Injury, Int. J. Care Injured 47 (2016) 2053–2059

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Review

Complex coronoid and proximal ulna fractures are we getting better at fixing these?

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ARTICLE INFO

Keywords:
Ulna fracture
Coronoid fracture
Elbow fracture

ABSTRACT

Technological advances and improved understanding of functional anatomy about the elbow have lead an evolution regarding operative reconstruction of complex proximal ulnar and coronoid fractures. When treating these complex and challenging fractures, goals of anatomic articular restoration along with balanced soft tissue stability can lead to early range of motion and thus, desired functional outcome. The purpose of this review is to outline and provide tips and pearls to achieve desired results, with a comprehensive update on the most recent literature to support the latest fixation methods and techniques.

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Introduction

More than a simple hinge joint, the elbow represents a complex marriage between its bony foundation and surrounding soft tissue to provide an essential component to everyday, upper extremity functional anatomy. Underestimating the importance of elbow mobility and the relationship between the soft tissue and bony anatomy in the face of complex reconstruction can lead to severe functional limitations and have a devastating impact on activities of daily living.

Recent advances in technology and studies have significantly improved our understanding of the elbow's complex anatomy [1–5]. Specifically regarding the coronoid and proximal ulna, important findings regarding the dynamic anatomic state has hoped to further improve our understanding and changed our goals in the face of complex reconstruction, notably when compared to simpler elbow fracture patterns found in isolation [2,4–12]. Especially in regards to complex coronoid and proximal ulna fractures and/or dislocations, functional anatomic reconstruction should result in improved outcomes. The purpose of this

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http://dx.doi.org/10.1016/j.injury.2016.07.060
0020-1383/

review is to provide an update on the current state of clinical outcomes following complex coronoid and proximal ulna fractures and pearls and pitfall to avoid during operative intervention.

Focusing on proximal ulnar and coronoid anatomy

Achieving restoration of the articular surface with balanced reconstruction of the injured bony and soft tissue elements requires intimate knowledge of essential anatomy. The elbow is more than a simple hinge joint. The osseous foundation consists of three joints: the proximal radioulnar, the radiocapitellar, and the ulnohumeral (trochlear) joints. Elbow stability is obtained via a complex relationship between the aforementioned bony elements with its surrounding soft tissue.

While the radiocapitellar joint acts as a secondary stabilizer to valgus load and posterolateral rotatory motion, the ulnohumeral joint remains the primary stabilizer of the elbow [6–8,12]. More specifically, the proximal ulna and the coronoid process act as the osseous foundation, anchoring soft tissue attachments to offer essential stability in all functional planes. In the past, excision of the olecranon for severely comminuted fractures was accepted clinical practice [6]. However, Morrey's group exhibited the importance of the olecranon in maintaining elbow stability and function; a similar more recent biomechanical study performed by Bell et al. conferred progressive loss of elbow stability with olecranon excision not only in the axial plane but also in regards to varus-valgus angulation and rotation [6,7].

The coronoid process acts as an important buttress as it physically prevents the ulna from translating posteriorly on the humerus. Inherently, it acts as a counter to the pull of the triceps, the biceps, the brachialis, and the brachioradialis, which pulls the humerus anteriorly on the ulna. Arguably more important is the coronoid's role as an anchor to both the lateral ulnar collateral ligament (LUCL) and to the anterior band of the medial ulnar collateral ligament (MUCL), two essential components of balanced elbow stability [3,8,13]. As the keystone to elbow stability, any injury to the coronoid, small or large, can almost be assumed to induce inherent instability to varying degrees. Thus, accurate injury pattern recognition via physical exam and proper imaging to allow for proper classification is of paramount importance prior to operative reconstruction.

Preoperative work-up and planning: imaging and classifications

Circumstances of urgency set aside (neurovascular compromise, open injury, etc.), physical examination in the immediate acute period following injury often is less than fruitful. Aside from extremity swelling and ecchymosis, very few reliable clinical exam findings, such as range of motion and stability, are often elicited in the emergency room. Even with higher energy injuries, where gross instability, deformity, and obvious loss of the extensor mechanism can be readily determined, no physical exam can rival the one performed in the operating room under anesthesia. While the patient is adequately sedated, a true test of ligamentous stability can be determined and can alter surgical planning. Furthermore, it is important to examine the contralateral extremity for any baseline deficits in range of motion or other deformities that may alter one's operative plan. Regardless, a thorough clinical exam, including a comprehensive secondary exam, can give important clues to the fracture pattern that lies underneath.

Imaging

Standard radiographic examination of the elbow should include a minimum of three views: an anteroposterior (AP), an oblique, and a lateral. Additionally, contralateral x-rays may prove especially valuable in the setting of distorted anatomy secondary to injury and should be obtained to aid in surgical planning. Radiographs performed in the coronal plane are important for assessment of the proximal ulna and preoperative planning. Anatomic morphometric studies noted a natural varus angulation of approximately 14° in regards to the olecranon in relation to the ulnar shaft [14]. Noting any anatomic variants diverging from normal varus angulation can be of paramount importance when planning to use plating constructs. Oblique radiographs, may not be as helpful in assessing for bony injury to the proximal radius and ulna, but can reveal subtle fracture lines that can occur with concomitant injury to the distal humerus, especially in osteoporotic bone. With decreases in bone mineral density and change in microarchitecture, injury forces are abnormally transmitted and the path of least resistance may lead to distal humeral injury. Additionally, the radiographic technique of taking the oblique x-ray often involves an unintended valgus stress; if grossly unstable, asymmetry in the joint line can be observed.

It is important to note that a perfect lateral radiograph is essential in performing a proper assessment of injury. A perfect lateral X-ray can allow for assessment of signs of instability that can be missed on a poorly performed radiograph. Subtle subluxation of the radial head can be found on the lateral X-ray in relationship to the capitellum [15]. Occult avulsion of the coronoid can be evidenced by drawing a line from the tip of the olecranon to the tip of the intact anterior articular surface. Measuring the angle formed between this line and a horizontal line drawn the ulnar shaft can offer a method to assessment involvement of the coronoid fracture. An intact coronoid will yield 30° and the angle flattens with increased involvement (Fig. 1) [16–18]. Furthermore, preoperative assessment of proximal ulnar dorsal angulation is important to maximize elbow range of motion

Fig. 1. Complex proximal ulnar and olecranon fractures typically occur from mechanisms outside from your standard fall.