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My Approach to the Terrible Triad Injury

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The combination of an elbow dislocation with fractures of the radial head and coronoid process has been labeled the terrible triad of the elbow. We prefer to repair the coronoid, repair or replaced the radial head, and reattach the origin of the lateral collateral ligament to the lateral epicondyle. Repair of the medial collateral ligament is not usually necessary.
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The combination of an elbow dislocation, a coronoid fracture, and a fracture of the radial head has been termed as the “terrible triad” of the elbow.^{1,2} This injury is associated with recurrent dislocation, subluxation, arthrosis, and heterotopic ossification, and optimal management requires a good understanding of the anatomy and careful preoperative planning.

Anatomy and Indications

Although each component of the injury can affect elbow function and stability, in combination they appear to create severe posterolateral rotatory instability. In a cadaveric model, Schneeberger et al³ found progressively increasing instability with consecutive resection of the lateral collateral ligaments (LCL), the radial head, and 30% of the height of the coronoid.⁴

The LCL is usually avulsed from the lateral epicondyle, often with a substantial portion of the common extensor muscle origin, leaving the epicondyle bare.^{5,6} Upon raising a skin flap, this extent of damage is typically not apparent (Fig. 1). The fascia can be intact or may have a small rent in the extensor origin. After developing this interval and incising the muscle fascia, the extensive avulsion becomes more apparent (Fig. 2).

The coronoid fracture is typically simple, transverse (type 1, as described by O’Driscoll et al), and small (<30% of the coronoid height) (Fig. 3).^{5,7} There is some debate about whether this fragment should be classified as Regan and

Morrey type 1 (a tip fragment) or type 2 (more than a tip, but <50% of the total height of the process). It is known that these fragments always have the anterior capsular insertion and that this insertion is 4-5 mm distal to the tip of the olecranon (Fig. 4).^{1,8} Using three-dimensional computed tomography images Doornberg and coworkers found that the average height of the coronoid fracture fragment in a terrible triad injury was 39% of the total height, ranging from 19% to 59%, numbers that do not include the cartilage tip of the fragment.^{2,7} In other words, these fragments, although small, are larger than what one might think. It is not clear whether the coronoid fracture contributes to instability via loss of bony buttress (biomechanical studies would suggest not),^{9,10} loss of anterior capsule, or both, or whether the coronoid fracture is a marker for a more severe soft-tissue injury than typical of other fracture dislocations.

Examination and Imaging

Acute neurological and vascular injuries are possible, particularly when it is part of a high-energy trauma, including other ipsilateral injuries of the limb,^{6,9} but are relatively uncommon. In contrast, about 20% of patients will develop ulnar neuropathy within the first 2 years; hence, a baseline neurological examination is important.^{8,10}

A computed tomography scan, particularly a 3D reconstruction, if available, is helpful in planning the exposure and management of specific injury components. The unfractured bones can be removed to improve fracture visualization (Fig. 3).

Surgical Strategy and Planning

The goal is to stabilize the elbow and limit injury- and treatment-related complications.¹¹ The overall strategy is to work

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Figure 1 After elevating a lateral skin flap, the extent of muscle and ligament avulsion from the lateral epicondyle may not be apparent initially.

primarily on the lateral side of the elbow to expose the injury component by component in a sequential fashion from the “outside” to the “inside”—LCL/common extensors, then radial head fracture, then coronoid fracture—and then to stabilize these components sequentially in the reverse order from “inside” to the “outside”—stabilize the elbow anteriorly by repairing coronoid fracture and the anterior capsule, then repairing or replacing the radial head, and finally reattaching the origin of the LCL and common extensor musculature to the lateral epicondyle.

On occasion, these 3 repairs are inadequate to stabilize the elbow. If the elbow dislocates in full gravity extension, with the forearm in neutral after repairing the coronoid, radial head, and LCL, repair of the medial collateral ligament or additional support of the elbow with either a hinged or static external fixator or cross pinning of the

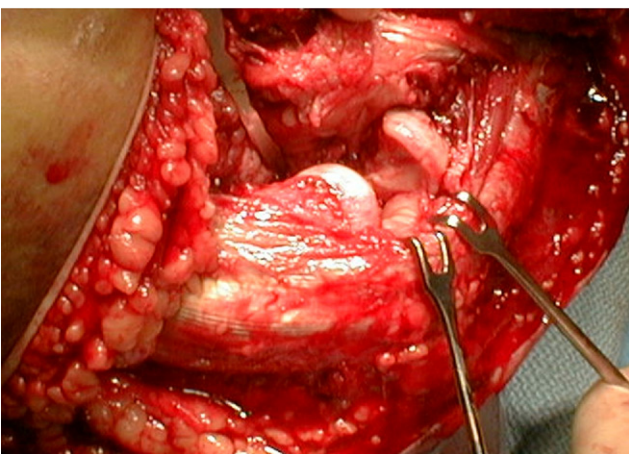


Figure 2 Once the fascia has been opened over the supracondylar ridge and an interval developed in the common extensors—splitting them into half anterior and posterior with respect to the midpoint of the capitellum—it is noted that the lateral epicondyle is bare, the origin of the lateral collateral ligament and common extensor musculature having been avulsed.



Figure 3 Three-dimensional reconstructions of computed tomography images with the distal humerus removed are very useful for characterizing fractures. In the terrible triad injury, the coronoid fracture is always transverse and includes the insertion of the anterior capsule. The radial head fracture is often comminuted with small, lost, or irreparable fragments.

elbow joint can be considered. A cast cannot be relied on to maintain reduction. Slight subluxation or sagging of the joint in the early postoperative period is analogous to pseudosubluxation of the shoulder and can usually be

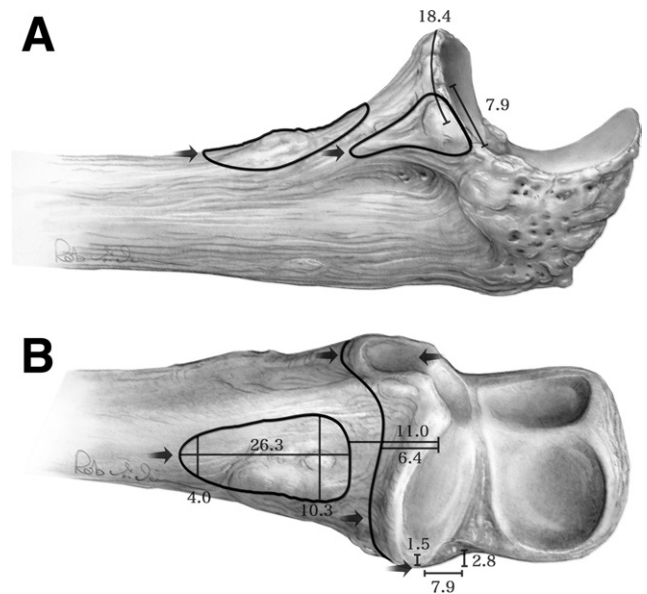


Figure 4 Cage et al measured the ligament and muscle insertions on the coronoid process, documenting that the anterior capsule inserts somewhat distal and inferior to the tip of the coronoid. (A) The distal mark represents the brachioradialis insertion. The proximal, medial mark represents the insertion of the anterior band of the medial collateral ligament on the sublime tubercle of the coronoid process. (B) The proximal line represents the capsular insertion on the coronoid, which is 6.4 mm distal to the tip of the coronoid on average.

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