

Intra-articular Monteggia Fracture: A Case Study of Using the Center of Rotational Angulation to Improve a Functional Outcome

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Learning Point of the Article:

For a chronic Monteggia fracture-dislocation, use the center of rotational angulation to determine the location of the ulnar osteotomy whether or not the fracture is intra-articular.

Abstract

Introduction: Elbow fractures are the most common pediatric fracture to require operative fixation and can be associated with significant morbidities such as vascular injury, neurologic injury, and loss of function. Specifically, the chronic Monteggia fracture-dislocation causes devastating losses in range of motion. Presenting as a proximal to midshaft ulna fracture and radiocapitellar joint disruption, the acute injury can be successfully managed with closed reduction, serial casting, and close follow-up. The chronic complications of this injury, however, usually occur from an unrecognized radial head dislocation. Here, we present the first known case of a chronic Monteggia fracture-dislocation in the setting of an intra-articular ulnar fracture. Using the center of rotational angulation (CORA) from injury mechanism and radiographs, an intra-articular osteotomy was performed to correct ulnar length and improve this child's range of motion.

Case Report: A 3-year-old Hispanic male was first seen in the emergency department for elbow pain following a fall from a sofa. He was incorrectly diagnosed with an isolated intra-articular ulna fracture. 5 weeks after the initially missed Monteggia fracture-dislocation, he presented to clinic with 90° flexion, 40° extension, and a 20° pronation/supination arc. An opening-wedge osteotomy was performed at the intra-articular CORA to restore ulnar length and allow for reduction of the radial head. The magnitude of the ulnar opening-wedge osteotomy was trialed until the radiocapitellar joint maintained reduction throughout pronosupination.

Conclusion: 7 months after the surgery, the patient displayed functional improvements with 115° flexion, 15° extension, and a 75° pronation/supination arc. On physical examination, he had no neuropathic symptoms, with intact median, radial, and ulnar nerves. Using the CORA from the perceived injury mechanism and radiographs, an intra-articular osteotomy was performed to correct ulnar length, reduce the radial head, and thereby improve this child's range of motion.

Keywords: Monteggia fracture, pediatrics, center of rotational angulation.

Introduction

Although awareness of the Monteggia fracture-dislocation presentation has increased among pediatric orthopedists [1, 2], this upper extremity injury still poses a diagnostic and subsequent therapeutic challenge to modern orthopedic surgeons. In 1943, Sir Watson-Jones stated "...no fracture presents so many problems; no injury is beset with greater difficulty; no treatment characterized by more general failure." [3] The Monteggia fracture-dislocation pattern is

classically described as a proximal third ulnar fracture and radial head dislocation. Normally, the longitudinal axis of the radius should bisect the ossification center of the capitellum in all radiologic views [4]. Focusing on the easily identified ulna fracture distracts a physician from the sometimes subtle radiocapitellar disruption in the under calcified elbow joint of a child. The ulna of such a missed presentation heals, but the dislocated radial head calcifies and can subsequently cause arthritis, pain, and loss of range of motion. Here, we present an

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Figure 1: Anteroposterior (AP) (a) and lateral (b) radiographs of the left elbow 1 day after the injury demonstrate a minimally displaced intra-articular olecranon fracture (arrow) with an overlying fiberglass cast. 5 weeks after the injury, AP (c) and lateral (d) radiographs reveal a healing, non-displaced olecranon fracture with callus formation and bony remodeling in the setting of a dislocation of the radial head (asterisk) medially and anteriorly.

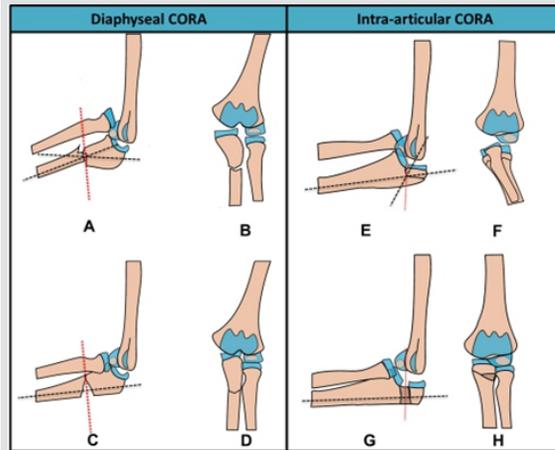


Figure 2: The center of rotational angulation (CORA-dashed red lines) in a lateral (a) and anteroposterior (AP) (b) view of the most common Bado type I (anterior) Monteggia fracture-dislocation displayed with a lateral (c) and AP (d) views of the ulnar osteotomy at the diaphyseal CORA. By contrast, lateral (e) and AP (f) views of the intra-articular Monteggia variant suggest the need for an intra-articular osteotomy to address the CORA and reduce the radial head as shown in the post-operative lateral (g) and AP (h) views. Iliac crest allograft (darker brown shade) was used in the presented intra-articular case. Anatomical axis (dashed black lines) of the proximal and distal ulnar fragment is shown to intersect at the CORA.

time were read as a “minimally displaced olecranon fracture” (Fig. 1a and b). While the lateral view shows an intact radiocapitellar line, the AP view shows that the radius is medial to the capitellum. This radial head dislocation was not recognized at the time. The patient was placed in a bivalve long arm cast and scheduled to follow-up in clinic in 1 week; however, he missed the original follow-up appointment. 5 weeks after the initial injury, the patient followed up in clinic. By that time, the physical examination showed limited range of motion with arm flexion to 90°, extension to 40°, and a 20° pronation/supination arc. Repeat radiographs demonstrated an intra-articular olecranon fracture with a radial

unrecognized Monteggia fracture-dislocation in the setting of an intra-articular ulnar fracture; more significantly, we show how knowledge of the center of rotational angulation (CORA) permitted the success of an intra-articular osteotomy to restore ulnar length and improve a functional outcome.

Case Report

A 3-year-old male was seen in the emergency department with left elbow pain following a fall from a sofa. No prior injuries or significant medical history were noted. On physical examination, the skin was intact with soft and compressible compartments. The patient was neurovascularly intact with normal sensation and strength of the median, radial, and ulnar nerves and associated musculature. Plain radiographs at the

head dislocation and disruption of the proximal radioulnar joint (Fig. 1c and d). The original diagnosis did not identify the radial head dislocation. Due to the lack of follow-up, the patient remained incorrectly treated for 5 weeks in a long arm cast before recognizing the original radiographs as a Monteggia fracture-dislocation. Treatment of a chronic Monteggia fracture-dislocation with pain and functional disability requires operative fixation [5]. To correct the angular deformation of the malunited ulna, the CORA must be recognized as the intersection of the proximal and distal ulnar anatomical axes. Thereafter, an opening-wedge ulnar osteotomy is performed at the CORA to restore ulnar length and allow for reduction of the radial head [6]. The unique CORA of this injury mechanism was used to plan the intra-articular ulnar osteotomy as opposed to the classically described diaphyseal ulnar osteotomy (Fig. 2a, b, c, d, e, f, g, h). A posterolateral incision was made to allow visualization of the ulnar malunion and development of the Kocher interval (ECU-anconeus) to evaluate the radiocapitellar joint. A separate incision in the anterior antecubital fossa allowed identification and protection of the radial nerve in the brachialis-brachioradialis interval. To perform the ulnar osteotomy, K-wires were first used to localize and develop the plane of the malunion. The posterior corticotomy was performed with sequential drilling, and an osteotome was used to complete and distract the osteotomy (Fig. 3a, b, c, d, e). The magnitude of the ulnar opening-wedge osteotomy was trialed until the radiocapitellar joint maintained reduction throughout pronosupination. The radiocapitellar joint was

	Flexion (degrees)	Extension (degrees)	Pronation/supination arc (degrees)
Pre-operative	90	40	20
Post-operative	115	15	75

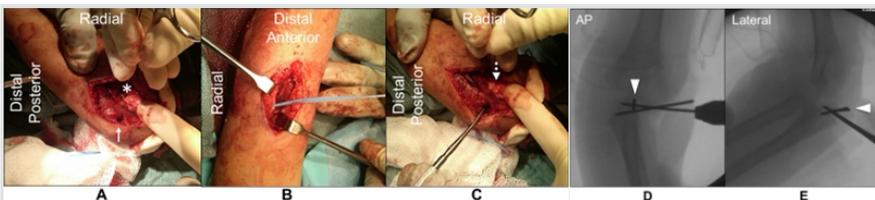


Figure 3: A posterolateral incision (a) was utilized to visualize the ulnar malunion (arrow-A) and develop the Kocher interval to evaluate the radiocapitellar joint, showing an absent, non-reduced radius (asterisk-A). A separate anterior incision in the antecubital fossa allowed identification and protection of the radial nerve in the brachialis-brachioradialis interval (b). Forearm supination while providing distraction with an instrument at the ulnar osteotomy (c) results in reduction of the previously dislocated radial head (dotted arrow-C). AP (d) and lateral (e) intraoperative fluoroscopic views display the ulnar osteotomy where the plane of the osteotomy was identified with K-wires (arrowheads), the posterior corticotomy was performed through drilling (d), and the osteotomy was completed with an osteotome (e).

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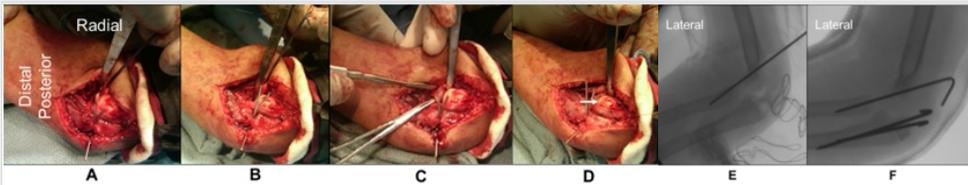


Figure 4: Chronic Monteggia reconstruction requiring pinning of the radiocapitellar joint (a) to reduce the radial head dislocation. The ulnar opening-wedge osteotomy (b) utilized tricortical iliac crest allograft (c) and the annular ligament was subsequently repaired (arrow-D) before irrigation, closure, and casting. This is well visualized by lateral fluoroscopy (e). Proper alignment of the two ulnar pins was verified by lateral fluoroscopy (f). Removal of the radiocapitellar pin occurred in clinic 4 weeks later.



Figure 5: 7-month post-operative images show 115 flexion (a) and 15 extension (b) with a 75 pronation/supination arc (c). On physical examination, he had no neuropathic symptoms with fully intact median, radial, and ulnar nerves. Anteroposterior (d) and lateral (e) radiographs of the left elbow demonstrate interval removal of K-wire fixation pins and incorporation of the olecranon bone graft (arrow). No new fractures are identified, and the radial head remains located (asterisk).

pinned to hold reduction while the ulnar opening-wedge osteotomy was completed with tricortical iliac crest allograft. At the end of the case, the annular ligament was repaired (Fig. 4a, b, c, d, e, f). A subtle amount of instability remained in the joint after the osteotomy; therefore, the radiocapitellar pin was left in place and ultimately removed 4 weeks later in clinic. 7 months after surgery, the patient displayed functional improvements with arm flexion to 115°, extension to 15°, and a 75° pronation/supination arc (Fig. 5a, b, c). On physical examination, he had no neuropathic symptoms, with intact median, radial, and ulnar nerve function. Radiographs confirmed incorporation of the olecranon bone graft (Fig. 5d and e). Most importantly, the radial head remained located and he regained most of his range of motion (Table 1).

Discussion

Acute Monteggia fracture-dislocations can typically be treated by closed reduction and serial casting with close follow-up [2]. Although common in pediatrics, these are frequently missed injuries, thus they can present as a chronic injury requiring open reduction with an osteotomy to restore ulnar length and forearm rotation [7]. The missed Monteggia fracture-dislocation presented here not only emphasizes the need for clinical awareness of this injury mechanism, but also illustrates the novel use of an intra-articular osteotomy to correct anatomical alignment. To prevent the morbidity of loss of function and need for a more complex surgery, a physician's suspicion for the Monteggia fracture-dislocation must heighten in the presence of an ulnar fracture; the subsequent transference of displacing forces through the stiff interosseous membrane toward the radial head necessitates a careful evaluation of elbow radiographs from multiple radiological views [8]. Simply, a pretzel cannot break in just one location, and an ulnar fracture in

pediatrics requires careful evaluation of both the proximal and distal radioulnar joints in addition to other potential trajectories of the force vector. The mechanism of this injury is best explained by visualizing the CORA. In essence, the injury mechanism of most pediatric fractures displays an axis of rotation, which helps to explain the varus or valgus positioning of extremities and subsequent need for supination or pronation maneuvers to reduce such fractures [9]. While displacing forces can both fracture and cause a rotational malformation, the CORA is the point about which a deformity

may be rotated to achieve correction. In the case of a proximal ulnar diaphysis fracture, the application of this knowledge correlates with the need for a diaphyseal ulnar osteotomy at the CORA to address the classically missed Monteggia fracture-dislocation [7]. The unique case presented here, however, suggested the use of an intra-articular ulnar osteotomy to address its CORA. In short, we propose that recognizing the location of the CORA aids in determining the location of the ulnar osteotomy. This study was limited by a loss in patient contact after the 7-month post-operative visit; nonetheless, a significant improvement in range of motion had been achieved at this point.

Conclusion

To the best of our knowledge, all reported pediatric cases of a chronic Monteggia fracture-dislocation injury involve an ulnar diaphyseal fracture and subsequent diaphyseal osteotomy to restore ulnar length and the longitudinal axis. By contrast, we present a unique intra-articular ulnar fracture variant of a missed Monteggia fracture-dislocation injury. More importantly, we use the CORA to explain the operative approach of an intra-articular osteotomy to improve the functional outcome.

Clinical Message

The Monteggia fracture-dislocation continues to beset the modern orthopedic surgeon, and this case study highlights the need for careful evaluation of the pediatric elbow from multiple radiologic views after an acute injury. If this injury pattern is missed and becomes a chronic malunion, however, we suggest using the CORA to determine the location of the ulnar osteotomy whether or not the fracture is intra-articular.

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