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Posterior approach to the elbow for insertion of the internal joint stabilizer

Gilberto A. Gonzalez Trevizo, MD, Jordan T. Carter, MD, Christopher Castagno, BA*, John B. Fuller, MD, Miguel Pirela-Cruz, MD

Department of Orthopaedic Surgery and Rehabilitation, Texas Tech University Health Science Center El Paso, Paul L. Foster School of Medicine, El Paso, TX, USA

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Management of unstable injuries was revolutionized by the Internal Joint Stabilizer (IJS). When compared to long-term immobilization, transarticular pinning, and hinge external fixation, the IJS results in decreased complications and improved clinical outcomes. Historically, the IJS was applied via a lateral approach; however, this limited intraoperative visualization and, in some cases, resulted in increased operative times. This technical report describes a posterior approach, for IJS application. The posterior approach involves an 8- to 10-cm incision over the posterior elbow through the deep fascia before identifying the olecranon and lateral capitellum, then proceeding with IJS application through manufacturer instructions. The ulnar and radial nerves must be identified as they could be damaged in this approach. Using the posterior approach at our institution, we have noticed a possible decrease in operative times and an increase in intraoperative visualization of the elbow without a subsequent increase in complications.

Management of the unstable elbow is a complex task with historically unsatisfactory results. These injuries have classically been managed using immobilization in elbow flexion, transarticular pinning, or hinged external fixation.[1,2,6] However, these methods prevent proper movement of the elbow postoperatively and lead to joint stiffness, arthritis, and chronic pain.[5] Transarticular pinning and external hinged fixation also come with the added risk of pin-site infections and articular surface damage.[1,2,6] Together, these unsatisfactory results and potentially serious complications have led surgeons to seek alternate methods for these repairs.

In 2014, Orbay and Mijares described a method for internal fixation of unstable elbow injuries using a Steinman pin shaped into an elbow stabilizer.[1] Since that time, a device made by Skeletal Dynamics (Miami, FL, USA) has been made commercially available for these injuries. A number of studies have reported postoperative range of motion (ROM), elbow function, and complication rates using the device IJS.[2,6] According to the manufacturer instructions, this technique is to be performed using a lateral approach midway between the lateral epicondyle and the olecranon process.[3] While a lateral approach has been described, a posterior approach has the advantage of allowing medial and lateral visualization through one approach. Here, we describe a technique with a Skeletal Dynamics Internal Joint Stabilizer (IJS) using a posterior approach to improve intraoperative visualization and access to the involved structures associated with complex fracture-dislocations of the elbow.

Technique/case report

Anesthesia

The patient is placed under general or regional anesthesia with a supraclavicular or infraclavicular nerve block.

Positioning

The patient is positioned in the lateral decubitus position with a bean bag, axillary roll, bone foam, and a plexiglass with the operative side facing upwards, that is, with the surgeon facing the draped posterior aspect of the elbow. All bony prominences are properly padded, and the patient is well secured. The nonoperative arm is placed on a plexiglass arm board, and the operative side is draped over an upper-extremity bone foam (Fig. 1). Everything supporting the arms is radiolucent, so there are no restrictions for c-arm access. An optional sterile tourniquet is placed after prepping and draping to permitting maximal access to the operative field (Fig. 2).

*Corresponding author: Christopher Castagno, BA, Orthopaedics Elp, 4801 Alberta Avenue, El Paso, TX 79905-2707, USA.

E-mail address: Christopher.Castagno@ttuhsc.edu (C. Castagno).

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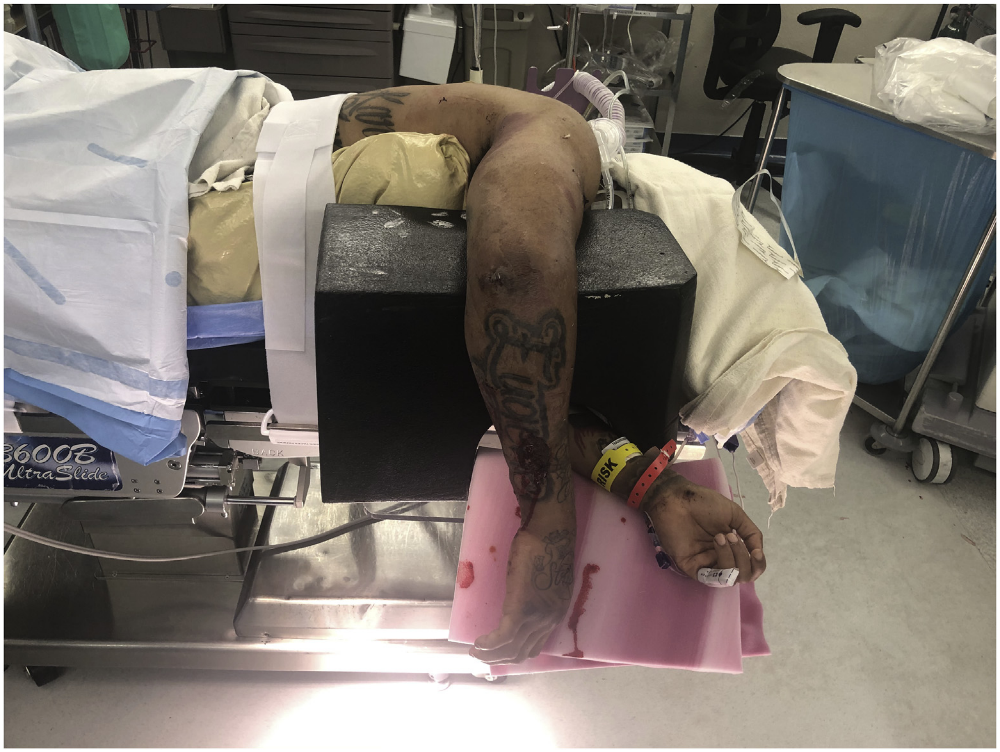

Figure 1 Patient positioning in the lateral position with bone foam placed under the injured arm.

Figure 2 The patient's injured arm draped as proximal as possible to maximize the operative field. No tourniquet was used during this procedure.

Figure 3 The incision marking extending from approximately 2 cm proximal to the olecranon, curving laterally along the tip of the olecranon, and finishing approximately 6-8 cm distal to olecranon overlying the posterior ulna in the midline.

Figure 4 Superficial dissection showing a proximal one-third diaphyseal fracture of the ulna.

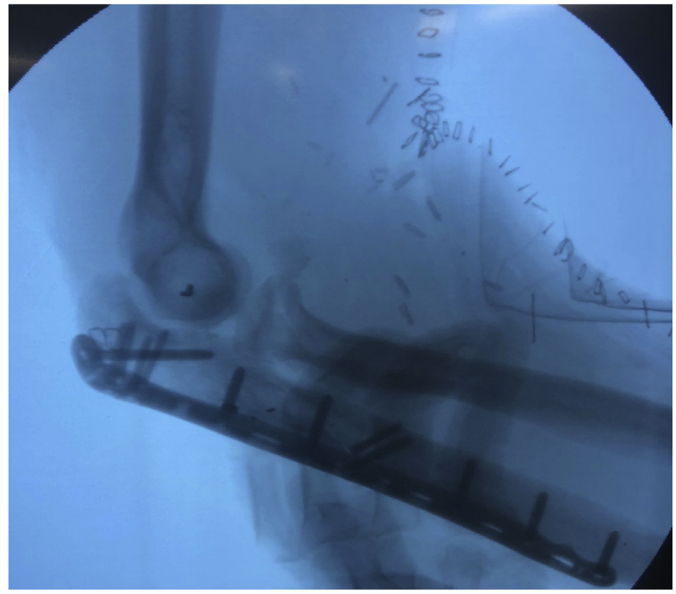

Figure 6 Lateral radiograph demonstrating ORIF of the ulna fracture, used to find the anatomic *center* of the lateral capitellum.

Figure 5 Plated fracture of the ulna using an olecranon plate. The ulnar nerve is marked with a green square.

Figure 7 Surgeon positioning the patient for the lateral radiograph. Note: Use of C-Armor and radiolucent bed optimizes the efficiency of getting intraoperative radiographs.

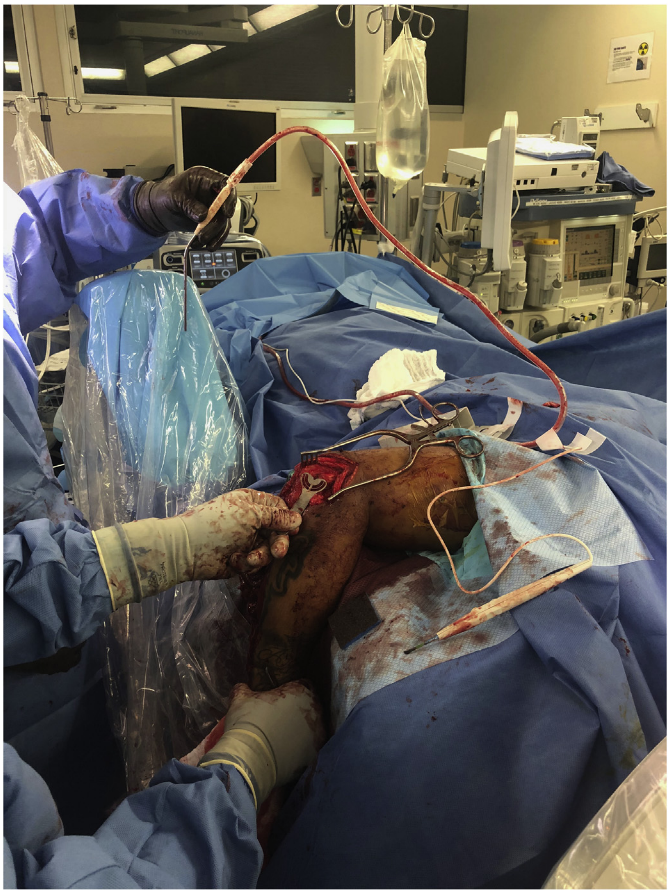

Figure 8 Axis-centering guide being used to find the anatomic *center* of rotation of the capitellum. Note full visualization of the lateral epicondyle is required for accurate placement.

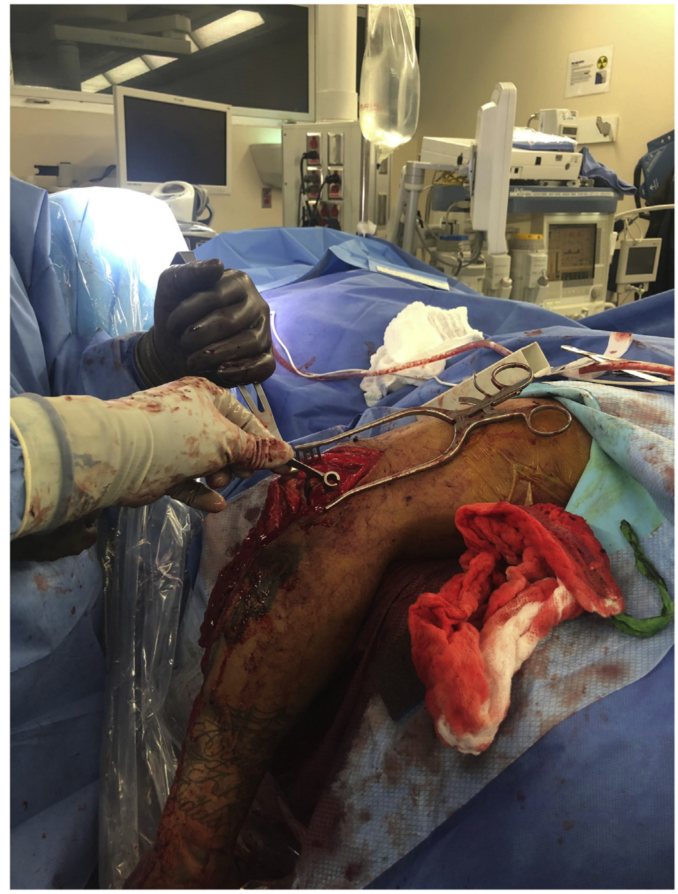

Figure 9 Placement of the axis guide into the trochlear groove.

Incision

Begin the incision 2 cm proximal to the olecranon in the midline of the posterior distal humerus (Fig. 3). Curve the incision laterally proximal to the tip of the olecranon along the lateral aspect of the olecranon process, then curve back medially over the middle of the posterior aspect of the subcutaneous ulna. The incision should measure approximately 8-10 cm (Fig. 4).

Superficial dissection and component placement

First, identify the ulnar nerve and fully dissect it away from its soft-tissue adhesions (Fig. 5). It is advantageous to identity and protect the ulnar nerve to avoid any traction injuries, and placing a vessel loop around the ulnar nerve will help to always know the nerve position during surgery. Incise the deep posterior fascia along the midline of the ulna.

Next, identify and mark the anatomic central axis of the lateral capitellum. This can be identified on a lateral radiograph (Fig. 6) of the elbow as the center of a circle that fits the curvature of the capitellum (Fig. 7). To accurately identify the anatomic center of rotation, using the axis-centering guide (Fig. 8), full visualization of the lateral epicondyle to the capitellum is critical.

In order to visualize the lateral epicondyle and capitellum, often this is stripped, and minimal further dissection is required to gain more access and identify the center of rotation. Apply a varus stress to open the joint. This allows access to insert the largest-size axis guide that is appropriate for the patient. When used properly, the axis guide handle should be parallel with the humeral shaft and fitted into the trochlear notch, engaging the medial trochlear expansion (Fig. 9). As a special note, the C-arm is configured in what we call the "Scorpion Configuration" which allows for easier access of the C-arm to the elbow).

1. Insert the K-wire Guide into the axis guide so that it is close to the lateral epicondyle but does not make contact. Contact with the lateral epicondyle will prevent the axis guide from engaging the medial trochlear expansion appropriately, leading to improper alignment.
2. Lock it into position by rotating it clockwise.
3. Advance the guidewire (1.5-mm K-wire) through the guide and into the humerus. Do not penetrate the medial cortex, which can put the ulnar nerve at risk for injury.
4. Once a guidewire is in place, remove the other parts of the assembly (Figs. 10 and 11). Use intraoperative fluoroscopy to confirm that the guidewire has been advanced to the correct depth and that the axis of rotation has been properly established.
5. Pass the depth gauge over the wire to measure the proper length of the axis pin (Fig. 12. Choose a shorter length if measurements fall between axis pin sizes.
6. Use the 2.7-mm cannulated IJS-E Drill to drill over the wire to the appropriate depth (Fig. 13).
7. After drilling, remove the guidewire.
8. Place the base plate on the proximal ulna with the use of fluoroscopy (Fig. 14).

Figure 10 Insertion of the K-wire at the anatomical *center* of the lateral epicondyle.

Figure 11 The guidewire in place after placement through the axis guide.

9. Use the 2.7-mm drill bit to drill a bicortical hole through the base plate's sliding slot (Fig. 15).
10. Placing your first screw here helps facilitate appropriate positioning. Aim toward the coronoid process, taking care to stay away from the radial notch and articular surfaces.
11. Measure the depth of your bicortical hole using the depth gauge and place an appropriate-length 3.5-mm compression screw (polyaxial nonlocking) using the T-10 driver.
12. Repeat the last two steps for the base plate's remaining two screw holes. The head of the proximal locking crew and the arrow of the distal locking joint should point proximally. If they do not, loosen the distal locking screw and remove the distal connecting rod.
13. Flip the distal locking joint 180°. Its arrow should now point proximally. Reinsert the distal connecting rod into the distal locking joint, with the proximal locking screw also pointing proximally.
14. Adjust the distal connecting rod to allow the selected axis pin to be inserted through the eyelet of the proximal connecting rod and into the humerus (Fig. 16).
15. Tighten the axis pin into place using the T-10 driver. While doing this, you can stabilize the proximal connecting rod by using the PROTEAN Pliers or a needle driver.
16. Reduce the elbow joint. Confirm anatomic alignment with fluoroscopic imaging (Fig. 17).
17. Placing the patient's hand over their face can aid in maintaining elbow reduction and minimizes shoulder rotational torque.
18. Lock the reduction by tightening the proximal and distal locking screws (proximal first). Use the T-10 driver and the counter torque tool to lock these screws. Maintaining elbow reduction requires full tightening of both the proximal and distal locking screws.
19. Use fluoroscopy to evaluate the patient's reduction through full ROM. Confirm that the reduction is maintained through the full ROM.
20. Using a pin cutter, remove any portion of the distal connecting rod that exits the distal locking joint. Trim this as closely as possible to the distal locking joint to minimize soft-tissue irritation.
21. Repair the origin of the lateral collateral ligament, which usually happens using suture anchors, unless there is a bone loss that requires the use of bone tunnels. The origin of the common extensor musculature using suture anchors inserted on the lateral epicondyle with #2 nonabsorbable sutures.
22. Close the incision in the usual fashion.

Danger structures

Ulnar nerve

The ulnar nerve should initially be identified and protected during the approach. It can usually be palpated 2 cm proximal to the medial epicondyle. Transposition of the ulna nerve is not necessary, as ulnar nerve neuropathy has not been observed.[5]

Figure 12 Depth gauge over the guidewire. Note there are 9 lengths of pins available.

Figure 13 A 2.7-mm cannulated drill being used to drill to the depth indicated by the guidewire. Note the depth marks etched in the drill.

Radial nerve

The radial nerve which is commonly not observed with this exposure is in danger proximally, as it travels from the posterior to anterior brachial compartments through the lateral intermuscular septum. The nerve can usually be found at the lateral border of the humerus near the distal one-third of the junction. On the other hand, the posterior interosseous nerve can be at risk if an ORIF procedure or radial head replacement procedure is required as it passes around the neck of the radius traveling through the supinator muscle. Radial nerve dissection would be required only if the fracture on radius is very distal to the radial neck.

Discussion

Posterior vs. lateral approach

While the suggested lateral approach is effective in the treatment of most unstable elbow injuries, intraoperative visualization of the medial structures is limited, even with effective retraction. Therefore, we have implemented a posterior approach at our institution to increase visualization of medial structures and allow for more effective repair of medial lesions without a second incision. Thus far, we have noticed no complications using this procedure and decreased operating times that can be attributed to the increased intraoperative visual field. There is also, an arguably, more cosmetic scar because of the placement of the incision in a location that is less visible.

Indications/contraindications

The absolute indications for IJS are rather vague. However, the device has been used to successfully treat grossly unstable elbow injuries including fracture/dislocations, “terrible triad” injuries, Monteggia injuries, chronic elbow dislocations, medial instability.[1,2,6] One of the major advantageous of the posterior approach is, if needed, the ability to repair the medial collateral ligament. Thus, potential disadvantages to a posterior approach are a more extensive dissection than the traditional lateral approach, and studies have focused on patients with good bone quality to allow adequate purchase by the device.[2] Patients should also be willing to undergo a second procedure to remove the device, as it is designed to be removed in 6-8 months according to FDA recommendations.[1-3,6] However, there have been reports of patients leaving the device in for up to 5 years with no side effects.[2,6] The posterior approach is particularly useful in cases where visualization of the medial epicondyle is necessary. These devices have been contraindicated in patients with previous hypersensitivity reactions to the metals in the device, bone loss greater than 30%, fractures involving an entire column of the humerus, patients with less than 50% of coronoid height remaining, and signs of an active infection.[2] This procedure is relatively contraindicated in patients where adherence to instructions would be a problem.

Postop results

Patients treated with an IJS generally achieve greater mobility, have improved functional outcomes, and suffer fewer

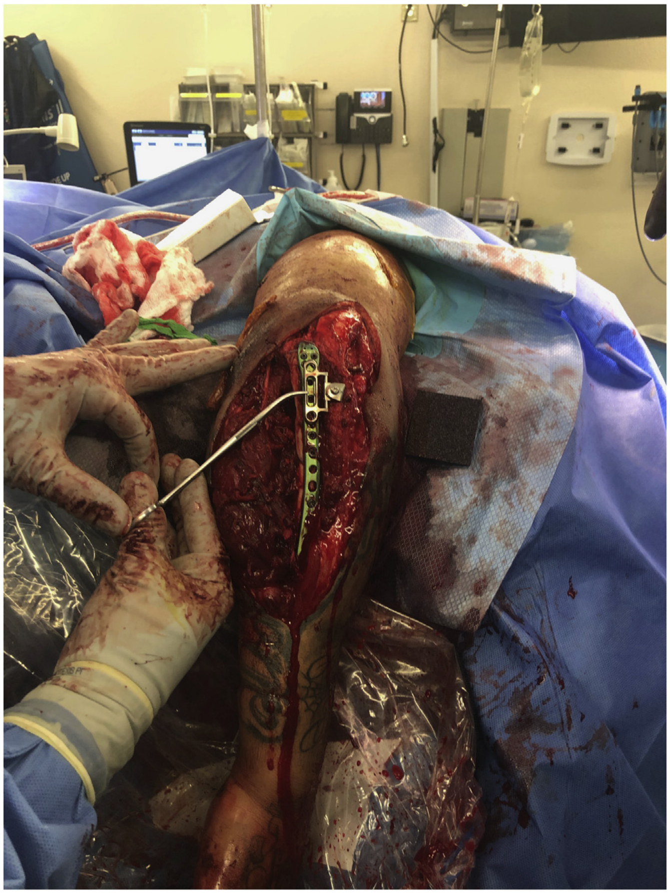

Figure 14 Base plate placed on the proximal ulna. Note the plate is placed over the olecranon. Plate used for ORIF of the ulna fracture. If there were no concomitant fracture, the base plate would be directly on the bone.

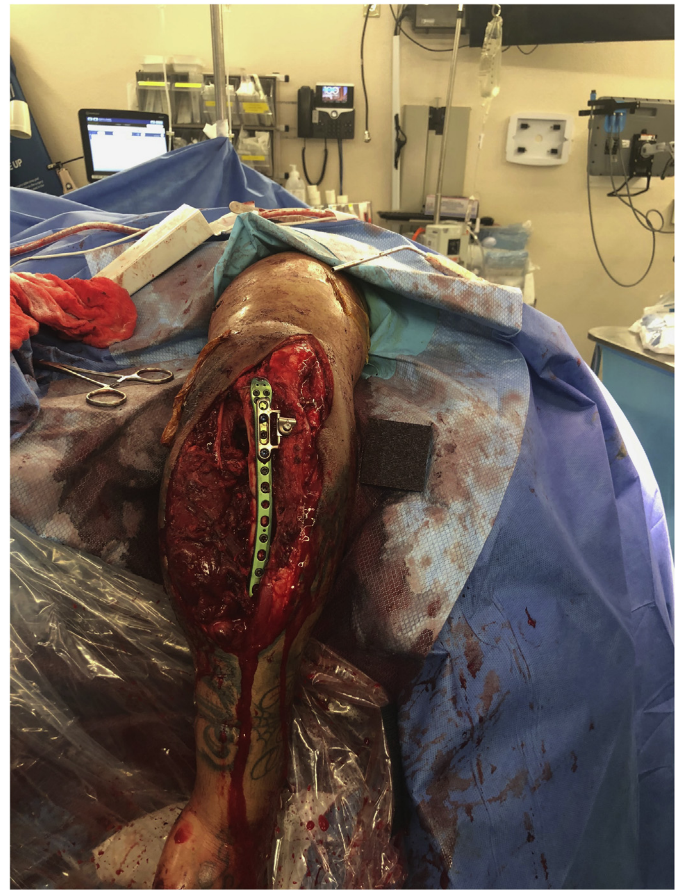

Figure 15 Nonlocking screw placed in the sliding hole of the ulnar base plate. Note placing your first screw here helps facilitate positioning.

postoperative complications than patients treated with traditional methods.[1,2,4,6] Previous studies have shown that patients were able to attain an average ROM between 124° and 134° using an IJS device,[1,2,6] compared to an average ROM of 104.5° (range: 85°–146°) in cases using an external hinged device.[2] The reported average postoperative DASH scores ranged from 16 to 37.3 in a few small case series,[2,4,6] compared with an 85.3 reported average for a preoperative DASH score in 1 study.[6]

Complications reported after IJS fixation include one case of a sterile inflammatory reaction, five cases of median or ulnar nerve palsy, one case of malreduction, one case of hardware failure, two cases of infection, one case of a superficial wound hematoma, one case of pain over the implant site, 2 cases of contracture formation, and one case of heterotopic bone formation after a terrible triad injury.[1,2,4,6] Comparatively, in studies involving external hinged fixation, pin-related complications are relatively common, occurring in up to 37% of cases.[2] Pin-site complications include, but are not limited to, pin-site infection, pin breakage, pin-site-related fractures, chronic regional pain syndrome, and nerve palsies in as high as 15% of patients, some of which require reoperation.[1,2,6] Non-pin-site-related complications include joint stiffness due to prolonged immobilization and significant patient discomfort due to the cumbersome size of these devices.[2]

Reoperation

Per manufacturer instructions, these devices are only intended to be left in place for 6 months postoperatively, meaning that a second procedure is required for device removal.[3] One study adhered to these guidelines and saw satisfactory results with no complications noted during the second operation.[2] However, in another study, these devices were left in place and only removed because of either complications or patient preference (6/20 devices removed). This study also achieved significant improvement in elbow ROM and function.[6] However, the average DASH scores after device removal in the first study was 16 compared with 37.3 in the study without device removal.[2,6] Better DASH scores could support device removal as per manufacturer instructions; however, further studies are needed to investigate the effects of the device being left in place for longer than 8 weeks.

Conclusions

Elbow instability presents a challenging problem for orthopedic surgeons. Traditionally these injuries have been repaired with long-term immobilization, transarticular pinning, or hinged external fixation with outcomes that produce inconsistent results. Recently, the use of IJSs has shown promise for these complex repairs. While manufacture recommendations call for a lateral approach for these procedures, we noticed difficulty visualizing medial structures intraoperatively and began using a posterior approach. The use of IJS with a posterior approach has shown promise at our institution in the repair of unstable elbow injuries, providing the surgeon with an increased visual field intraoperatively.

This has led to greater ease of device placement and possibly decreased operative times have thus also been observed.

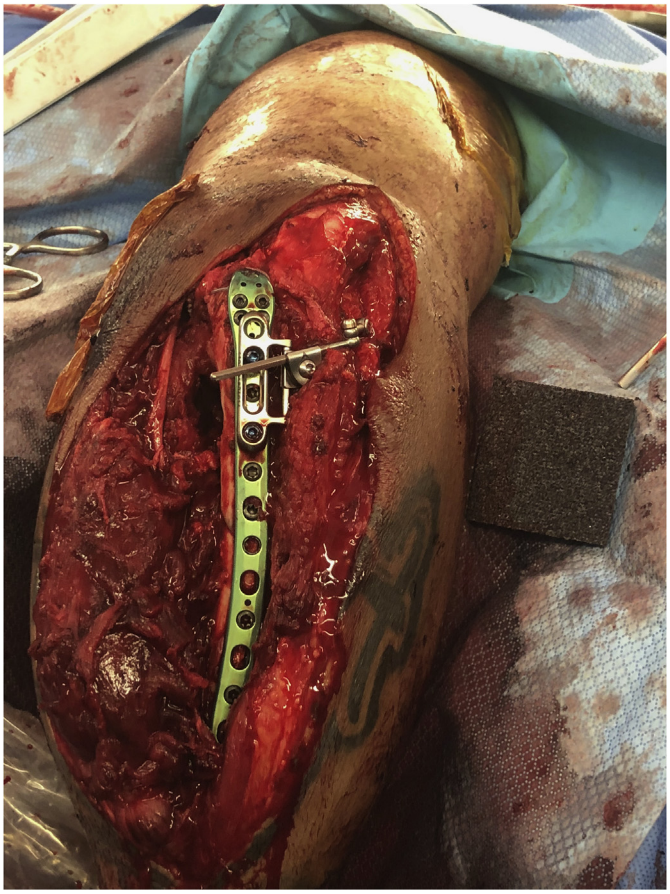

Figure 16 IJS in place with axis pin inserted through the eyelet of the proximal connecting rod.

Figure 17 Lateral radiographs confirming anatomic alignment of the IJS through the range of motion.

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