

Clinical case

Type V floating elbow with type III A3 exposure and nerve lesion. Initial and definitive treatment with a minimally invasive technique. A case report

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ABSTRACT. Background: the increased number of high energy accidents has led to the occurrence of several injuries in a single extremity, particularly among youths. Stanitski and Micheli defined the floating elbow as a forearm fracture plus an ipsilateral supracondylar fracture. Its incidence ranges from 3% to 13%, predominant ages are 7 to 11 years, with a 2:2 male:female ratio. The mechanism of injury is as follows: fall from a height with elbow hyperextension and wrist dorsiflexion and pronation of the forearm. **Objective:** to present the case of a child with a type V left open floating elbow injury, severe soft tissue injury and median and radial nerve injury. **Clinical case:** A 12-year-old male weighing 70 kg and a height of 170 cm fell from a height of around 50 cm while riding on a skateboard and sustained a type V floating elbow injury. He was managed with a double antibiotic regimen, decontaminating wound care and fracture stabilization with a minimally invasive approach, using crossed Kirschner nails in the elbow, and centromedullary and retrograde nails in the radius and ulna. He underwent early rehabilitation. The patient resumed his usual activities at month 3 and was assessed using the DASH scale. The nerve injury was classified as neurapraxia. **Results:** the skin healed at ten days. Passive motion of the elbow and wrist was started at week 2. Bone healing of the radio-ulna occurred

RESUMEN. Antecedentes: El aumento en la incidencia de accidentes de alta energía, hace que se presenten lesiones diversas en una misma extremidad, sobre todo en jóvenes. Stanitski y Micheli definieron al codo flotante, como una fractura de antebrazo más una fractura supracondílea ipsilateral. Su incidencia va de 3% a 13%, predominando las edades de 7 a 11 años, con relación 2:1 para el sexo masculino. Su mecanismo de lesión: caída de altura con hiperextensión del codo y dorsiflexión de la muñeca con pronación del antebrazo. **Objetivo:** Presentar el caso de un niño con codo flotante izquierdo tipo V expuesto, lesión severa de tejidos blandos, lesión de los nervios mediano y radial. **Caso clínico:** Masculino de 12 años, con peso 70 kg y talla 170 cm, quien sufre caída de altura aproximada a 50 cm al jugar en patín en movimiento, presentando codo flotante tipo V. Manejado con doble esquema de antibióticos, cura descontaminadora y estabilización de las fracturas con mínima invasión, clavillos de Kirschner cruzados en codo, centromedular y retrógrado en radio y cúbito. Se inició rehabilitación temprana. Regresó a su actividad habitual al tercer mes, evaluado mediante la Escala DASH. La lesión nerviosa se clasificó como neuropraxia. **Resultados:** La piel cicatrizó a los 10 días. Se inició movilidad pasiva a la 2ª semana en codo y muñeca. Mostró consolidación ósea a los 35 días del radio-cúbito y a los

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at 35 days and of the humerus at 30 days. The nerve injury evolved properly without leaving any sensory or motor sequelae. According to the DASH Scale, the functional course was appropriate; the patient resumed his usual activities at month 3. No infection or compartmental syndrome occurred. **Conclusions:** the early and thorough washing of these injuries is an important factor to decrease the risk of infection. The minimally invasive approach is perfect to treat these injuries in children; it is less aggressive and preserves the integrity of soft tissues. Early rehabilitation and the prompt management of the nerve injury are fundamental to the functional result. The DASH Scale identifies the functional course, is easy to use and convenient for the patient.

Key words: elbow, fracture, injury, neuropathy.

30 días del húmero. La lesión nerviosa tuvo buena evolución sin dejar secuela sensitiva o motora. Se observó mediante la Escala DASH adecuada evolución funcional, incorporándose el paciente al tercer mes a sus actividades habituales. No se presentó infección o síndrome compartimental. **Conclusiones:** El lavado temprano y adecuado de estas lesiones, es un factor importante para disminuir riesgos de infección. El método mínimo invasivo es el ideal en este tipo de lesiones en niños, es menos agresivo y preserva la integridad de los tejidos blandos. La rehabilitación temprana y el pronto manejo de la lesión nerviosa, es fundamental para el pronóstico funcional. La Escala DASH identifica la evolución funcional, es sencilla de elaborar y cómoda para el paciente.

Palabras clave: codo, fractura, lesión, neuropatía.

Introduction

Currently, the increase in the incidence of motor vehicle accidents, extreme sports, falls from considerable heights and other high energy accidents have led to an increased frequency of patients with multiple fractures who present at the emergency services, particularly young ones. There are reports of multiple injuries in one extremity.⁽¹⁾ The term floating elbow was mentioned for the first time by Stanitsky and Micheli, who reported the type of characteristic injury pattern that includes a forearm fracture plus an ipsilateral humeral supracondylar fracture.²

Even though the bones that are always injured include the humerus, ulna and radio, there is a wide variety of injuries that are determined by the mechanism, force and position of the extremity in the space at the time of the trauma, such as the vascular, neurologic and soft tissue injuries.

This is a serious injury that usually occurs in adults as a result of high energy trauma and in children due to falls on the thoracic limb, thus producing soft tissue changes that may result in neurovascular compromise or compartmental syndrome.^{3,4}

The world literature reports a 2:1 male:female ratio with the highest incidence occurring at 7-11 years of age. The mechanism of injury is usually a fall from a height with elbow hyperextension and wrist dorsiflexion with forearm pronation.⁵

Even though supracondylar humeral fractures and forearm fractures are common in children, their combination is rare. The incidence rate of this association ranges between 3% and 13%.

The recommended treatment for this fracture combination is still controversial,⁶ although there are publications

recommending to perform surgery as soon as possible after patient admission, preferably with percutaneous or minimally invasive fixation and, if possible, avoiding the occurrence of compartmental syndrome or additional neurologic and vascular injuries.⁷

The treatment of an open fracture has always represented a challenge for the therapeutic criteria and methods of the orthopedic surgeon. In any case, it should be considered that the treatment of an open fracture is an emergency and the patient should be transferred to the operating room as soon as possible. The cost of care of a patient with these injuries is very high, but if care is systematized, this cost will be considerably reduced and the functional prognosis will improve. An open fracture (exposed or compound) is the injury in which the fracture site communicates with the outer environment, i.e., when the rupture of the skin and the underlying soft tissues produces communication between the fracture and the outer environment, it always involves the risk of infection. We must remember that an open fracture in itself should be treated like a true surgical emergency and the patient requires comprehensive care.⁸⁻¹⁰

Our patient was managed by assessing the limb viability by means of the MESS scale, which allowed evaluating the limb parameters and scores; the decision was made to salvage the limb due to a score of 5.^{11,12}

It is important to mention that an increasing number of children have a size and weight that are greater than expected according to the percentiles; some may have a variety of problems due to their extreme height, which may lead to the request of treatment to reduce their height or prevent it from increasing, by means of high sexual steroid doses. Fortunately, most children that are too tall for their age have variants of normality that include that one or both parents are very tall.^{13,14}

The purpose of this paper is to present the case of a child with an open radius and ulna fracture with important soft tissue injuries, as well as neurologic injury of the median nerve, besides an open supracondylar humeral fracture with radial nerve injury; altogether, these lesions are known as open «floating elbow»; the patient underwent immediate surgical management with decontamination care and percutaneous fracture stabilization with Kirschner nails.

Clinical case presentation

Male, 12-year old patient without any pathologic history relevant to the current condition. The patient is 1.70 meters tall and weighs 70 kg; he fell from a height of approximately 50 cm from a skate when he was rotating on it, with elbow hyperextension and wrist dorsiflexion, as well as left forearm pronation. He was admitted in the Emergency Room of this hospital with his mother and general practitioner. He had deformity of the left elbow and distal forearm, besides limitation of hand function. A 7 cm wound was observed on the anterior aspect of the distal forearm, with exposure of the radius and ulna, which were contaminated with soil and grass, and one more injury in the medial elbow, 1.5 cm long, with exposure of the distal humerus, both of them with mild to moderate bleeding. Initial X-rays were taken (Figures 1-4). The patient underwent an orthopedic assessment, whose findings included important pallor and paresthesia of the left hand, in the territory of the radial and median nerves, as well as limitation of the finger extension movement. He had weak pulses and a 5-second capillary filling.

The initial management in the ER included analgesics, nonsteroidal anti-inflammatory agents, a double regimen of antibiotics (Cefalotin-Amikacin), antitetanus gammaglobulin, and regional anesthesia to relieve the strong pain. Later

the mother was informed about the severity of the injury and the possible functional sequelae, and was told about the need for surgical treatment; she signed the informed consent form, then decontamination care and debridement were performed in both open fractures within 2 hours of the injuries; important soft tissue damage and a 2 cm hematoma of the median nerve were found. Closed reduction and stabilization were performed with crossed Kirschner nails in the distal humerus (Figures 5 and 6), and in the forearm (Figures 7 and 8) with retrograde Kirschner nails, centromedullary to the radius and ulna, with fluoroscopic control, for a total operative time of 70 minutes. In both injuries a drain



Figure 2. AP X-ray showing bone disorganization and dorsal and antegrade displacement.



Figure 1. Lateral X-ray of the distal forearm taken upon admission, showing a metadiaphyseal fracture with bone exposure.



Figure 3. AP elbow X-ray showing a supracondylar fracture with anterior displacement and valgus angulation.

was left in place. Later the area was covered and a posterior brachio-palmar splint was placed in supination and with 90° of elbow flexion. The patient was kept at the hospital for IV antibiotic therapy and medical surveillance. He was later discharged with a clinical nerve lesion of the radial and median nerves, and was assessed and managed by the rehabilitation specialist; he began physical therapy at post-operative day 35, with a 15-day rehabilitation period after the removal of the nails and the posterior splint; at postoperative day 10 he began daily passive motion and showed an improvement trend in strength and sensitivity. The Orthopedics service followed him up, he was seen at 10, 30, 45, 60, 90 days and 6 months after the primary surgery (*Figures 9 and 10*), when his condition was assessed using the DASH scale (functional scale for thoracic limbs), which asks di-



Figure 4. Oblique X-ray showing saddling and displacement.

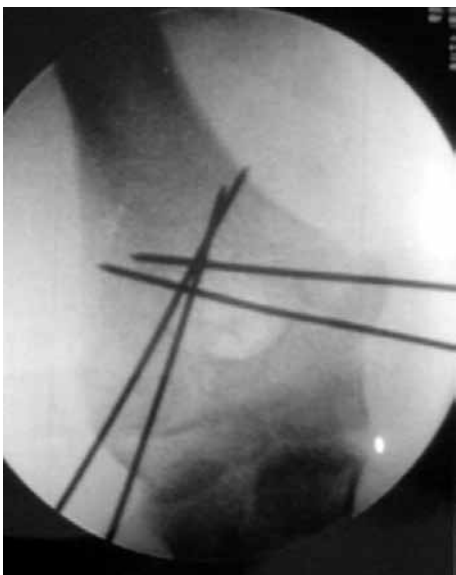
rectly about the symptoms and the capacity to perform certain activities or tasks with the affected thoracic limb.¹⁵ The patient had a satisfactory course and was able to resume his usual activities by 3 months (*Table I*) (*Figure 11*).

Discussion

The floating elbow is an infrequent injury, with limited descriptions in the literature relating it to other types of injuries, and less frequently to associated injuries, like the case reported herein, which included fracture of the radius, ulna and humerus, as well as injury to the radial and ipsilateral median nerve. The literature reviewed shows that the patient was properly managed. Quick and emergency pain management was provided with a regional block, the surgery performed included early surgical lavage and debridement of the injuries, providing stability to the lesions by means of closed reduction and percutaneous internal fixation with crossed nails in the humerus and retrograde centromedullary nailing in the radius and ulna; rehabilitation was started early, as the literature reports, to decrease or avoid the possible complications. The patient evolved without clinical signs of compartmental syndrome.

This research found out that there is no morphologic, functional, universal or official classification of the floating elbow that allows determining standardized treatment strategies. That is why, for the purposes of this paper, the classification proposed by doctors Cuéllar- Nieto in 2007 at Victorio de la Fuente Narváez Trauma Hospital was used (*Table II*). The latter provides a comprehensive idea of the prognosis and treatment, and considers the fracture characteristics based on the mechanism of injury, the fracture level, the time of exposure and associated injuries. It includes six types.⁵

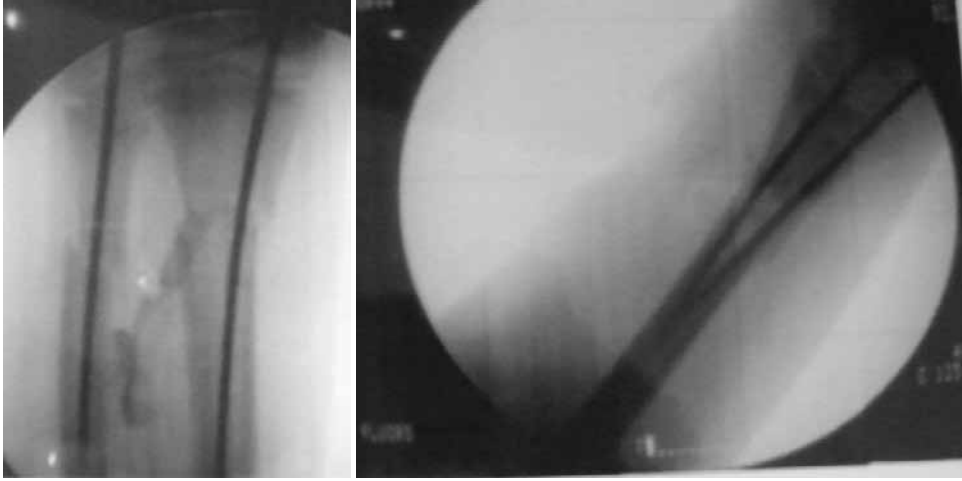
Although the Gustilo classification is the most widely used globally for open bone injuries, in this case we decided to use the one proposed by the Open Fracture Service at



Figures 5 and 6. Postoperative fluoroscopic control showing the anatomical reduction and fixation with crossed Kirschner nails.

Victorio de la Fuente Narváez Hospital because it is more comprehensive and provides a realistic idea of the lesion, its treatment and prognosis.⁹

We must remember that the management of these complex injuries has evolved with the understanding of the stabilization of isolated fractures of the thoracic limbs. Even



Figures 7 and 8. Postoperative fluoroscopic control of the radius and ulna showing appropriate alignment in both the AP and the lateral X-rays.



Figure 9. X-ray controls of the distal forearm at 10 and 30 days and at 6 months.



Figure 10. X-ray controls of the elbow at 10 and 30 days and at 6 months.

though the objectives are the same, the treatment guidelines for children and adults differ slightly. Regardless of age, initial treatment should include temporary or definitive fracture immobilization and proper debridement of the wounds of open fractures, as well as the appropriate and prompt administration of IV antimicrobial agents, as was done in this case.¹⁶

Antibiotic administration was been considered as part of standard health care since 1974, when Patzakis and his group of researchers published the use of cefalotin, a first-generation cephalosporin, to treat open fractures.¹⁷ The benefit granted by antibiotics was confirmed by a recent systematic Cochrane review showing that antibiotic administration immediately after an open fracture leads to a 59% reduction in the risk of infection, with a relative risk of 0.41; CI 95%, 0.27-0.63.¹⁸ Currently there is controversy around the use of the specific antibiotic or antibiotics that should be administered after an open fracture. While some have recommended to treat all open fractures with a combination of a first-generation cephalosporin and an aminoglycoside,¹⁹ others has advocated monotherapy with a first-generation cephalosporin for Type I and II fractures, and the combination with an aminoglycoside (they usually suggest gentamycin) for type III fractures.²⁰ This is what was decided in this case.

According to a study by Bowen and Widmaier, published in 2005, with 174 patients who had long bone open fractures, not only was the Gustilo and Anderson classification

considered, but also the number of comorbid alterations, as relevant predictive factors of infection. Patients were divided into three classes according to the presence or absence of 14 medical and immunosuppressive factors, such as more than 80 years of age, current nicotine use, diabetes, malignancies, respiratory failure, systemic immunodeficiency, etc. The reported infection rates were 4% for class A patients (with no compromising factors), 15% in class B patients (with one or two compromising factors), and 31% in class C patients (three or more compromising factors).²¹

In the management of these injuries it is important to know about the appearance and closure of the ossification centers and, at the time of surgery, avoid producing an iatrogenic injury. Likewise, we know that in Mexican children the appearance of these ossification centers is delayed, mainly in the epitrochlea and the olecranon, so we should spare them.²²

Even though there are publications in which crossed nails have been used, and which recommend their use, other papers,

Table 1. Results of the DASH Functional Assessment of the Upper limb.

Day	Final result
35	68.3
45	36.6
60	21.6
90	5.0

Table 2. Cuellar-Nieto Classification of the HTVFN, IMSS, Mexico.

Type I	Distal metaphyseal fracture of the humerus with metaphyseal fracture of the radius and/or ulna, with <20° of volar angulation with lateral displacement <90°.
Type II	Humeral diaphyseal fracture plus metaphyseal fracture of the ulna and/or radio, with >20° of volar angulation with independent lateral displacement
Type III	Humeral diaphyseal fracture plus metaphyseal fracture of the ulna and/or radius, with >20° of volar angulation and >90° of lateral displacement
Type IV	Open fracture in Types I, II, or III with neurovascular compromise
Type V	Open fracture in Types I, II, or III within less than 6 hours
Type VI	Open fracture in Types I, II, or III within more than 6 hours



Figure 11. The patient doing several ranges of motion and strength movements.

like the one by Skaggs et al., do not recommend their routine use so as to prevent an iatrogenic injury to the ulnar nerve. This author concludes that lateral nails are more than enough to provide appropriate fixation in supracondylar fractures.²³

Conclusions

Appropriate decontamination care and debridement of these injuries as soon as possible are an important factor to reduce the risk of infection. The minimally invasive approach continues to be perfect to treat these injuries in children; it is less aggressive and preserves the integrity of soft tissues. Appropriate early rehabilitation and the prompt management of the nerve injury are fundamental to the functional result. The DASH Scale identifies the functional course, is easy to use and convenient for the patient. As a result of this research, we think that the field of traumatic floating elbow injuries is a territory with huge knowledge gaps that offers ample room to continue investigating. When the term floating elbow is used, it should encompass a series of conditions that may in themselves produce a high rate of poor prognoses, both esthetic and functional, and may even progress to severe lesions that may place the viability of the limb at risk. Each injury should not be treated separately, but rather all of them should be treated as a whole, based on Hippocrates's principle of **Primum non nocere** (First do no harm), despite the anatomical and functional complexity of the limb.

With the trend of the new percutaneous techniques or minimal incisions, we may offer a better course to the patient, preserving tissue integrity, and improving the esthetic and functional aspects. The physician, who is knowledgeable of these lesions, should be one step ahead, guiding the patient's course, committing both the patient and his family to learn about the disease, thus allowing diminishing to the extent possible the sequelae that may occur.

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