



Revision management of a 17-year-old patient initially treated with radial head excision following terrible triad injury with associated Essex Lopresti



John J. Heifner, MD^{a,*}, Gustavo E. Lacau, MD^b, Jorge L. Orbay, MD^b

^aMiami Orthopaedic Research Foundation, Miami, FL, USA

^bMiami Bone and Joint Institute, Miami, FL, USA

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Complex elbow injury resulting from high-energy mechanisms may have associated injury to the interosseous ligament (IOL), namely an Essex-Lopresti injury. The central band of the IOL transfers longitudinally applied loads from the radius to the ulna, restrains proximal migration of the radius in the presence of an absent or deficient radial head, and resists forces that may disrupt the transverse radioulnar relationship. Loss of integrity of the central band can lead to ulnar impaction syndrome and instability during forearm rotation.^{2,24}

The indications for radial head excision have narrowed due to improved understanding of radial head function. The radial head provides valgus, transverse, and rotational stability; therefore, loss of the radial head portends chronic dysfunction and instability.^{14,22,25} There is increasing evidence for adverse effects following excision of the radial head including unsatisfactory function, increased tension on the central band, and forearm laxity.^{3,31} Importantly, excision may be contraindicated in the presence of IOL injury.¹² Clinical manifestations of excision include ulnar impaction at the wrist and longitudinal instability.^{8,13}

Terrible triad injuries often occur due to high-energy mechanisms. Though they are classically described as a posterolateral external rotation injury pattern, there is evidence of posteromedial rotatory patterns.²⁷ Axial and rotatory forces result

in fractures to both anterior osseous structures—the radial head and coronoid—and the ligamentous stabilizers at the direction of dislocation. Recent attention has been placed on early postoperative rehabilitation, as extended immobility may result in poor function and morbidity.^{6,28}

We present a revision case of terrible triad injury with associated Essex-Lopresti in a teenage patient who was initially treated with radial head excision and ulnohumeral pinning. This case was treated with radial head arthroplasty, repair of the IOL central band, and a temporary internal joint stabilizer. The patient's legal guardian provided informed consent for the case data to be published.

Case report

Background

A 17-year-old male who sustained a terrible triad injury during high-velocity motor vehicle accident was acutely treated with closed reduction and casting (Fig. 1). At four weeks postinjury, he was found to be dislocated in the cast and was surgically treated. The radial head was deemed irreparable and was excised, and the ulnohumeral joint was pinned (Fig. 2). Following six weeks of immobilization, the pins were removed, and rehabilitation was initiated. The patient presented to us approximately 14 weeks postinjury—10 weeks postoperatively. Clinical investigation demonstrated an elbow arc of motion of 15 degrees, a pronosupination arc of motion of 20 degrees, and symptoms of high ulnar nerve palsy (Videos 1 and 2). Radiographic investigation demonstrated proximal migration of the radial stump and a positive ulnar variance of plus two millimeters compared to neutral

The work was performed at Miami Bone and Joint Institute. Approval from the institutional review board was not applicable to the current work. Informed consent was obtained from the patient's legal guardian.

*Corresponding author: John J. Heifner, MD, Miami Orthopaedic Research Foundation, 8905 SW 87th Ave, Miami, FL 33176, USA.

E-mail address: johnjheifner@gmail.com (J.J. Heifner).

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Figure 1 (a) Anteroposterior and (b) lateral radiographs of radial head and coronoid fractures with elbow dislocation performed at the initial injury presentation at an outside institution.

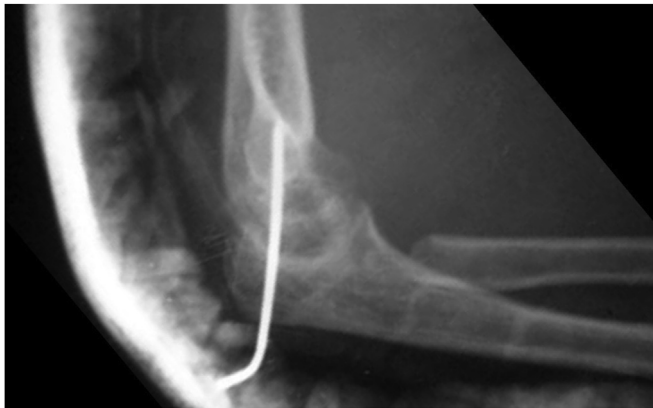


Figure 2 Lateral radiograph following ulnohumeral pinning and radial head excision, performed approximately five weeks postinjury after failed conservative treatment at an outside institution.

ulnar variance on the contralateral side (Fig. 3). This finding suggested an injury to the central band, which altered the longitudinal relationship between the radius and ulna. The decision was made for surgical treatment with radial head arthroplasty and repair of the central band with a suture construct. Given the stark loss of motion and revision intervention, early postoperative mobilization was deemed an imperative aspect of the postoperative course. Thus, an internal joint stabilizer (IJS; Skeletal Dynamics, Miami, FL, USA) was used to protect the ligament repairs and allow early motion.

Surgical treatment

Separate incisions were made to access the proximal and distal insertions of the central band. The Thompson approach was used to expose the proximal insertion of the central band between extensor carpi radialis brevis and extensor digitorum communis. This is located just proximal to the insertion of the pronator teres. A

distal ulnar approach between extensor carpi ulnaris and flexor carpi ulnaris was used to expose the distal insertion, which is approximately six centimeters proximal to the ulnar head. A custom drill guide was used to create bone tunnels at approximately 30 degrees in relation to the longitudinal axis of the bone (Fig. 4), which is consistent with anatomic investigations.^{7,33} This may minimize suture fraying on the sharp internal borders of the radius and ulna. A mini TightRope (Arthrex, Naples, FL, USA) suture construct was passed from proximally through the radius to distally through the ulna with buttons securing the suture to the bone surfaces.⁹ The radius was incrementally brought to its anatomic longitudinal alignment using a tensioner. The final position was confirmed by a neutral ulna variance.

The case required combined medial and lateral approaches to the elbow. A flexor carpi ulnaris split approach was used medially for ulnar nerve release, scar tissue resection, and capsulectomy, which contributed to restoration of elbow extension. Laterally, a Kocher approach utilized the interval between the anconeus and extensor carpi ulnaris to replace the radial head, perform capsulectomy, and apply the IJS.

Following exposure of the lateral aspect of the elbow, the ulnohumeral axis of rotation was identified using instrument guides. The IJS axis pin was placed along the axis of rotation using fluoroscopy for confirmation (Fig. 5).^{29,32} The proximal radius was prepared for arthroplasty according to the previously described technique (Align; Skeletal Dynamics, Miami, FL, USA).^{11,21} Prosthetic length was determined in relation to the corner formed by the lesser and greater sigmoid notch when evaluated on a true anteroposterior fluoroscopic image with the forearm in supination. The ideal length of the prosthetic head is approximately 2 millimeters distal to the corner of the notches. Following implantation of the definitive prosthesis, a forearm-length jig was placed onto the prosthetic head and at the ulna fovea distally (Fig. 6). A torque-limiting driver fastened the head to stem maintaining the orientation. This process aligned the prosthesis with the forearm axis of rotation. Following prosthesis implantation, the IJS was placed to maintain concentric joint reduction and protect the ligament repair during early mobilization. The



Figure 3 (a) Anteroposterior and (b) lateral radiographs demonstrating excised radial head and proximal migration of the radius. (c) Posteroanterior radiographs demonstrating positive ulnar variance at the right wrist (d) compared to neutral ulnar variance on the contralateral side.

baseplate was fixed to the olecranon, and connecting rods were linked to the previously placed axis pin. The lateral collateral ligament complex (LCLC) was repaired with number-two braided suture using a figure of eight configuration.

Postoperative course

The operative arm was maintained in a sling for six days with mobilization beginning thereafter. At three weeks postoperatively, the patient achieved 175 degrees of elbow extension, 120 degrees of flexion, and an arc of pronosupination of 145 degrees. At five months postoperatively, the IJS was removed (Fig. 7), and at 13 months, the patient demonstrated a stable elbow with motion that was comparable to that of the contralateral arm (Videos 3 and 4). The patient reported the ability to resume sporting activities with little noticeable detriment.

Discussion

This case was initially treated at an outside facility with radial head excision and ulnohumeral pinning, and the resultant dysfunction was quite evident. At approximately three months postinjury, our radiographic and clinical evaluation indicated that the patient's initial injury pattern was likely to have been a terrible

triad with associated Essex-Lopresti. The wrist was ulnar positive, which differed from the ulnar neutral contralateral side on posteroanterior radiograph. It is feasible though less likely that the central band sustained a subclinical injury and became attenuated under the additional stress caused by radial head excision.^{15,18} Our revision management consisted of radial head arthroplasty, repair of the central band, and temporary internal stabilization.

There is limited evidence for acute management of terrible triad injury with associated Essex-Lopresti. Salazar et al²⁹ reported on a 19-year-old with this injury pattern and concomitant distal radius fracture. The LCLC was repaired, the radial head fracture was fixed with screws, a dorsal spanning plate was applied to the distal radius, and the IJS was used for temporary stabilization. At three months, the dorsal spanning plate and IJS were removed, and at final follow-up, the elbow arc of motion was 125 degrees. Ramzi et al²⁶ reported on a 56-year-old who suffered a ground-level fall. Radiographic investigation demonstrated a terrible triad injury of the elbow with an ulnar positive wrist. The LCLC was repaired, and a tightrope device was applied to the distal radioulnar joint. Intraoperative assessment determined that the coronoid and radial head fractures did not require fixation. At eight months postoperatively, the elbow was stable with an arc of motion of 80 degrees.

Essex Lopresti injuries are often missed due to the emphasis of examination at the elbow and misinterpretation of the subtle



Figure 4 (a) Intraoperative image showing drill guide and (b) tensioner used for suture construct repair of the (c) central band with suture button fixation.

symptoms which may suggest injury to the IOL.²⁹ Additionally, these injuries may occur from low-energy mechanisms that are less likely to alert the clinician for an Essex-Lopresti injury.³⁰ Acute treatment of Essex-Lopresti injuries avoids the difficulty of restoring anatomic position to a proximally migrated radius, which can become fixed in that position over time.¹⁹ Schnetzke et al³⁰ reported that acute treatment in Essex-Lopresti cases demonstrated superior outcomes compared to chronic treatment, where wrist-related sequelae was frequent. The biomechanical investigation by Hackl et al⁹ supported central band repair with a TightRope and suture button technique to restore rotatory stability to near-native levels following simulation of Essex-Lopresti injury. Clinically, this construct has demonstrated satisfactory outcomes when treating acute Essex-Lopresti injury.⁴ The authors describe the repair as maintaining tension throughout the pronosupination arc, which off-loads the injured central band and radial head, allowing healing.

Understanding of surgical treatment for terrible triad injury has improved. There is established agreement for the following surgical algorithm: fixation or replacement of the radial head, repair of the LCLC, and fixation of the coronoid in the setting of an appropriate fragment size. Despite improved clinical outcomes following surgical management, the rate of complication remains high in aggregate reporting.^{16,17} Recent investigations have identified early mobilization as integral to achieving favorable outcomes following terrible triad injury.^{6,23}

The kinematic and mechanical importance of the radial head continues to be elucidated. In many cases, function and stability may be compromised in the presence of radial head excision. These complications have even greater implications in young patients. Recent evidence demonstrates that excision is being utilized less frequently, and the use of arthroplasty has experienced a large increase.¹⁶ Zhang et al³⁴ reported on 11 cases of acute radial head fracture treated with excision that demonstrated satisfactory

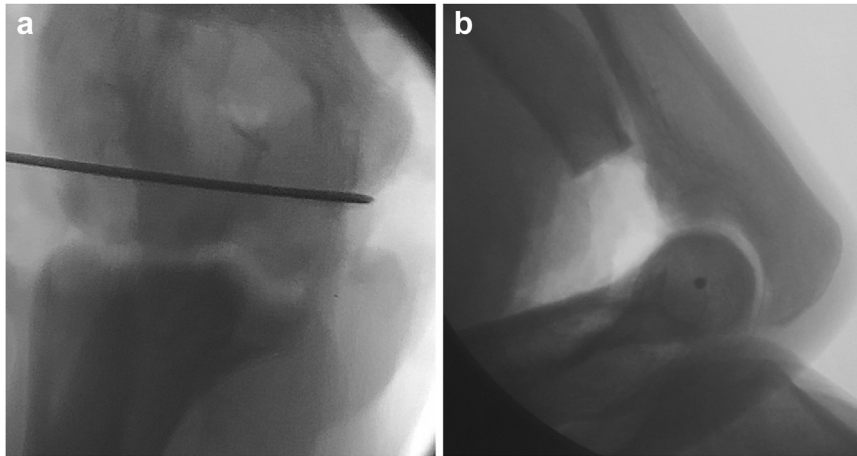


Figure 5 (a) Anteroposterior and (b) lateral fluoroscopy showing placement of the axis pin for the internal joint stabilizer along the ulnohumeral axis of rotation.

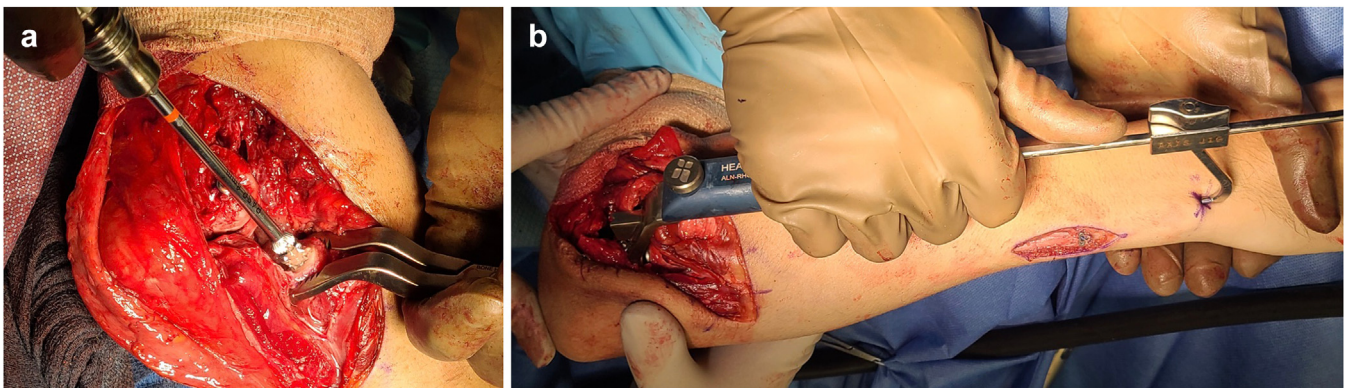


Figure 6 (a) Intraoperative image showing preparation of the proximal radius for arthroplasty and (b) alignment of the final implant with the forearm axis of rotation.

clinical outcomes and stability at a mean of 36 months postoperatively. Their retrospective analysis was intended to determine the likelihood of a missed Essex-Lopresti based on the outcome data. The authors concluded that, following intraoperative determination of longitudinal stability, radial head excision for acute fracture is a safe procedure. This position is consistent with Hildebrand et al,¹² who concluded that although radial head excision resulted in good to excellent results for acute fracture, excision may be contraindicated with concomitant ligamentous disruption.

Stiffness is common following surgical management of traumatic elbow injury and may be exacerbated following extended immobilization. Previous reports describe immobilization beyond two weeks as a substantial risk factor for elbow stiffness following complex injury.^{10,20} Akhtar et al¹ concluded that early mobilization in the postoperative traumatic elbow is an essential component of achieving a favorable outcome. Consistent with the case report of Salazar et al,²⁹ we applied an IJS to protect the LCLC repair and to allow early mobilization, which began at one week postoperatively. The internal joint stabilizer is a temporary device that provides stability and offloading of the soft tissues during the healing phase. Importantly, this option allows early mobilization and does not utilize external components. Another internal stabilization option is transarticular pinning which provides an environment that is conducive for ligamentous healing, but there is a high risk for stiffness with longer periods of immobilization, as demonstrated in the current case.¹⁰ Hinged external fixation allows mobilization, but

pin-track complications and functional inefficiency may reduce the utility of this option.⁵

There are three important elements to this case that were critical to attaining a satisfactory outcome. First, the recognition of injury to the central band, which destabilizes the forearm. The radiographic and clinical signs that may yield a high index of suspicion for this injury pattern include an ulnar positive wrist that differs from the contralateral side, pain at the level of the distal radioulnar joint, and limited forearm rotation. The central band was repaired to provide longitudinal stability to the forearm and restore an anatomic radioulnar relationship. This option maximized the potential for functional recovery. Second, replacement of the radial head, which re-established length and stability following failed radial head excision and proximal migration of the radius. Third, the initiation of early mobilization to mitigate stiffness and maximize function. We used an internal joint stabilizer to maintain a concentric joint and provide the capacity to withstand the forces of early motion.

This is a unique case of revision surgery following failed radial head excision and ulnohumeral pinning in a 17-year-old who suffered a terrible triad injury with associated Essex-Lopresti. Our choice in treatment reflects the condition of the patient at revision presentation, which may differ from the optimal treatment at injury presentation. Our access to investigations performed at injury presentation was limited due to initial management at an outside institution. Thus, we postulate on the injury pattern based

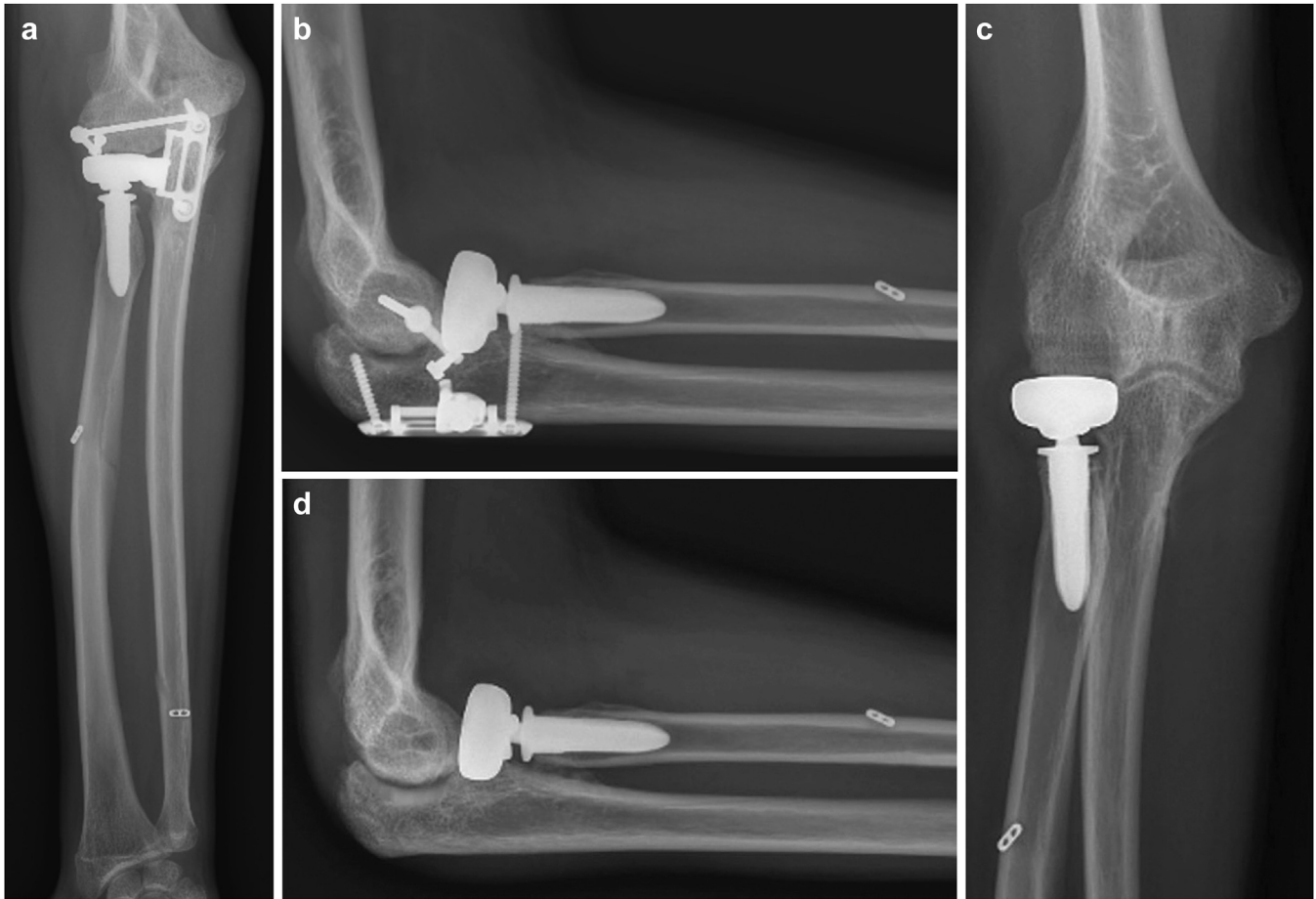


Figure 7 (a and b) Anteroposterior and lateral radiographs at 3 months and (c and d) 5 months postoperatively following removal of the internal joint stabilizer.

on the presentation at three months following initial surgical intervention. The short-term favorable outcomes indicate that recognition of concomitant injury in complex elbow trauma is a crucial aspect of appropriate management. Further, current evidence is clear that radial head excision and extended elbow immobilization are indicated within narrowed confines.

Conclusion

We performed revision management following failed radial head excision and ulnohumeral pinning in a 17-year-old who suffered a terrible triad injury with associated Essex-Lopresti. Radial head arthroplasty, repair of the central band, and temporary internal elbow stabilization yielded dramatic improvements in function.

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Conflicts of interest: Jorge Orbay: Irrevocable trusts, of which J.L.O. and his family members are the beneficiaries, own stock in Skeletal Dynamics. Skeletal Dynamics reimburses expenses when J.L.O.

speaks or presents on the company’s behalf. The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article. Patient consent: Obtained.

Supplementary Data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.xrtr.2023.09.009>.

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