Humeral Plate Augmentation of an Elbow Internal Joint Stabilizer

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Summary: We describe a unique case of a distal humerus fracture involving the capitellum with associated elbow dislocation. Preoperative computed tomography demonstrated avulsion fractures of the medial collateral ligament, triceps insertion, and lateral epicondyle indicative of significant elbow instability. The patient underwent capitellar fixation and internal joint stabilizer. Because of the osseous compromise of the lateral distal humerus, the internal joint stabilizer was augmented with a precontoured lateral distal humeral plate to maintain the axis pin position.

Key Words: capitellum fracture, complex elbow dislocation, elbow instability, internal joint stabilizer, hinged elbow fixator

INTRODUCTION

Complex elbow dislocations are challenging to manage. The combination of osseous injury with soft tissue disruption often renders the joint unstable. This issue is further complicated in the presence of significant fracture comminution or poor bone quality. A stable fixation construct that allows for early range of motion is preferred to other treatment modalities.1

Postoperative stiffness after complex elbow injuries is a significant complication often requiring secondary procedures and may lead to worse functional outcomes.2 Hinged elbow fixators, static external fixation, and crossed pinning have demonstrated success in the treatment of a variety of complex elbow injuries. Hinged elbow fixators provide satisfactory stability to allow early range of motion in the setting of elbow instability.3 In the setting of complex articular fractures, hinged elbow fixation has also proven to be a useful adjunct in protecting articular fracture fixation while allowing for early range of motion.4 The notion of offloading the articular fixation by augmenting the construct with a hinged external fixator has been shown to increase stability.4

The internal joint stabilizer (IJS) of the elbow is a novel fixation device for treatment of elbow instability. Previous studies of the IJS have demonstrated equivalent functional outcomes and range of motion to hinged external fixators in the treatment of acute or chronic elbow instability.5,6 The internalized hinged mechanism minimizes the risks associated with traditional external fixators, such as pin tract infections, pin breakage, and nerve injury.2 There has been increased adoption of the IJS in management of persistent elbow instability after osseous and ligamentous repair.5,7

In our report we describe a fixation modification of supplementing the IJS system with a lateral axis plate in the treatment of capitellum fracture dislocation.

PATIENT INFORMATION

OTA/AO Classification: 13B3.1 [5a]

A 48-year-old woman sustained a left elbow injury after a fall from standing height while working in her garden. Radiographs demonstrated a left capitellar shear fracture of the distal humerus with anterolateral dislocation of the elbow (Figs. 1A, B). She underwent temporizing bedside reduction and splinting. A preoperative computed tomography (CT) scan revealed significant comminution of the capitellum with avulsion fractures of the triceps insertion, sublime tubercle, and lateral epicondyle (Figs. 2A, B). The origin of the lateral ulnar collateral ligament was avulsed taking a thin cortical shell fragment.

Surgical Technique

The patient was positioned supine with the arm placed in a McConnell arm positioner (McConnel Orthopedic Manufacturing Company, Greenville, TX). A posterior curvilinear skin incision was made over the elbow. Full-thickness flaps were developed down to the
fascia. There was a traumatic avulsion of the lateral collateral ligament complex from the distal humeral epicondyle with concomitant fracture. The lateral traumatic interval was developed into an arthrotomy to gain access to the elbow joint. The capitellar shear fragment was identified along with significant injury to the lateral trochlea. The capitellar and trochlear fragments were reduced and fixed with guidewires for headless compression screws (Skeletal Dynamics, Miami, FL).

Once the fracture was provisionally reduced, the guidewire for the IJS axis pin (Skeletal Dynamics) was placed to recreate the distal humerus rotational axis (Fig. 3A). Once the axis pin was placed, the headless compression screw guidewires were replaced by screws. Afterward, a lateral distal humeral plate (Zimmer Biomet, Warsaw, IN) was applied. Care was taken to center the most distal hole of the plate over the capitellum center to allow the IJS axis pin to be placed through the plate into the distal humerus (Figs. 3B, C). Cancellous allograft was then placed to fill the void behind the capitellum. The elbow was reduced and lateral collateral ligament was repaired. The IJS hinge mechanism was assembled. The elbow was stable and well aligned.

Postoperative Course
The patient was placed into a posterior long arm splint and their weightlifting restricted to 5 pounds. Ten days after her surgery, the splint was removed, postoperative radiographs were obtained, and the patient started elbow range of motion exercises with formal physical therapy (Figs. 4A, B).

Six months after her initial procedure, the patient underwent removal of her IJS (Figs. 5A, B). The elbow was stable with smooth range of motion after removal of the implant. At her 15-month postoperative visit, the patient had a flexion arc of 140 degrees (10–150 degrees) and a pronosupinatory arc of 150 degrees (Fig. 6).

DISCUSSION
In our case, this patient had articular fractures of the capitellum extending into the trochlea in the setting of global ligamentous instability (avulsion fractures of the triceps, lateral collateral, and medial collateral ligament complexes). Despite the ability to treat the capitellum fracture with direct fixation, the patient had a globally unstable elbow.

The IJS has proven to be effective in treating acute elbow instability. The axis pin for the IJS is inserted laterally through the capitellar center. Given the extensive comminution of the capitellum involving the axis pin insertion site, a precontoured lateral distal humeral locking plate was used to maintain the ideal lateral position of the mechanical axis. The goal of the plate was to act as an addi-

FIGURE 1. Anteroposterior (A) and lateral (B) injury radiographs demonstrating complex elbow dislocation.

FIGURE 2. Computed tomography (CT) scan 3D reconstruction of the preoperative left elbow revealing capitellar shear fracture with avulsion fractures of the triceps insertion, sublime tubercle, and lateral epicondyle.
Identification of the elbow axis of rotation has been shown to be critical in minimizing motion resistance. It has been described as running from the center of the trochlea, then exiting laterally at the capitellum center. 

Proper placement of the pin determines the functional stabilizing point of fixation for the IJS axis pin to allow the elbow to maintain its proper axis of rotation. It is our practice to use the IJS system in the treatment of complex elbow injuries when there is persistent instability after osseous fixation and ligamentous repair.
The functional motion of the construct. A cadaveric study by Madey et al. demonstrated that misplacement of the axis pin by 5 degrees off the ideal trajectory increases energy expenditure 3.7-fold when used in a hinged external fixator system. Misplacement jeopardizes concentric elbow motion but can also increase stress at the capitellar fracture fixation site. Correct axis pin placement is also critically important in the IJS system. It is our preference to place the guide wire for the axis pin at the beginning of the case. There is only one correct trajectory for the axis pin, and in this case it was possible to adjust the distal humerus fixation around the pin such that both were well positioned.

The short segment of fixation in the capitellum fragment paired with the significant lateral comminution diminished the rigidity of the construct. In addition, the patient in our case sustained near global ligamentous instability after the dislocation. Taking these factors into account, the additional support of a hinged elbow fixator allowed for stable, early range of motion.

Our technique of supplemental lateral axis plate is a viable solution to the management of complex elbow injuries with concomitant lateral comminution at the axis pin insertion site. Utilization of other points of fixation provides additional support for the IJS axis pin. This may also be useful in the setting of compromised bone quality, such as with osteoporotic bone. Similar to standard implantation of the IJS, it is recommended to have a secondary surgery for removal of the implant.

CONCLUSIONS

The IJS remains an effective tool in the treatment of complex elbow injuries. In the presence of significant lateral distal humerus comminution at the axis pin insertion site, stability of the axis pin should be evaluated. If there is any increased motion laterally, the use of a precontoured lateral distal humeral plate can provide another point of support. The authors have also used this plate augmentation technique in patients with significant osteoporosis to control possible axis pin migration.

REFERENCES


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