total elbow arthroplasty and joint fusion. Joint fusion or total elbow arthroplasty are not the best choice for young patients. Treatment of open elbow fractures is a challenging problem that necessitates multidisciplinary approach from different specialties (Orthopedic surgery, plastic surgery, vascular surgery, neurosurgery, infectious diseases and physiotherapy).

Keywords*: Gunshot injury; Distal humerus fracture; Nerve injury*

Introduction

Gunshot injuries are characterized by massive destruction of bony structures, primary contamination, and modified reactivity of the body. In these injuries, bone fractures are comminuted **(**95%**)**, displaced, devitalized and accompanied by bone loss. Soft tissue injuries **(**skin loss, vascular and nerve injury**)** can make it even more complicated to treat these types of injuries. At our institution, we dealt with a big number of major injuries. All our patients with gunshot injuries that have a significant degree of bone fractures, soft tissues injuries and skin loss are treated with wound debridement, external fixation, empirical IV antibiotics till we receive the result of the wound cultures. A wound VAC dressing is applied and wound revisited after 24-48 hours for second look and we either close the wound primarily or continue VAC dressing if the wound condition still questionable. In cases of infected wounds with bone loss, we use antibiotic spacer using cement to fill the defect and later bone grafting once the culture results are negative **(**Masquelet Technique**)**. Definitive fixation with plate and screws performed once the soft tissue condition improved without local or systemic signs of infection. The bone defect is filled with autologous bone graft from the iliac crest.

Case Report

We present a case of 30 years old male patient who presented to emergency room with a close range firearm injury to the left elbow with open fracture Gustilo type III-B, with highly comminuted fracture of the distal humerus and complete trans -section of the ulnar nerve.

This patient was referred to our hospital 3 days post the gunshot injury to his left elbow. He has no other injuries. The patient has open wound and skin defect of about 3 x 5 cm at the posterior aspect of his elbow. He has claw hand with loss of sensation in the ulnar nerve distribution. The radial pulse is intact. Wound swabs sent for gram staining and culture and sensitivity. Empirical IV antibiotics started preoperatively for surgical prophylaxis. Left elbow radiographs showed comminuted distal humerus fracture and multiple bullet fragments **(**Figure 1**)**. Computed Tomography **(**CT**)** of the left elbow with three-dimensional bone reconstruction **(**3D**)** was done to delineate the fractures pattern and assess the integrity of the elbow joint **(**Figure 2**)**. The CT showed comminuted distal humerus fracture, multiple bullet fragments and intact elbow joint.

Patient was managed with wound debridement and external fixation with primary ulnar nerve repair and later open reduction and internal fixation with plate and screws and bicortical bone grafting for treatment of bone loss.

Surgical Technique

The patient was taken to the operating theatre **(**OT**)** for primary assessment of the wound and provisional fixation of the fracture. Patient underwent general anesthesia and positioned on lateral position with the left elbow supported by an elbow support. The patient was already on empirical IV antibiotic that was started preoperatively for surgical prophylaxis.

The posterior elbow wound debrided and washed with 9L of normal saline. All devitalized tissues excised. The distal humerus fracture was reduced and provisional fixation was done with K-wire to the articular fragments and spanning external fixation was applied **(**Figure 3**)**. Primary repair of the Ulnar nerve was performed after identification of the proximal and distal ends of the nerve. VAC dressing applied. A week later split thickness skin graft applied to the skin defect by plastic surgery.

Two months post-injury, the patient was taken to the OT for removal of the external fixator, K-wires and definitive fixation of the fracture. The patient was positioned on lateral position with the left elbow support and a pneumatic tourniquet was used. After isolation of the ulnar nerve, olecranon osteotomy was performed to expose the articular fragments. The massive bone loss was managed with bicortical

graft from iliac crest. The fracture reduced and fixed with 2 plates on the medial and lateral side. The olecranon osteotomy reduced and fixed with tension band wiring, reduction and fixation was satisfactory under x-ray control **(**Figure 4**)**. Wound closed in layers and arm sling applied. Patient was discharged home the next day in a stable condition. Two weeks later sutures removed in the clinic and physiotherapy started. The patient followed up on monthly basis with the left elbow x-rays and assessment of ulnar nerve. At 9 months post- operatively, the elbow xrays show solid healing of the fracture **(**Figure 5**)** and recovery of the ulnar nerve with residual hyposthesia of the ulnar nerve distribution in the hand.

Range of motion: Flexion of 110, extension 10 degrees with full pronation/ supination and normal handgrip. Now, the patient is 5 years post-operatively with excellent outcome, elbow ROM and recovery of the ulnar nerve function **(**Figure 6**)**.

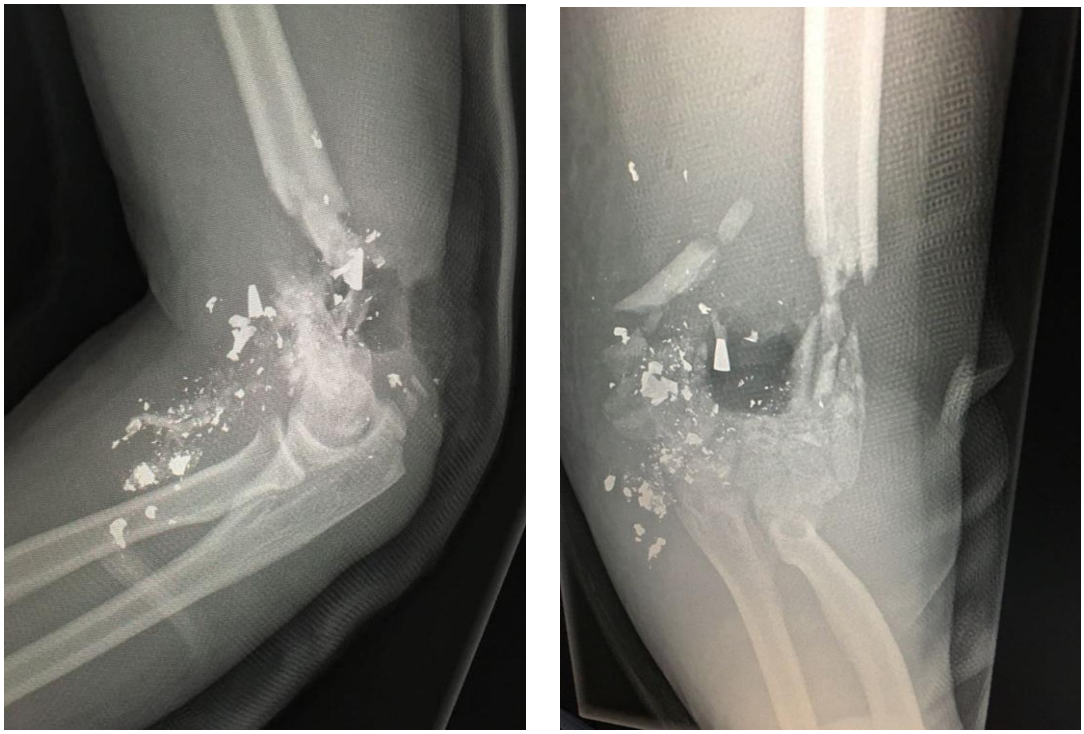

Figure 1. Left elbow X-ray **(**AP & Lateral views**)**.

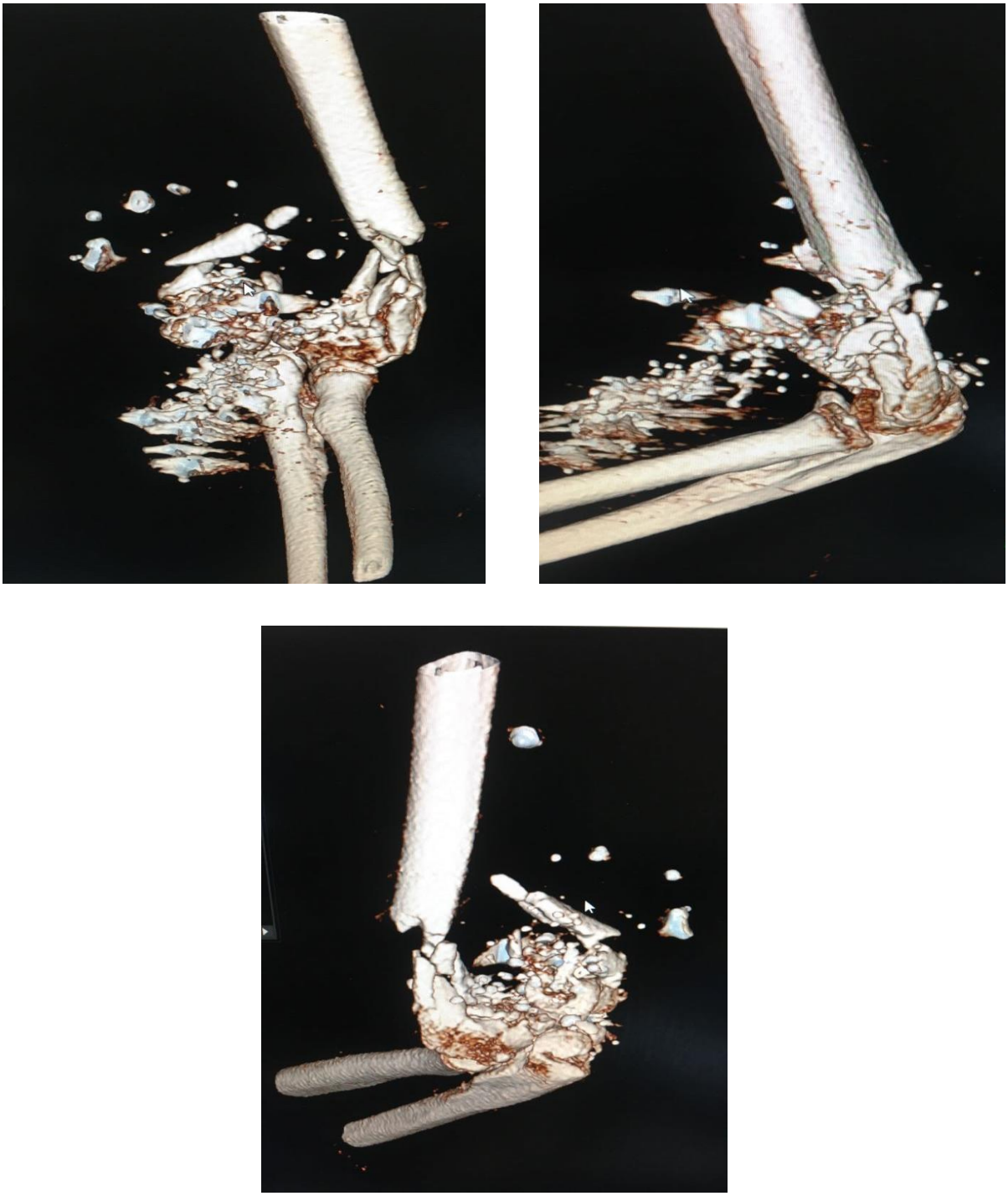

Figure 2. Left elbow three-dimensional bone reconstruction **(**3D**)**.

Figure 3. Left elbow provisional K-wire fixation & External fixator

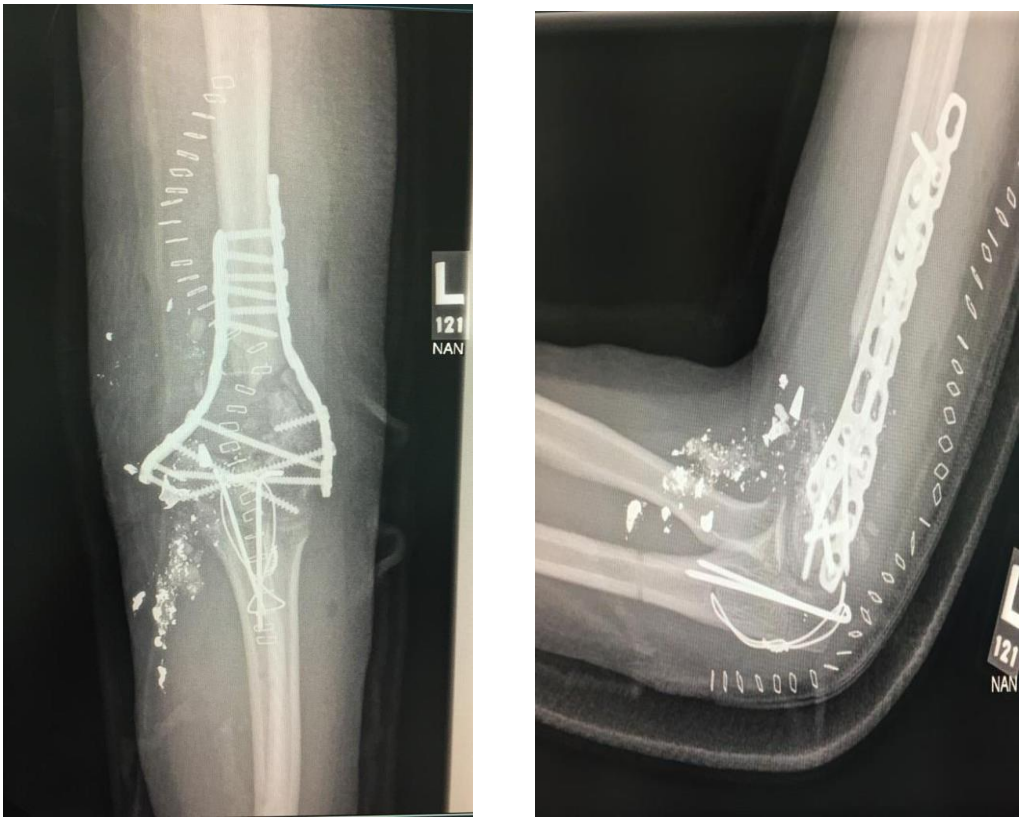

Figure 4. Post-operative x-rays of ORIF Distal Humerus & TBW of Olecranon Osteotomy

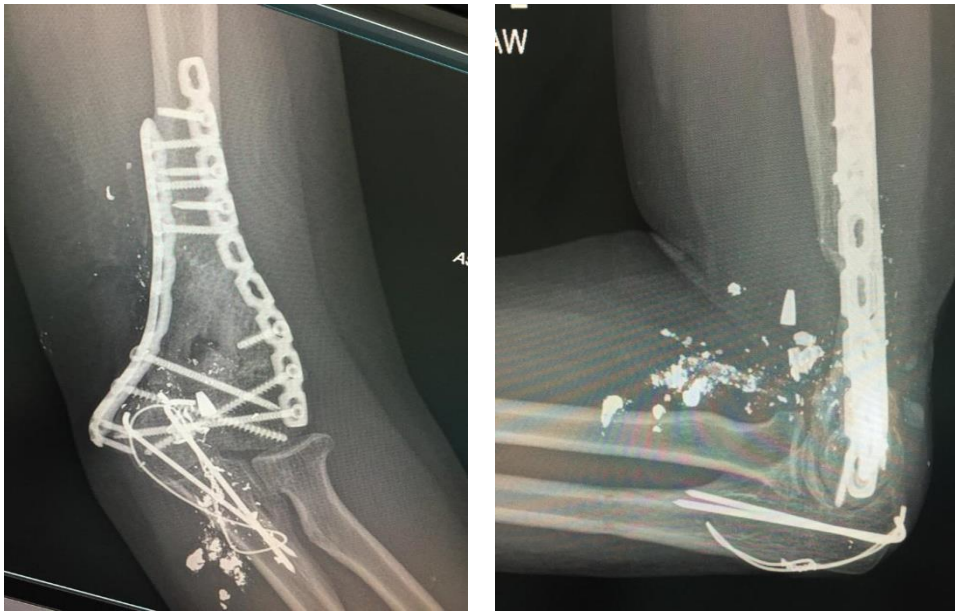

Figure 5. Final Xrays of left elbow post-op

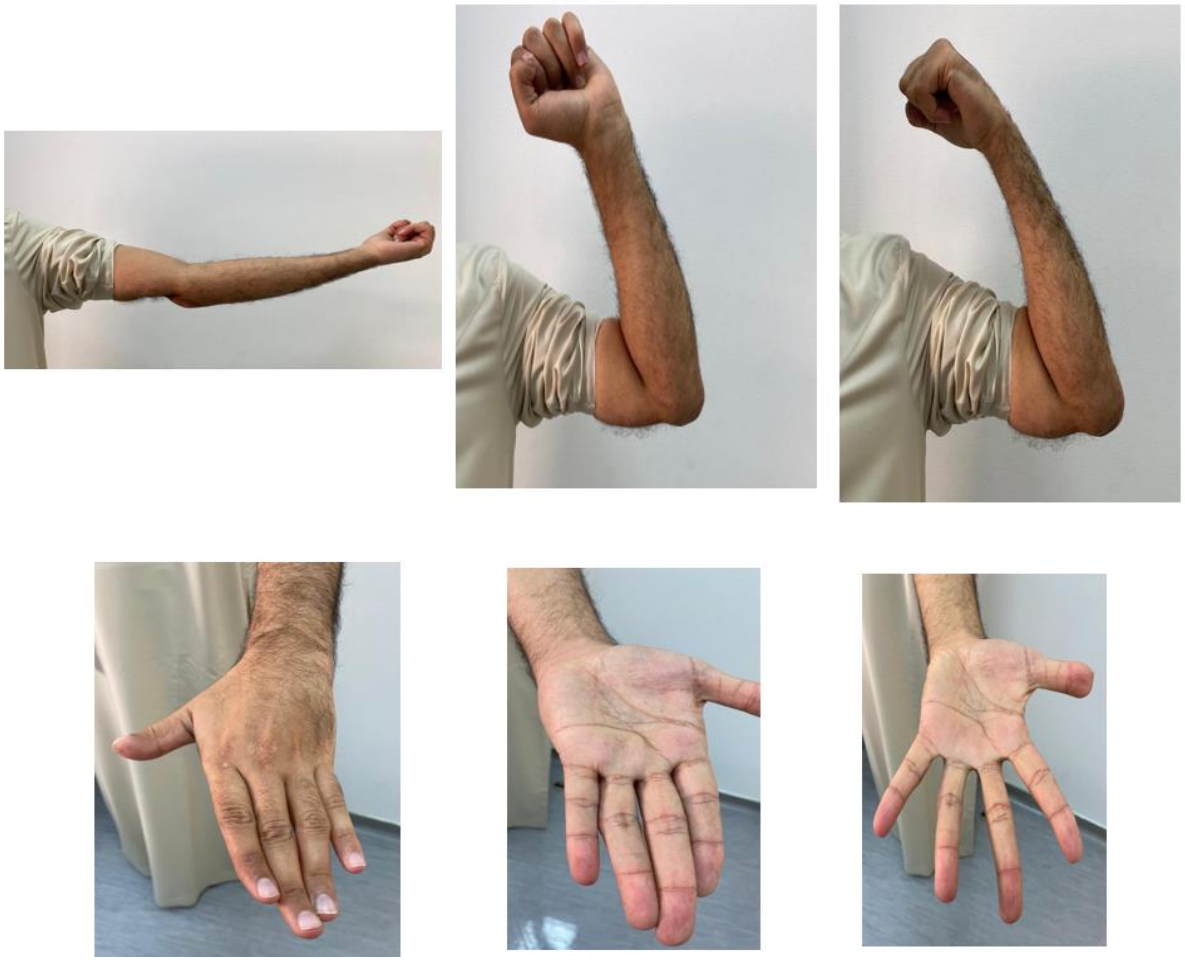

Figure 6. Range of motion & Ulnar nerve function

Discussion

This case report describes a gunshot injury to the distal humerus with severely comminuted distal humerus fracture and ulnar nerve transection. The incidence of these injuries to the elbow is not commonly reported in the orthopaedic literature **(**1,2,3,4**)**.

Intentional firearm-related injuries are considered as one of the highest nonfatal violence- related injury in the United States as per the Centers for Disease Control **(**5**)**.

In a level-I trauma centre, fractures rates associated with the extremities' gunshot wound **(**GSW**)** was 22%. In another evaluation of GSWs, 32.2% of the GSWs involved the upper extremity **(**6,7**)**.

GSW injury to the elbow can be challenging due to the high risk of associated neurovascular injury and elbow stiffness because of capsular contracture and heterotopic ossification. It can be complicated by infection, nerve injury, vascular injury, malunion and nonunion. The initial management of GSW injury with comminuted distal humerus fracture and ulnar nerve injury includes open irrigation and debridement of the wound, removal of bullet fragments and foreign material and removal of devitalized bony fragments. Temporary stabilization of the fracture can be done with a splint or spanning external fixator. Computed Tomography **(**CT**)** of the elbow with three-dimensional **(**3D**)** bone reconstruction can help to delineate the fractures pattern and plan for surgical fixation pre-operatively. If there is clinical evidence of compromised vascularity, arteriography is required to rule out major vascular injuries.

Surgical stabilization aims at stable construct to provide early range of motion of the elbow and function restoration that leads to improved functional outcomes.

There are many options available for definitive surgical management including open reduction and internal fixation, hinged external fixation, total elbow arthroplasty, distal humerus hemiarthroplasty and elbow arthrodesis.

Since fractures caused by GSW carry a high risk of contamination, internal fixation in the first surgery is avoided due to infection risk **(**8**)**. Therefore, these cases should be managed differently from open non-GSW huemrus fractures. Furthermore, early exploration of nerve injuries combined with bony and soft tissue reconstruction in the same setting minimizes risks **(**9**)**.

Komurcu et al reported on 19 cases of distal humerus fractures caused by gunshot injury. These cases were treated with an Ilizarov ring fixator. Out of these cases, 8 patients had a good result, 7 patients had a moderate result, and 4 had an unsatisfactory result. Fracture union was reported in all the cases

(10**)**. Demiralp et al reported a consecutive series of seven patients who underwent a semiconstrained total elbow arthroplasty for the management of comminuted elbow fractures caused by gunshot injuries. Five out of seven patients had poor long-term outcome. Two cases had humeral and three cases had ulnar component loosening **(**2**)**. The authors acknowledge the unsatisfactory long-term outcomes of semi-constrained total elbow arthroplasty especially in young patients with comminuted elbow fractures caused by gunshot injuries.

Total elbow arthroplasty, distal humerus hemiarthroplasty and elbow arthrodesis are good options in low demand and elderly patients. Arthrodesis can be an indication in a non- salvagable elbow joint that has intact neurovascular function of the upper limb.

Upper extremity nerve palsies are common after GSW-related humerus fractures. However, peripheral nerves transection is uncommon. The nerve injuries are caused by direct impact or the cavitation effect on the surrounding soft tissue. The prevalence of nerve injuries is higher in distal humerus than proximal humerus injuries.

It was evident that in cases, which have vascular injury, there is a nerve injury requiring surgical intervention **(**11**)**. The nerve injuries can include ulnar, radial, and median nerves. The median nerve is the most commonly injured nerve and the ulnar nerve is the second most commonly injured nerve caused by gunshot injury.

In acute exploration of the GSW, the injured nerve is assessed to determine the degree of the damage. In complete transection of the nerve, the ends of the nerve are approximated to prevent further retraction **(**12**)**. The transected nerve is treated 1 to 3 weeks post-injury to assess the extent of the transection. If the nerve is intact, the patient is observed for clinical improvement over the period of 2 to 3 months. If there is no clinical improvement, re-exploration of the nerve and end-to-end repair or nerve grafting is performed **(**13,14**)**.

Pannell et al reported a 17% rate of nerve laceration in a cohort of 41 patients who sustained GSW to the upper extremity **(**15**)**. Secer et al recommended early exploration of the injured nerve and primary repair or nerve grafting within 4 months to avoid retraction of the nerve and adherence of the nerve to the soft tissue or scar tissue. They also used physical examination, nerve conduction studies and electromyography to establish the type of the nerve injury and nerve function recovery **(**16**)**.

In conclusion, GSW injuries to the elbow are associated with bony and soft-tissue injuries that can be difficult to treat. There is no consensus on the best surgical fixation of these injuries. Nerve injury

around the elbow caused by GSWs is common and patients should be closely monitored, as it is unpredictable.

There are a limited number of high-quality studies to compare surgical options for the management of GSW related distal humerus fractures. Much of the literature on GSW- related distal humerus fractures is Level-III or IV evidence. This warrants the need for prospective and randomized highly powered studies.

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