Terrible Triad Elbow Fracture-Dislocation With a Significant Coronoid Fracture

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Summary: The terrible triad elbow fracture-dislocation injury pattern is challenging to treat. The goal of treatment is to restore alignment and stability to the elbow joint. These injuries consist of a radial head fracture, a coronoid process fracture, and ulnohumeral joint dislocation. Typically, significant coronoid fractures associated with this injury pattern require management by internal fixation to confer elbow stability. In this article, we present a case of a terrible triad injury with a significant coronoid fracture that did not require coronoid fixation to provide stability to the elbow because of the placement of the internal joint stabilizer-elbow (IJS-E) device.

Key Words: terrible triad, elbow fracture-dislocation, coronoid fracture, internal joint stabilizer

INTRODUCTION

The terrible triad elbow fracture-dislocation injury pattern consists of a radial head fracture, a coronoid process fracture, and ulnohumeral joint dislocation. The coronoid functions as an anterior buttress that prevents posterior ulnar translation and is subject to fracture due to the axial load component of the terrible triad mechanism of injury. The management of a terrible triad elbow fracture-dislocation is challenging because of the possibility of residual joint instability despite the repair of the affected anatomical structures.

Historically, type I coronoid fractures have been treated by fragment excision, anterior capsule suture repair, suture repair of the small fragment, or no treatment. Type II fractures, involving up to 50 percent of the coronoid process, have typically been treated with internal fixation when possible. If extensive coronoid comminution does not allow for operative fixation, persistent instability may result due to the diminished buttress effect of the insufficient coronoid. Type III fractures typically require open reduction and internal fixation because disruption or avulsion of the insertion of the anterior bundle of the medial collateral ligament on the sublime tubercle usually occurs as a component of the fracture. Coronoid reconstruction is considered for irreparable type III fractures to provide stability to the ulnohumeral joint.

Methods to address residual instability after the repair of the osseous and soft tissue components of the injury include the placement of an external fixator, either static or dynamic, or the placement of transarticular pins with casting to maintain the ulnohumeral joint reduced. Static fixation is associated with some degree of loss of motion, which can be treated with postoperative rehabilitation protocols with possible adjuvant capsular release and joint manipulation. Dynamic external fixation provides the advantage of allowing motion; however, the placement is technically more challenging than static fixation, particularly with determining the axis of rotation of the ulnohumeral joint. External fixators are susceptible to complications associated with transcutaneous placed pins, including pin tract complications.

The development of the internal joint stabilizer for the elbow (IJS-E; Skeletal Dynamics, Miami, FL) has provided another option for restoration of elbow stability during surgical management of terrible triad injuries. The subcutaneous position of the device allows for unrestricted motion without the complications typically associated with dynamic external fixation devices, including pin tract infections, pin loosening, or pin site fractures. Coronoid fracture fixation combined with the use of the IJS-E device for persistent instability protects the fracture fragments from posteriorly directed load due to the neutralization of such forces by...
the device. In cases with significant coronoid deficiency, the placement of the IJS-E relieves the coronoid of its buttress function. The device maintains joint stability while allowing for early motion as collateral ligament and osseous healing occurs.5

PATIENT INFORMATION

This patient is a 51-year-old man who sustained a fall from a bicycle onto his outstretched right hand resulting in severe pain with immediate loss of active range of motion of his elbow. He presented to the emergency department and underwent elbow imaging that revealed fractures of the radial head and coronoid process with posterior dislocation of the ulnohumeral joint consistent with the terrible triad injury pattern (Figs. 3, 4A, B). He was placed into a posterior splint and was seen in our office on the day of injury. A discussion of the treatment options with their associated risks and benefits was held with the patient; the patient decided to proceed with operative treatment.

SURGICAL TECHNIQUE

The patient was taken to the operating room and placed supine on the operating room table. The elbow approach was through a posterolateral elbow incision, beginning proximally over the lateral epicondyle and curving posterolaterally over to the proximal posterior ulna. Anterior and posterior flaps were raised, allowing access to the entire lateral aspect of the elbow joint. The posterolateral approach revealed a bare epicondyle sign with avulsion of the lateral collateral ligament origin from the humerus. Evaluation of the radial head revealed comminution consistent with the preoperative imaging. The radial head fragments were removed, and the decision was made to replace the radial head because of the extensive comminution. The resection of the radial head and proximal neck allowed for excellent coronoid exposure from the lateral side.

The examination of the coronoid revealed a type II fracture with extensive comminution consisting of small fragments not suitable for internal fixation. The decision was made to excise the loose comminuted fragments. The portion of the coronoid tip attached to the anterior capsule was left in place. The examination of the remaining coronoid revealed an approximately 50% loss of coronoid height. Because of this coronoid deficiency, the decision was made to place the transhumeral axis pin of the IJS-E device to address any persistent instability after radial head replacement and lateral collateral ligament repair.

FIGURE 3. Preoperative lateral and anteroposterior elbow films.

FIGURE 1. Coronoid fracture types as per Regan and Morrey classification scheme. Note the insertion of anterior bundle of medial collateral ligament complex on sublime tubercle.

FIGURE 2. Coronoid fracture schematic based on proximal olecranon. The parallel line to the proximal olecranon tip divides type II above and type III below.

Attention was then turned to radial head replacement. Once the definitive implant was placed, the elbow was taken through a range of motion and the radial head was found to be properly aligned to the rotational axis of the forearm with full pronosupination noted.

The evaluation of the ulnohumeral and radiocapitellar joints revealed persistent instability; therefore, the decision was made to proceed with the placement of the IJS-E. The posterior flap of the incision was developed further posteriorly, the olecranon was exposed, and the elbow was stabilized with the IJS.

Repair of the lateral collateral ligament was performed by placing crossed anterior to posterior drill holes into the lateral humeral cortex just proximal to the axis pin. The lateral collateral ligament was sutured in a running locked fashion using #2 FiberWire, and the sutures limbs were passed through the drill holes. The suture was tied over the lateral cortical bony bridge formed by the drill holes, and the same #2 FiberWire was used to repair the annular ligament and to attach the common extensor origin back to the humerus. The elbow was taken through a full range of motion and was found to be stable. A concentric reduction of the ulnohumeral joint was confirmed with the image intensifier. The skin was closed with staples, and a dry sterile dressing was applied along with a posterior splint at 90 degrees with the wrist in neutral rotation (Fig. 5).

POSTOPERATIVE COURSE

The patient was seen in follow-up at 1 week, and a removable posterior splint was applied. The patient began range of motion exercises with the occupational therapist twice weekly. Follow-up at 8 weeks postoperative revealed a stable elbow with extension to 30 degrees short of full extension and flexion to 130 degrees. The patient was taken back to the operating room at postoperative week 8 to remove the IJS-E. No splint was applied after the retrieval procedure (Fig. 6).

The patient continued therapy after IJS-E removal. Strengthening was progressed, and at 12 weeks follow-up after IJS-E removal, the range of motion had reached 10 degrees short of full extension to 135 degrees of flexion. The patient reported no pain with elbow use and reported no episodes of perceived instability. The patient was subsequently discharged from therapy and was advised to follow-up as needed (Fig. 7).

DISCUSSION

Terrible triad elbow injuries include the constellation of radial head fracture, coronoid fracture, and elbow dislocation. For most of these injuries, operative treatment is indicated in the form of repair of both the osseous and soft tissue components of the injury to restore elbow stability. Once the osseous and soft tissue components of the injury have been repaired, assessment for residual instability is performed. Papatheodorou et al postulated that type II coronoid fractures do not require repair in those terrible triad injuries where the combination of radial head repair or reconstruction and lateral collateral ligament repair restores elbow stability. If residual instability is present, stability can be restored using external fixation, either static or dynamic, or by obtaining transarticular fixation with K-wires. Medial-sided ligament repair or reconstruction may also be performed as an adjuvant to, or instead of, such fixation. The goal of adjuvant stabilization is to obtain and maintain elbow reduction while ligament healing occurs. Because all of the static methods include complete immobilization of joint motion, these treatment options are typically associated with stiffness after fixator removal requiring prolonged rehabilitation and possible capsular releases. The placement of dynamic external fixation introduces the additional challenge of properly determining the axis of joint rotation to allow for early motion while maintaining joint congruity. To avoid intraarticular pin placement or nerve injury, the fixation pins are typically placed away from the axis of rotation. Such placement can amplify instability secondary to incorrect determination of axis of rotation. Because of the effect of longer pin length on increasing the length of the lever arm, dislocation can still occur despite proper application of the external fixator.

Complications associated with external fixation devices include stiffness associated with static external fixation and the possibility of pin tract and pin site complications. Pin tract infections, fractures of bone, fractures of pins, and loss of joint congruity have all been seen after external fixator application. Pin complications have also
been seen with transarticular K-wire fixation placed for postoperative stability. There is a learning curve associated with the technical challenge of placing a hinged external fixator at the correct position corresponding to the proper axis of rotation of the ulnohumeral joint. The IJS-E system includes an axis pin guide that allows for the determination of the ulnohumeral axis of rotation using anatomical landmarks. The axis pin guide ensures the placement of the transhumeral axis pin is easiest to use at the beginning of the case when the ulna can be dislocated and the entire trochlea is easily accessible. Once the transhumeral axis is drilled, the repair of the affected structures is usually performed from medial to lateral, starting with the coronoid, proceeding next to the radial head, and then to the lateral collateral ligament complex.

Assembly of the IJS-E before the repair of the lateral collateral ligament allows for a tension-free repair of the ligament through humeral drill holes or with the use of a suture anchor placed slightly superior and posterior to the axis pin. Because the origin of the lateral collateral ligament is more akin to a postage stamp-sized area on the lateral epicondyle rather than a concentrated point, repairing the ligament to a location slightly superior and posterior to the center of rotation will still allow adequate area for healing of the repaired ligament back to its region of origin at the lateral epicondyle. If the device is placed after radial head repair and before collateral ligament repair such as with this case of an irreparable type II coronoid fracture, then a properly tensioned lateral collateral ligament repair can be performed because the IJS-E will maintain isometric joint alignment while the repair is being performed. Assembling the IJS-E before a lateral collateral ligament repair is also useful in cases of lateral collateral ligament reconstruction because it facilitates proper tensioning of the graft while maintaining an isometric reduction.6

We have a low threshold for placing the transhumeral axis pin at the beginning of the case because this allows for the placement of the IJS-E whenever it is deemed necessary to restore stability. If the ulnohumeral joint is determined to be sufficiently stable after repairing the affected structures and the IJS-E is therefore not needed, the only alteration to the patient’s anatomy is the placement of a single 2.7-mm drill hole into the lateral humeral cortex. If the transhumeral axis pin is drilled but not used and ulnohumeral joint instability is noted on follow-up, the IJS-E can be placed at that time without having to take down any of the previously performed repair because there is no need for intraarticular access to place the device. The transhumeral axis pin and the ulnar base plate can be applied and the connecting rod assembled in its usual position without disturbing the deeper periarticular soft tissue envelope.

In our practice, the IJS-E has created a paradigm shift in management of elbow instability including instability associated with terrible triad injury patterns. Type II coronoid fractures that are irreparable because of extensive comminution can now be managed with the placement of the IJS. Applying the IJS-E neutralizes the posteriorly directed forces against the coronoid while ligament healing is occurring and allows for early motion to reduce the loss of range of motion associated with static immobilization to maintain elbow stability. The IJS-E is well tolerated by patients, even those with a thin soft tissue envelope overlying the elbow joint and does not hinder elbow motion and splint use. In our practice, we have not seen any soft tissue associated issues with the initiation of early motion with the device applied. The use of the IJS-E does not impede advancing therapy, with the patients typically obtaining full functional range of motion with the device in place.

**CONCLUSION**

Terrible triad elbow injuries continue to present challenges in surgical management with the goals of minimizing residual elbow stiffness and loss of motion while conferring enduring stability. This case advances the concept that type II coronoid fractures do not require repair if the IJS-E device is used to restore initial ulnohumeral joint stability in terrible triad injuries. The availability of the IJS-E device adds a powerful tool to the surgical armamentarium for the management of elbow instability associated with terrible triad injuries, including those with significant coronoid fractures.

**FIGURE 7.** Clinical photographs demonstrating the final range of motion.
REFERENCES


