ELBOW DISLOCATIONS ASSOCIATED WITH PROXIMAL ULNA FRACTURES (CORONOID PROCESS / OLECRANON)

Bonilla Ensenat, Fernando

Abstract: *The elbow is the second joint in the body that suffers the most dislocations, after the shoulder and the first in childhood. In up to 25% of cases it is associated with fractures of structures involved in joint stability, the most important being the humerus-ulnar hinge. When the surgeon is faced with a fracture dislocation of the elbow, he must ask himself the following questions: what bone structures are affected? Is it convenient to osteosynthesize them and what sequence should he follow? Is it necessary to perform any gesture on the collateral ligaments? what is the best elbow approach for the case? What postoperative protocol should I follow?*

Objective: In *this review we will try to resolve these questions focused specifically on elbow dislocations associated with fractures of the proximal end of the ulna, that is, associated with involvement of the choroid process and olecranon.*

1Corresponding Author: Bonilla Enseñat, F, La Fe Hospital.
f.bonilla.e92@gmail.com

Av Fernando Abril Martorell 106, Valencia, Spain. ZIP: 46026

[2]The Faith Hospital. Av Fernando Abril Martorell 106, Valencia, Spain. ZIP: 46026

INTRODUCTION

The elbow joint is a complex joint, formed in turn by the combination of 3 joints: humeral-ulnar, radiocapitellar, proximal and radioulnar(1) .

It is the second joint in the body that suffers more dislocations after the shoulder, and the first in childhood.
In up to 25% of cases it is associated to fractures of structures involved in joint stability(1) .

Joint congruence and stability rely on items static and dynamic stabilizers:

- Dynamic stabilizers

  they include all the muscles that cross the joint, exerting a compression force and increasing its congruence(1) .

- The static stabilizers of the elbow are three (humerulnar joint, medial collateral ligament (MCL) and lateral collateral ligament (LCL)), but the most important is the bone morphology of the humerulnar hinge(1) .

This hinge is made up of the proximal portion of the ulna, wide and thick, forming the greater sigmoid cavity (or trochlear notch) that articulates with the trochlea of the humerus. The cavity

The greater sigmoid is bounded by the coronoid process and olecranon joined by a small bare area of cartilage. They are the main responsible for the stability of the joint against dislocations

posterior (coronoid process) and anterior (olecranon)
respectively(2) .

On the lateral aspect of the coronoid process, the lesser sigmoid cavity, or radial notch, articulates
with the head of the radius. In the face lateral to the proximal ulna, a bump called the crest of the supinator, is the distal insertion site of the lateral collateral ligament or radial collateral ligament. It is primarily responsible for stabilizing the elbow against forces in

varus and rotary(3) .

On the medial aspect of the facet process coronoids stands out the anteromedial and the sublime tubercle, insertion site of the anterior fascicle of the medial collateral ligament or ulnar collateral ligament, one of the basic structures for the stability of the elbow in valgus(3) .

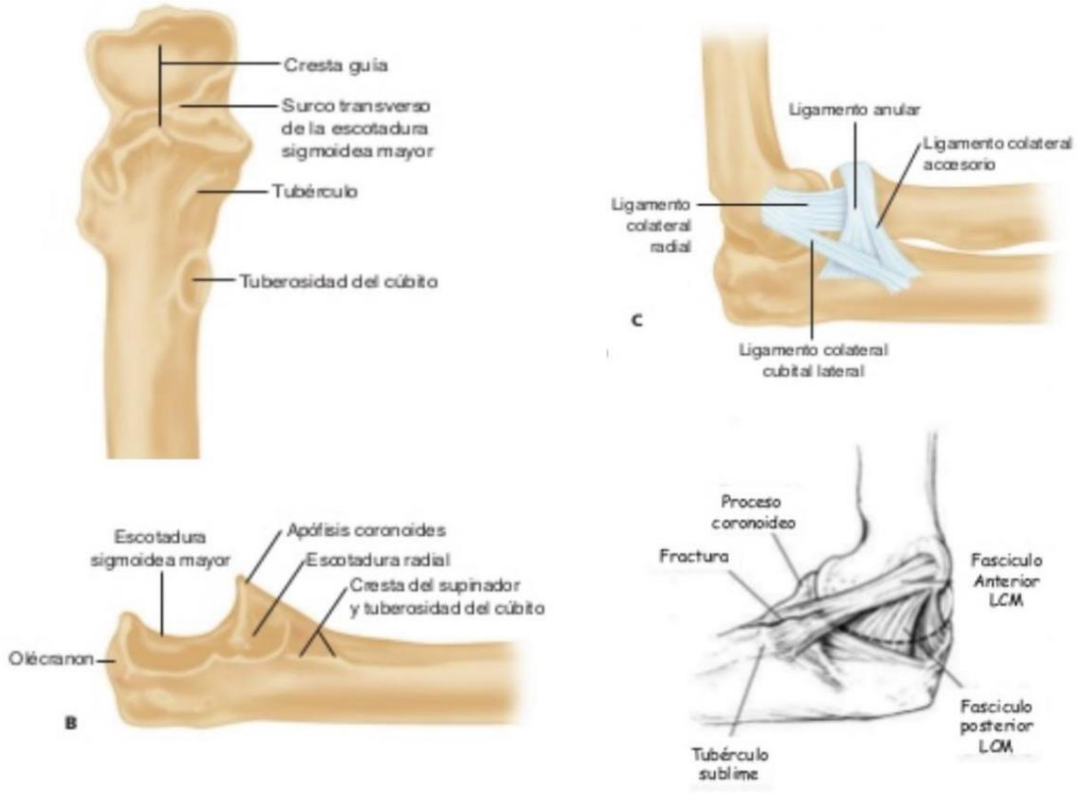


Figure 1. Anatomical memory of the important structures at the level of the elbow.

When the surgeon is faced with a dislocated fracture of the elbow, he must Ask yourself the following questions: what bone structures are affected? Is it convenient to osteosynthesize them? And what sequence to follow? Is it necessary to perform any gesture on the collateral ligaments? what is the best elbow approach for the case? What postoperative protocol to follow?

In this review we will try to solve These questions focused specifically on elbow dislocations associated with fractures of the proximal end of the ulna, that is, associated with involvement of the choroid process and olecranon.

dislocations OF ELBOW ASSOCIATED WITH FRACTURES OF CORONOID PROCESS

Elbow dislocations are associated with 2% to 15% with fractures of the coronoid process of the ulna(4) .

EVALUATION AND RANKINGS

The first step to assess the lesion is a radiographic study that includes the anteroposterior, lateral (best projection to characterize size and displacement of the coronoid) and oblique(5) projections .

Figure 2. Position and radiographic image of the elbow in anteroposterior projection.

Figure 3. Position and radiographic image of the elbow in lateral projection.

Figure 4. Position and radiographic image of the elbow in external oblique projection.

In most cases, radiographic studies will be difficult to assess because the cortical bone structures will overlap, but they allow us to identify fracture dislocations and suspect injuries to the radial head, coronoid process, and olecranon, as well as of ligamentous structures. For this reason, given the suspicion that we

we are faced with a case of fracture elbow dislocation, it is indicated to extend the study with a CT, once the dislocation has been reduced(5) .

RANKINGS

Traditionally the classification used has been that of Regan and Morrey described in 1989 (based on radiographic studies) based on the fragment size of the fractured coronoid process:

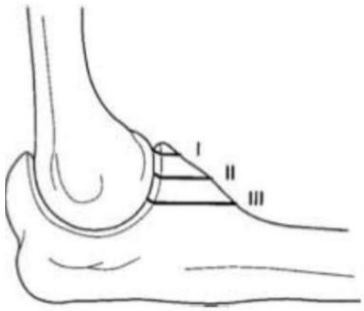


Figure 5. Illustrative image of the Regan and Morrey(1) classification .

O'Driscoll proposed a classification scheme that is based on the number and location of coronoid fragments studied in the sections.

CT coronals. This classification recognizes the importance of anteromedial facet fractures caused by a rotary posteromedial force.

REGAN AND MORREY CLASSIFICATION	
Type I	Fracture/avulsion of the tip of the coronoid process
Type II	Fracture involving 50% or less of the coronoid process
Type III	Fracture that is greater than 50% of the coronoid process

Table 1. Reagan and Morrey classification

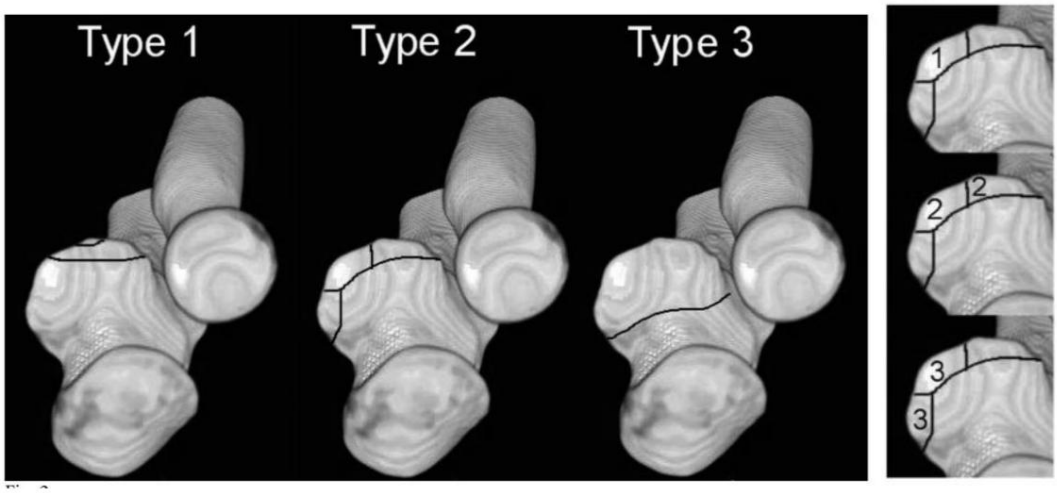


Figure 6. Illustrative image of O'Driscoll's classification together with subtypes of anteromedial facet fractures (type II). Adapted from Doornberg JN, Ring DC. Fracture of the anteromedial facet of the coronoid process. J BoneJointSurgAm 2006;88:2216-2224.

O'DRISCOLL CLASSIFICATION			
LOCATION **TYPE**		SUBTYPE	DESCRIPTION
	Tip	1	< 2mm
		2	>2mm
II	anteromedial		anteromedial border
		1 2	anteromedial edge + tip
		3	Anteromedial border + tip + sublime tubercle
II	Basal	1	coronoid and base
		2	Transolecranon including coronoid base

Table 2: O'Driscoll classification

According to this classification system, type I would be fractures of the coronoid tip, the same as in the previous classification. These types of fractures are part of the terrible elbow triad and posterolateral elbow instability.

O'Driscoll type II fractures include involvement of the anteromedial facet.

They are further subdivided into subtype 2 if they include the coronoid tip or subtype 3 if the sublime tubercle is also affected. This fracture pattern is associated with instability

posteromedial elbow and lateral collateral ligament injury.

O'Driscoll type III fractures affect the base of the coronoid process and in many cases are associated with other fractures.

fractures of the proximal ulna such as the olecranon or the proximal shaft of the ulna.

PATHOPHYSIOLOGY

The specific mechanisms of fracture production are varied and often include torsion, bending, and shear forces. If the different forces are combined, three possible fracture mechanisms are generated that can guide the surgeon when planning surgery and treatment(6):

- Due to instability rotary
  posterolateral valgus valgus (IRPLV): associated with injury to the lateral collateral ligament and often with
  radial head fractures. Are
  fractures of the tip of the coronoid process (avulsions).
  This group of lesion is also known as the “Triad
  Terrible Elbow” by Hotchkiss.

- By Instability rotary
  posteromedial varus (IRPMV): associate to injuries of the
  lateral collateral ligament, arise from a varus force and are a special subtype of injury involving the

  anteromedial facet(7) .

- Fractures-dislocations
  transolecranon: depending
  of the displacement of the ulna and radius on the humeral blade are subdivided into anterior and posterior.

  - o Fractures-dislocations
    transolecranon
    above: they usually associate
    fractures involving large
    fragments of the coronoid base.

  - o Fractures-dislocations
    transolecranon
    posterior: frequently associated with fractures of the
    coronoids, head of
    radio and ligament
    side collateral.

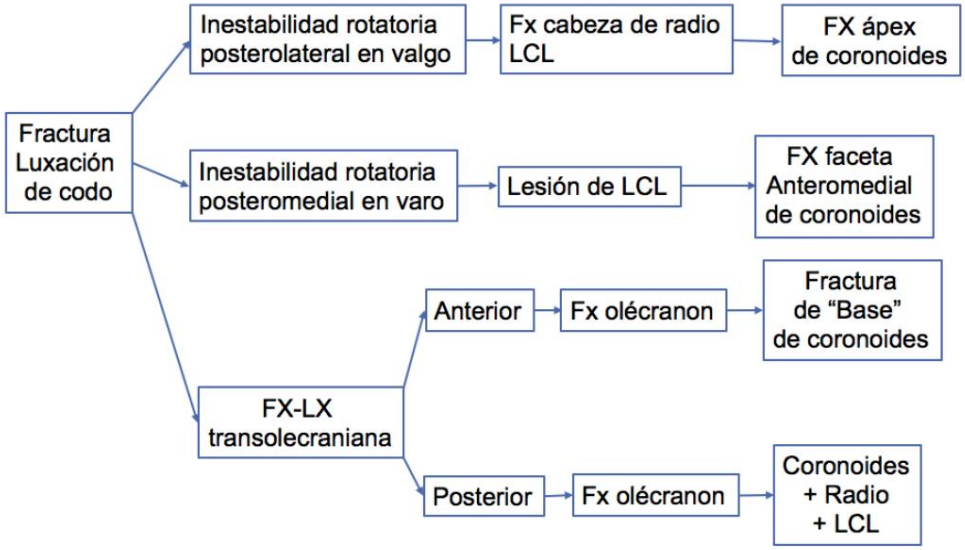


Table 3: different possibilities of fracture-dislocation of the elbow.

TREATMENT

The decision to operate or not operate on a coronoid process fracture is based on associated injuries (radial head fracture, ligamentous injuries) and assessment of elbow stability, as well as fragment morphology and displacement.

CONSERVATIVE TREATMENT

Recently phoruria et to the. they have presented the results of his conservative treatment protocol for a series of patients treated with elbow immobilization and a clinical guided exercise program, obtaining results

excellent or good in more than 90% of the patients.

This treatment is based on maintaining congruent to favor the recovery of the parts joint

soft and thus maintain stability.

As a conclusion of the study, it can be said that fractures of the coronoid process associated or not with dislocations

of elbow that encompass less than 50% of it, without involvement of the radial head and with an elbow joint, the congruent immobilization in the CT images, can be treated conservatively regardless of after the affected region(8) .

The non-surgical treatment protocol consists of:

- Three weeks of immobilization with brachial splint at 90º elbow flexion and neutral pronosupination plus sling.
Daily sling removal and assisted shoulder exercises are allowed during the day to avoid varus-valgus stress forces at the elbow.

- Next, the splint is removed and the sling is maintained for another 3 weeks.

During this new period, the patient will perform elbow flexoextension exercises in maximum pronation and pronosupination in maximum flexion three times a day.

- At the sixth week of treatment

remove the sling and are allowed to perform basic activities of the day to

days without weight. At this time, varus and valgus stress tests will be performed to assess the stability of the joint.

- In the third month, loading, sports activity and simply avoiding those activities that may cause pain are authorized.

c)

Figure 7. Different positions of the patient in the Surgical table. a: lateral decubitus. b: decubitus supine. c) prone position. Adapted from Jennings JD, Hahn A, Rehman S, Haydel C. Management of Adult Elbow Fracture Dislocations. OrthopClin North Am. 2016 Jan;47(1):97-113

to)

b)

SURGICAL TREATMENT

A) ELBOW APPROACHES

Depending on the structures that we need to repair, we will choose one approach or another. The patient can be placed in the lateral, prone, or supine position. In any case, it is recommended to mark the radial side and the ulnar side, as well as the expected course of the ulnar nerve, since once the procedure has started the surgeon can easily become disoriented.

We highlight 3 access routes to the

coronoid process:

1. Universal posterior approach: provides circumferential access to the elbow and a panoramic view of the elbow. create skin bridges between different incisions. If a hinge-type external fixator is to be used, it is a good

Developing a full skin flap toward the medial and lateral sides allows for medial and lateral approaches avoiding

boarding(10) .

2. Independent lateral approach: The lateral column can be approached from different deep planes regardless of the lateral skin incision or

later. During the we must dissection keep the forearm

pronated to reduce the risk of damage to the posterior interosseous nerve. They are used when treating the fracture of

coronoid process next to the radial head fracture (10). Highlights:

- Kocher's posterolateral approach: between the extensor carpiulnaris and the anconeus. It provides good access to the joint capsule but there is a risk of damage to the LCL.

- Kaplan's lateral approach: between the extensor muscle interval

digitorum communis and the extensor carpiradialis brevis. You have a lower risk of damaging the LCL, but if it is already injured, this approach does not allow good visualization of the LCL for repair or reconstruction. On the contrary, since it is a more anterior approach, it has a greater risk of damaging the posterior interosseous nerve.

3. Independent medial pathway. Medial approaches: Allow good access to the

coronoids and medial structures.
Used when it comes to

osteosynthesize fractures of

larger coronoids with plates.
The posteromedial approach through the flexor carpiulnaris stands out, which

B) SURGICAL PLANNING IN FUNCTION OF THE PATTERNS

will require ulnar nerve transposition or the Hotchkiss approach dividing the flexor and pronator tendons
round. Care must be taken not

damage branches of the cutaneous nerve

medial forearm during dissection distal to the incision

middle(9) .

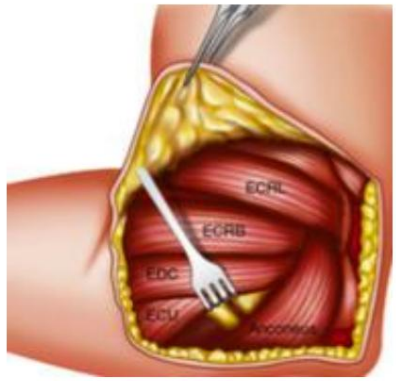


Figure 8. Kocher posterolateral approach

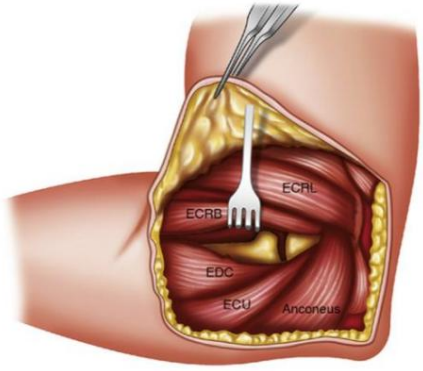


Figure 9. Lateral Kaplan approach

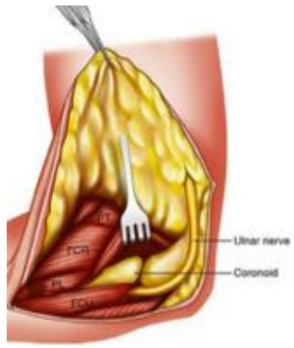


Figure 10. Medial approach

FRACTURE- DISLOCATION

The surgical procedure depends on the specific fracture pattern and associated injuries at the elbow level. So,
We highlight 3 main patterns that can be used when planning and repairing the injury.

The order of repair generally used follows the algorithm from medial to lateral and deep to superficial: coronoid processÿ radial head ÿolecranonÿ LCL ÿ MCL ÿ fixator

external.

1. Elbow fractures dislocations due to rotational instability mechanism

   posterolateral valgus (elbow terrible triad):

In this pattern of fracture dislocation we must pay attention to the three mentioned structures

already previously; the apex of the coronoid, the head of the radius, and the lateral ligamentous complex.

Repair is usually performed following the sequence: coronoid, radial head, and lateral collateral ligament. If instability persists after repairing the aforementioned structures, it will be necessary to add an external fixator or revise the medial ligamentous complex. The action plan is schematized in figure 12.

This fracture pattern is usually associated with type I fractures (of the coronoid tip). Restoring joint stability by reanchoring the joint capsule as a buttress is more important

than anatomic reduction in these small fractures. They are usually too small fragments to osteosynthesize, which generally uses suture and anchoring techniques. recommends using one or two sutures garrigues et to the.

strong passes through brocaded tunnels in the ulna. The sutures

can pass through the coronoid fragment or more frequently the

joint capsule over coronoid proximally [eleven].

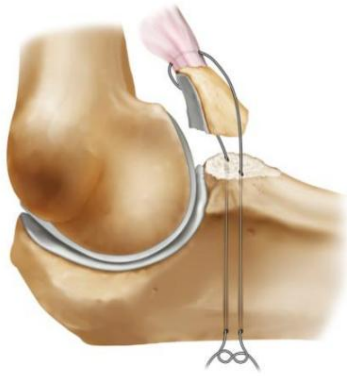


Figure 11. Illustration of capsule and coronoid reanchoration by means of sutures. Adapted from Garrigues GE, Wray WH, Lindenhovius AL, et al. Fixation of the coronoid process in elbow fracture-dislocations. J Bone Joint Surg Am 2011; 93(20):1873–81.

Other authors recently defend

that the fixation of small fragments of the tip of the coronoid (less than 10-30%) and reanchoring the anterior joint capsule do not provide great benefits when the elbow is stable after the repair of the radial head and the lateral ligamentous complex

[12].

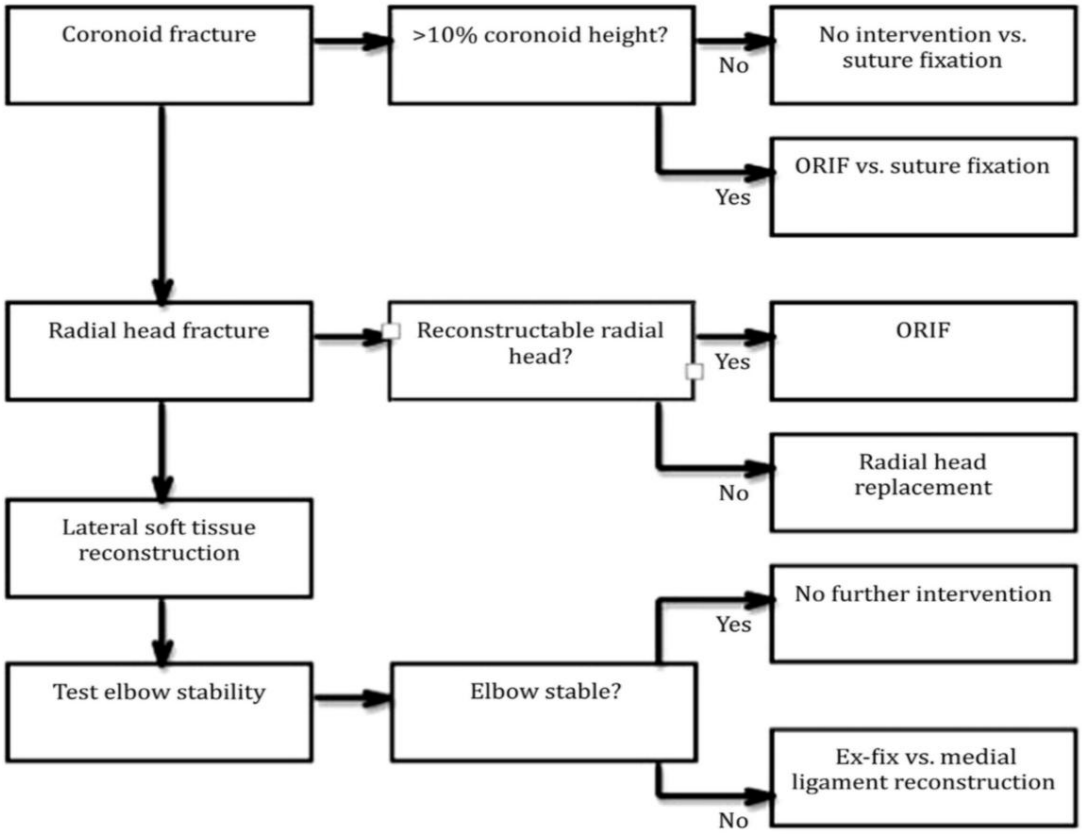


Figure 12: treatment scheme for fractures-dislocations due to valgus instability

2. Elbow fractures dislocations due to instability mechanism of

varus posteromedial rotator:

In this case, you should check the facet lesion association anteromedial coronoid (type II fractures), the lateral collateral ligament and the medial collateral ligament. As in the previous case, it usually starts repair with coronoid osteosynthesis(13) .

A posterior incision is used with medial and lateral approaches. Once the coronoid is exposed, it is provisionally reduced with Kirschner wires.

For definitive osteosynthesis, recommends using pre-contoured screws or plates to fix the fragments with the help of sutures, anchors, wires or screws (13)

.

Figure 13. Anteroposterior X-ray of the elbow showing a coronid plate.
Adapted from Steinmann S. Coronoid Process Fracture. J Am AcadOrthopSurg 2008;16:519-529.

Next, the lateral collateral ligament, the main structure against varus forces, should be checked.

Of elbow. After its repair, if the instability of the joint persists, we would review the medial collateral ligament, which depending on the case could be affected at a distal level, due to injury to the sublime tubercle of the ulna.

or proximally at its origin in the humerus. In this lesion pattern, the head of the radius is not usually affected (13) .

The scheme of action is summarized in figure 14(13):

3. Type III fractures of the base of the coronoids

These are injuries that are usually associated with olecranon fractures, which is why they are developed in the next section of the topic.

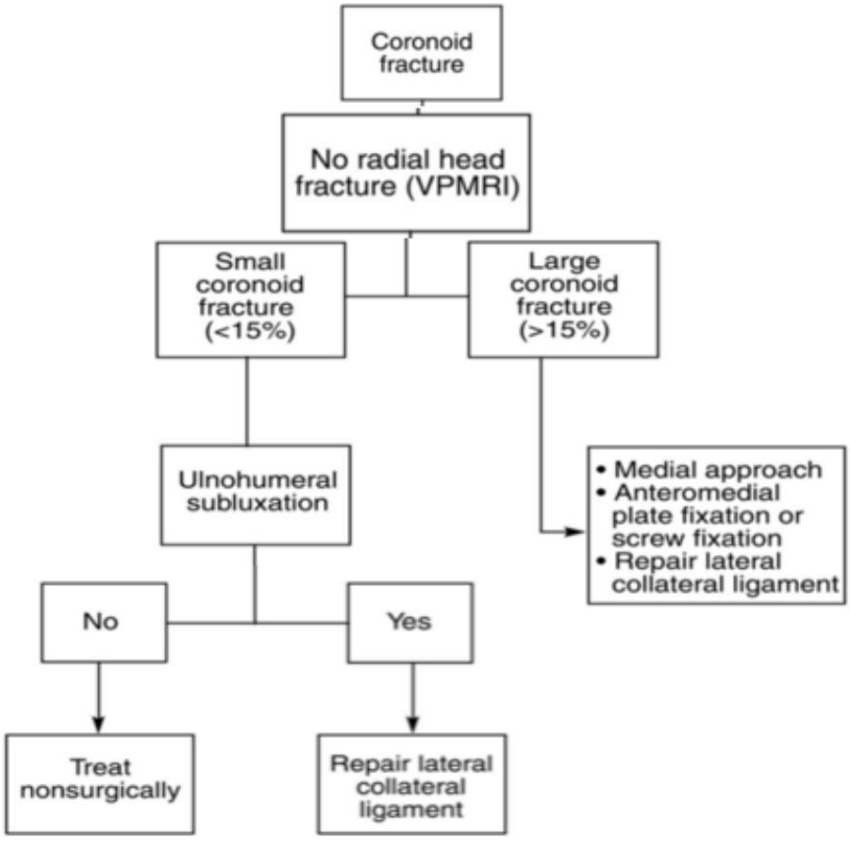


Figure 14: Diagram of action in the event of posteromedial rotational instability in varus.

dislocations ELBOW ASSOCIATED WITH FRACTURES OF olecranon

Olecranon fractures can occur after direct trauma, by an avulsion mechanism after traction of the triceps tendon, or

after a dislocated elbow fracture transolecranon(1) . In the latter we we will focus below.

CLASSIFICATION

The Mayo classification will give us the therapeutic algorithm for these olecranon fractures. Fractures of olecranon associated with dislocations of Elbow fractures are generally large, unstable and displaced, which is why they are classified as type 3 and will require open reduction and fixation with plates and screws (14).

.

On the other hand, transolecranian elbow fractures can be divided into anterior and posterior fractures based on the displacement of the ulna and radius on the distal humerus.

FRACTURES DISLOCATIONS OF ELBOW TRANSOLECRANIAN PREVIOUS

fractures dislocations of elbow anterior transolecranon tendons be produced by high energy mechanisms and in many cases they are open fractures affecting the joint humeroulnar. Without However, it usually spares the proximal radioulnar joint and the collateral ligamentous complexes. The Radio Head Injury Association

it is also rare. On the contrary, the coronoid process is usually affected, in the case of large fragment fractures of the base (Type III O'Driscoll) that allow stable reconstruction of the humerulnar hinge and therefore a restoration of a joint stability.

(10)

As a consequence of this injury, it is logical to think that the flexoextension of the elbow is affected, but not the pronosupination of the forearm.

It is important to note that on many occasions this injury will be classified wrongly shaped like a fracture Monteggia dislocation. This is incorrect, as a dislocation of the radioulnar joint does not occur.

proximal (fifteen).

For osteosynthesis of these fractures the posterior approach can be used, through the olecranon fracture osteosynthesizes the coronoid fracture with screws and later the olecranon fracture is fixed with a plate. If necessary, it is supplemented with a medial approach to osteosynthesize the coronoid fragments with plates or screws. fracture reduction

of olecranon can be hindered by its comminution. In these cases it is often helpful.

be guided by the external cortex instead of of cartilage, and the articular surface since it must be remembered that there is a bare area

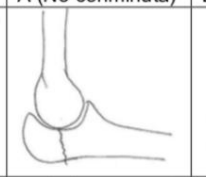
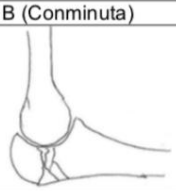
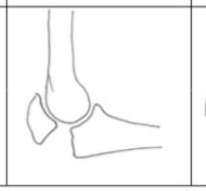
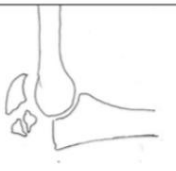
Tipo	Subtipo A (No conminuta)	Subtipo B (Conminuta)	Tratamiento indicado
Tipo 1: No desplazada (< 2mm), extensión activa OK			Inmovilización con cabestrillo y permitir movilización progresiva (evitar carga resistida 6 – 8 semanas); seguimiento radiológico semanal
Tipo 2: Desplazada > 3mm, Estable. No extensión activa			Tipo 2A – Reducción abierta y osteosíntesis con agujas (1,6 mm) y cerclaje o con placa y tornillos (sobre todo si fractura distal a la ap. Coronoides) Tipo 2B – • Paciente joven (< 60 años), activo: Reducción abierta y osteosíntesis con placa y tornillos • Paciente mayor: Plantear escisión de los fragmentos proximales y avance del tendón del tríceps
Tipo 3: Desplazada > 3mm, Inestable			Tipo 3A – Reducción abierta y osteosíntesis con placa y tornillos Tipo 3B – Reducción abierta y osteosíntesis con placa y tornillos vs escisión de los fragmentos proximales (riesgo de inestabilidad residual)

Figure 15. Mayo classification for olecranon fractures

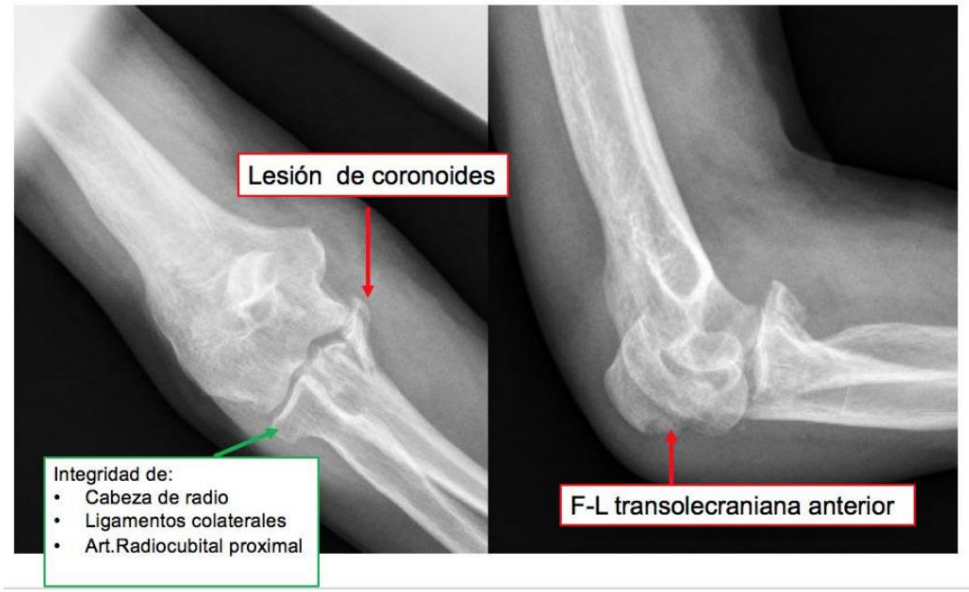


Figure 16. Anteroposterior and lateral X-ray of the elbow showing the lesions associated with anterior transolecranon elbow fractures and dislocations

this avoids generating a too narrow major sigmoid cavity as shown in figure 18 (16)

.

to)

b)

Figure 17. TO) and Control B) intraoperative fluoroscopic after osteosynthesis of a dislocated elbow fracture anterior transolecranon.

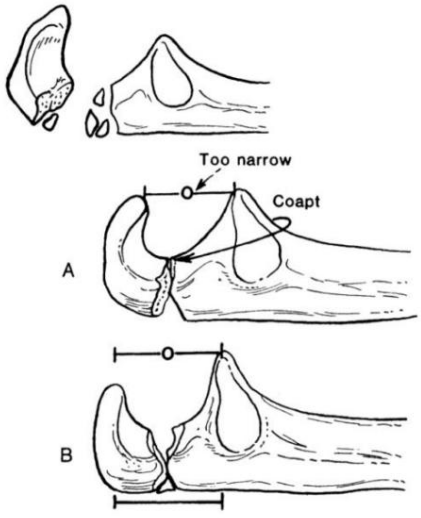


Figure 18. Representative image of the reduction of the greater sigmoid notch.

FRACTURES DISLOCATIONS OF ELBOW TRANSOLECRANIAN LATER

Posterior dislocation fractures of the olecranon are considered a type of Monteggia dislocation fracture, unlike the anterior ones. In these elbow injuries the

radial head dislocates posteriorly and is frequently fractured

together with a disruption of the proximal joint, coronoid process and lateral collateral ligament radioulnar (10)

.

By definition, this type of Monteggia dislocation fracture is classified according to Bado in type II (posterior Monteggia) and according to Jupiter in IIA and IID (coronoid involvement).

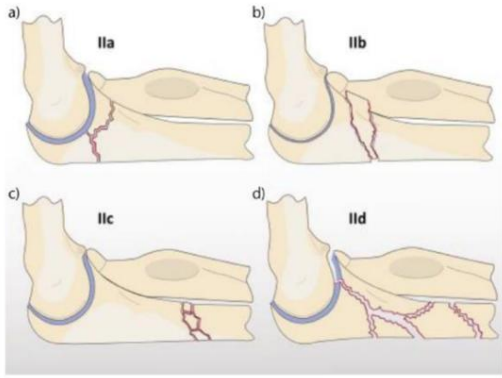


Figure 19. Representative image of Jupiter's classification

Restoring ulna length and alignment will facilitate reduction of the radioulnar joint.

proximal. When the coronoid process is affected, its repair will be essential to return the

for

stability to the joint

humeroulnar. is generally used

a posterior approach to the elbow that can be complemented with medial and lateral approaches (10) .

The order of repair is variable, but usually begins with osteosynthesis of the

radial head, followed by the coronoid process, ulnar metaphysis, and olecranon using plates and screws.

In the event that after completing the osteosynthesis we do not obtain a stable elbow, the first thing we should review is our osteosynthesis, since it is most likely that it has not been correct.
If it were, we should go on to check the lateral collateral ligament (10) .

COMPLICATIONS

Despite correct treatment of these dislocation fractures and rehabilitation protocols with early mobility, patients are susceptible to developing complications during their follow-up.

The following (9) stand out:

- Joint stiffness: The loss of mobility of the affected elbow is the

most frequent complication. In many cases, the mobility deficit does not imply a limitation for the activities of daily living of the patients. It can be due to multiple causes such as postoperative fibrosis, heterotopic ossifications, joint incongruity...

- Heterotopic ossification: Observed in up to 40% of cases. Could be

asymptomatic or cause stiffness and pain. It occurs more frequently in “terrible triad” injuries and transolecranial fracture-dislocations.

Indomethacin can be used as prophylaxis.

- Recurrent instability: One of the

causes of postoperative pain and joint subluxations. It usually requires surgical reinterventions.

- Ulnar neuropathy: Between 10% and 20%. It can be caused by the initial trauma, iatrogenic during surgery, as a sequel to inflammation and fibrosis or pseudoarthrosis after surgery. For this reason, its exploration and registration in the patient's clinical history in the initial exploration is very important.

- Post-traumatic osteoarthritis (10-80%): Frequent sequel that in most cases does not affect the patient's quality of life.

CONCLUSIONS

- They represent a challenge due to the variability of associated injuries, surgical technique and sequelae.

- We must recognize the fracture pattern for good surgical planning and repair all damaged elements.

- Complications are frequent and are related to the severity of the injury and incorrect treatments.

BIBLIOGRAPHY

1. Cristina Ojeda Thies, Alberto Delgado Martínez, David Cecilia López. Theme 42. Elbow dislocations. fractures head of radius and olecranon. In: Training program in Orthopedic Surgery and Traumatology. 5 edition.

2. Siebenlist S, Buchholz A, Braun KF. Fractures of the proximal ulna: current concepts in surgical management. EFORT Open Rev. 2019 Jan;4(1):1-9.

3. Michael Schünke, Erik Schulte, Udo Schumacher. Member superior. Bones, ligaments and joints. Elbow joint. In: Prometheus Text and Atlas of Anatomy. 2 edition. Pan American;

4. Wells J, Ablove RH. Coronoid Fractures of the Elbow. Clin Med Res. 2008 May 1;6(1):40-4.

5. Lowery M, Massey P. Coronoid Fractures. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 [cited February 5, 2020]. Available at: http://www.ncbi.nlm.nih.gov/books/NBK544236/

6. Sanchez-Sotelo J, Morrey M. Complex elbow instability: surgical management of elbow fracture dislocations. EFORT Open Rev. 2016 May;1(5):183-90.

7. Doornberg JN. Fracture of the Anteromedial Facet of the Coronoid Process. J Bone Jt Surg Am. 2006 Oct 1;88(10):2216.

8. Foruria AM, Gutierrez B, Cobos J, Haeni DL, Valencia M, Calvo E. Most coronoid fractures and fracture-dislocations with no radial head involvement can be treated nonsurgically with elbow immobilization. J Shoulder Elbow Surg. 2019 Jul;28(7):1395-405.

9. Jennings JD, Hahn A, Rehman S, Haydel C. Management of Adult Elbow Fracture Dislocations. Orthop Clin North Am. 2016 Jan;47(1):97-113.

10. Wong JC, Getz CL, Abboud JA. Adult Monteggia and Olecranon Fracture Dislocations of the Elbow. hands clin. 2015 Nov;31(4):565-80.

11. Garrigues GE, Wray WH, Lindenhovius ALC, Ring DC, Ruch DS. Fixation of the Coronoid Process in Elbow Fracture-Dislocations: J Bone Jt Surg. 2011 Oct;93(20):1873-81.

12. Antoni M, Eichler D, Kempf JF, Clavert P. Anterior capsule reattachment in terrible triad elbow injury with coronoid tip fracture. Orthop Traumatol Surg Res. December

2019;105(8):1575-83.

13. Steinmann SP. Coronoid Process Fracture. J Am Acad Orthop Surg. 2008;16(9):11.

14. Sullivan CW, Hayat Z. Olecranon Fracture. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 [cited February 5, 2020]. Available at: http://www.ncbi.nlm.nih.gov/books/NBK537295/

15. Mouhsine E, Akiki A, Castagna A, Cikes A, Wettstein M, Borens O, et al. transolecranon anterior fracture dislocation. J Shoulder Elbow Surg. 2007 May;16(3):352-7.

16. McKay PL, Katarincic JA. Fractures of the proximal ulna olecranon and coronoid fractures. Hand Clin. February of 2002;18(1):43-53.