

Orthopaedia Belgica 2019 Congress

Treatment of terrible triad injuries

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25/04/2019

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Elbow stabilizers
 Role of bony structures

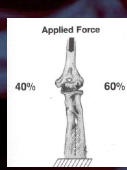


- Great congruence of the elbow joint
 - 85% of valgus constraints are restrained by the olecranon proximal half
 - 67% of varus constraints are restrained by the coronoid process
 - In extension, the olecranon tip is encased in the olecranon fossa
- Role of the coronoid in the A-P stability
- Role of the radial head

Morrey BF, Chao LY. The effect of partial removal of proximal ulna on elbow constraints. Clin Orthop Relat Res. 1991;270:5

Elbow stabilizers
 Role of the radial head

- In full extension, 60%* of the axial constraints from the forearm to the arm crosses the radio-capitellar joint
- Secondary valgus stabilizer of the elbow



Morrey BF, An KN, Stormont TL. Force transmission through the radial head. J Bone Joint Surg Am. 1986;68:25016.

Elbow stabilizers
 Role of ligaments

- Medial collateral ligament= Valgus primary stabilizer
- Radial head= Secondary valgus stabilizer

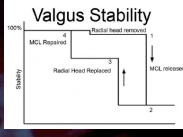
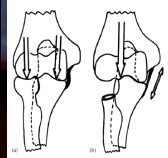



Figure 1 (A) Compression forces transmitted equally to distal humerus, by rigging an object to compress the forearm muscle. (B) The tendency of the forearm to generate valgus after radial head resection is prevented by an intact medial collateral ligament-compression of the lateral epicondyle.

Morrey BF, Tanaka S, An KN. Valgus stability of the elbow. A definition of primary and secondary constraints. Clin Orthop Relat Res. 1991;265:87-95.

Elbow stabilizers
 Role of ligaments

- Valgus stability provided by the medial collateral ligament complex, particularly the anterior oblique ligament/ anterior band

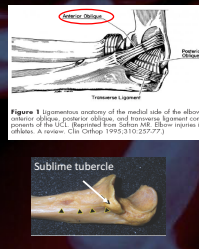


Figure 3 Ligamentous anatomy of the medial side of the elbow: anterior oblique, posterior oblique, and transverse ligament components of the UCL. (Reprinted from Salovey SR. Elbow injuries in athletes. A review. Clin Orthop. 1995;310:237-77.)

Sublime tubercle

Morrey BF, Tanaka S, An KN. Valgus stability of the elbow. A definition of primary and secondary constraints. Clin Orthop Relat Res. 1991;265:87-95.

Elbow stabilizers

Role of ligaments

- Valgus stability provided by the medial collateral ligament complex, particularly the anterior oblique ligament anterior band
- Varus stability provided by the lateral collateral ligament, particularly the ulnar collateral ligament and the capsule

Figure 1 Ligamentous anatomy of the medial side of the elbow. Anterior oblique ligament (AOL) and ulnar collateral ligament (UCL). (Reprinted from Cohen MS, Elbow Instability in Children. A review. Clin Orthop 1995; 311(5):272-77. J Shoulder Elbow Surg January/February 2000)

Figure 2 Anatomy of the lateral collateral ligament complex. (Reprinted from Cohen MS, Elbow Instability in Children. A review. Clin Orthop 1995; 311(5):272-77.)

Morrey BF, Tezuka S. An RN. Valgus stability of the elbow. A definition of primary and secondary constraints. Clin Orth Relat Res. 1991;265:87-93

Elbow stabilizers

Role of ligaments

- The lateral collateral ligament complex of the elbow
 - 1 Anterior Band
 - 1 Posterior Band
 - 1 Superior Band

→ Y shape structure whose the 3D structure is defined by the radial head

- Rotatory stability of the elbow
- Radio-capitellar stability
- Proximal radio-ulnar joint stability
- Role of the radial head againsts varus constraints by tensioning the lateral collateral complex resisting againsts varus constraints

Seki A, Olsen BS, Jensen SL, Egegaard D, Sobjerg JO. Functional anatomy of the lateral collateral ligament complex of the elbow: configuration of y and its role. J Shoulder Elbow Surg. 2002; 11:53-9

Elbow stabilizers

Static

- Primary**
 - Ulna-humeral joint
 - aMCL
 - LCL (LCUL)
- Secondary**
 - Radial head
 - Flexors and extensors origins
 - Joint Capsule

Dynamic

- Triceps
- Brachialis
- Anconeus

- An elbow with its three primary stabilizer intact will remains stable
- Radial head become a critical stabilizer in case of coronoid fracture
- Dynamic stabilizer → compressive force on the joint

The unstable elbow. O'Driscoll SW, Jupiter JB, King GJ, Hochhaus RN, Morrey BF. Instr Course Lect. 2001;50:89-102. Review.

Elbow static stabilizers

Defenses of a fortress

The unstable elbow. O'Driscoll SW, Jupiter JB, King GJ, Hochhaus RN, Morrey BF. Instr Course Lect. 2001;50:89-102. Review.

Elbow dislocation

- 10-25% of all elbow lesions
- Second most frequent dislocation after shoulder
- Incidence: 5/100000 person per year
- 44,5% of elbow dislocation occur during sports practice
- 90% : posterior or postero-lateral
- High energy trauma in young subjects
- Median age: 30 ans
- Predisposal factor : shallow olecranon fossa and prominent olecranon
- Simple or complex

Elbow instability. SP Steinmann, S.W O'Driscoll. Curr Orthop 2002 16:341-348 O'Driscoll SW
Morris MS, Ozer K. Elbow Dislocations in Contact Sports. Hand Clin. 2017 Feb;33(1):63-72.

Elbow dislocation

Trauma mechanism:

- Fall on outstretched hand, elbow in extension, arm in abduction
- Elbow Flexion → Triceps excentric contraction → External torque moment on the ulno-humeral joint
- Shoulder adductors and internal rotators Contraction → Humeral internal rotation
- Valgus
- progressive radial head and coronoid rotation underneath the capitellum → Dislocation

Elbow instability. SP Steinmann, S.W O'Driscoll. Curr Orth. 2002 16:341-348

Pathoanatomy The Horii circle

- Lateral to medial progressive lesions
- Pass through soft tissues and / or bone
- Joint capsule lesion except in cases of associated coronoid fracture

*The unstable elbow. O'Driscoll SW, Jester JB, Ring D, Hollister RN, Morrey BF. Instr Course Lect. 2001;50:89-102. Review.
 *Elbow instability. SP Steinhilber, SW O'Driscoll. Curr Orthop. 2000;16:341-348. O'Driscoll SW.
 *Elbow subluxation and dislocation. A spectrum of instability. Morrey BF, Korinek S, An KN. Clin Orthop. 1992;280:194.

Elbow dislocation Classification

- Stage I: Postero-lateral rotatory Subluxation
Positif Lateral pivot shift test
- Stage II: uncomplete dislocation of the elbow
Trochlea perched on the coronoid process
- Stage III: Complete dislocation
 - A: MCL Anterior band intact
Valgus stability after reduction
 - B: MCL completely torn
varus/valgus/rotatory instability → 35° of flexion needed to prevent subluxation
 - C: Distal humerus stripped of soft tissues
Unstable elbow in the cast

Outcomes of simple dislocations

- Good in 75%
- 1-2% of Recurrence
- Better than results after complexe dislocation (17% of recurrence)
- Decrease of satisfactory rate with the duration of immobilisation
- 15% residual loss of extension of 3° to 30°
- 7% Evolve to chronic PLRI
- Decrease of 15% of strength
- Return to sport when ROM are painless, comfortable and strength is almost symmetrical

Plancher KD, Lucas TS. Fracture dislocations of the elbow in athletes. Clin Sports Med. 2001 Jan;20(1):59-76. Review
 Kovacic J, Bergfeld J. Return to play issues in upper extremity injuries. Clin J Sport Med. 2005 Nov;15(6):448-52.

Complexe elbow dislocation

- Dislocation + fracture
- Radial head > Coronoid process - Olecranon- Lateral - epicondyle

Complexe elbow dislocation Coronoid process fracture

Regan-Morrey Classification:

- Type I: Small bony fragment
- Type II: Less than 50% of the coronoid height
- Type III: More than 50% of the coronoid height

Regan W, Morrey B. Fractures of the coronoid process of the ulna. J Bone Joint Surg Am. 1989 Oct;71(9):1348-54.

Complexe elbow dislocation Coronoid process fracture

O'Driscoll Classification

Fracture type and location	Subtype	Description
Tip	1	≤2 mm of coronoid body height (flake fracture)
	2	≥2 mm of coronoid body height
	3	Anteromedial rim
Anteromedial	1	Anteromedial rim
	2	Anteromedial rim + tip
	3	Anteromedial rim + sublime tubercle (14q)
Basal	1	Coronoid body and base
	2	Transolecranon basal coronoid fractures

O'Driscoll, S.W., Jupiter, J.B., Cohen, M.S., Ring, D., McKee, M.D. Difficult elbow fractures: pearls and pitfalls. Instr Course Lect. 2003;52:113-134

Complex elbow dislocation

Coronoid process fracture

Impair stability by two manners:

1. Loss of the anterior buttress resisting posterior forces in the flexed elbow
2. Loss of distal attachment of the anterior band of MCL

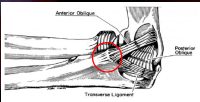
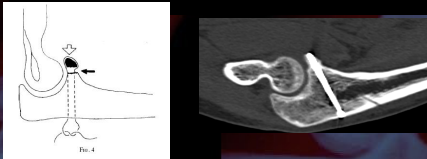


Figure 1 Ligamentous anatomy of the medial side of the elbow: anterior oblique, posterior oblique, and transverse ligament complex, portion of the LCL. (Reprinted from Nelson MP. Elbow injuries in athletes. A review. Clin Orthop. 1992;10:237-273.)

Complex elbow dislocation

Coronoid process fracture

- Intrinsic stability regain by restoring anatomical dimensions of greater sigmoid notch
- Primary static stabilizer of the elbow. Coronoid fracture → Radial head become a critical stabilizer



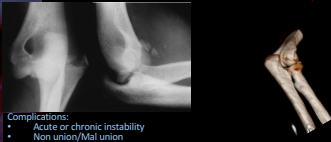
Complex elbow dislocation

Radial head fracture

- May be associated with MCL, LCL and/or IOM lesions
- In case of non reconstructable fracture, radial head excision is contraindicated in case of additional MCL and/or IOM lesion → Arthroplasty should be performed
- Partial excision if:
 - Non articulating fragment
 - <30% of the radial head

Terrible Triade (Hotchkiss)

1. Elbow dislocation (LCL and/or MCL lesion)
2. Radial head fracture
3. Coronoid process fracture




Complications:

- Acute or chronic instability
- Non union/Mal union
- Proximal radio-ulnar synostosis
- Stiffness
- Pain
- Late arthrosis

Armstrong AD. The terrible triad injury of the elbow. *Curr Opin Orthop.* 2005 16:267-270.

Terrible Triad

Principle of treatment



Transforming a complex dislocation in a simple dislocation
→ Prognostic Improvement

Terrible Triad

Principles of treatment

- Repair the damaged structures sequentially from deep to superficial
- From lateral approach: Coronoid then anterior capsule then radial head and lateral ligament complex
- Work through any soft tissue disruption in order to preserve intact tissue as much as possible
- Restore sufficient stability so that early motions can be allowed

McKee MD, Pugh DM, Wild LM, Schemitsch EH, King GJ. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. *Surgical technique. J Bone Joint Surg Am.* 2005 Mar;87 Suppl 1(Pt 1):22-32.

Approach

- Posterior
- Extended Lateral and/or Medial

Sequences of the repair

1. Restore coronoid stability (R-M type II and III) or anterior capsular repair (R-M type I)
2. Restore radial head stability (ORIF or Replacement)
3. Restore lateral stability: lateral ligament complex and/or common extensor tendon origin and or postero-lateral capsule
4. Repair medial collateral ligament (if residual posterior instability)
5. Hinged external fixator if still unstable

Pugh DM, Wild LM, Schemitsch EH, King GJ, McKee MD. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. J Bone Joint Surg Am. 2004 Jun;86-A(6):1122-30.

Coronoid fracture repair

Regan-Morrey
type I

- Pull through suture technique
- Anchors

Type II
Screw

McKee MD, Pugh DM, Wild LM, Schemitsch EH, King GJ. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fracture. Part V. Use of suture anchors for coronoid fractures in the terrible triad of the elbow. J Orthop Surg (Hong Kong). 2009 Apr;17(1):31-5. Surgical technique. J Bone Joint Surg Am. 2005 Mar;87 Suppl 1(Pt 1):22-32.

Radial head repair or replacement and LCL complex repair

McKee MD, Pugh DM, Wild LM, Schemitsch EH, King GJ. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. Surgical technique. J Bone Joint Surg Am. 2005 Mar;87 Suppl 1(Pt 1):22-32.

Progressive stabilization to obtain concentric stability

Treatment algorithm

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    graph TD
      A[Posterior view reduction] --> B[Deep lateral approach]
      B --> C{Radial head fracture healing}
      C -- No --> D{Radial neck comminution?}
      C -- Yes --> E{Coronoid fracture heals from lateral approach?}
      D -- No --> E
      D -- Yes --> F[Fit coronoid from deep medial approach]
      E -- No --> F
      E -- Yes --> G{Elbow stable}
      F --> H{Fit or replace radial head}
      H --> I{Fit or replace radial head}
      I --> J{Repair medial collateral ligament}
      J --> K{Elbow stable}
      J --> L{Elbow unstable}
      L --> M[Apply external fixator]
      K --> N[Done]
      M --> N
  
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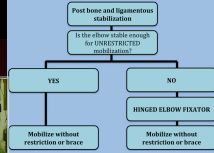
Mathew PK, Athwal GS, King GJ. Terrible triad injury of the elbow: current concepts. J Am Acad Orthop Surg. 2009 Mar;17(3):137-51.

Hinged Exfix

- Indications :

- Remaining instability after ORIF and/or radial head prosthesis and soft tissues repair
- Acute instability in non operable patient
- Protection of a poor bone fixation during rehabilitation

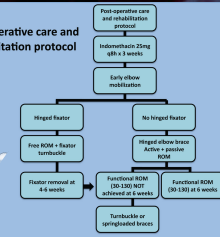
Hinged fixator protocol



Zaiders GJ, Patel MK. Management of unstable elbows following complex fracture-dislocations—the "terrible triad" injury. J Bone Joint Surg Am. 2008 Nov;90 Suppl 4:75-84.

Postoperative rehabilitation

Post-operative care and rehabilitation protocol



Zaiders GJ, Patel MK. Management of unstable elbows following complex fracture-dislocations—the "terrible triad" injury. J Bone Joint Surg Am. 2008 Nov;90 Suppl 4:75-84.

Conclusion

- When a fracture is associated with an elbow dislocation management is almost always surgical
- Terrible triad is the worst presentation of elbow dislocation
- Acute or chronic instability, stiffness, late arthrosis and pain are the main complications if proper treatment is not performed
- Standardized surgical protocol is mandatory to obtain a stable elbow that allows early active mobilization

Thank you for your attention

