SUBSPECIALTY PROCEDURES

OPEN REDUCTION AND INTERNAL FIXATION FOR LATERAL UNICONDYLAR DISTAL HUMERAL FRACTURES

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Introduction

Unicondylar distal humeral fractures are uncommon, partially intra-articular fractures (OTA/AO type B1) that are among the most complex fractures to treat^{1,2}; however, most displaced distal humeral fractures, including lateral unicondylar distal humeral fractures²⁻⁵, can be effectively managed with open reduction and internal fixation. The goal of treatment is to achieve anatomic reduction with stable fixation^{5,6}. Fixation can be achieved using pins, headless screws, lag screws, locking compression plates, or dynamic compression plates^{2,6} to allow for early range of motion.

Indications & Contraindications

Indications

- Lateral unicondylar distal humeral fractures (OTA/AO type-B1 fractures)

Contraindications

- Active infection
- Severe open wounds with inadequate soft-tissue coverage
- Unacceptable surgical risk
- Severe osteoporosis
- Noncompliant patient

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Step 1: Preparation of the Operating Room and the Patient

Perform sterile preparation, have the patient brought into the operating room, induce anesthesia, and place the patient in the lateral decubitus or supine position before sterile draping.

- Consider a preoperative computed tomographic (CT) scan as an option to assess intra-articular comminution. This information is helpful in deciding whether olecranon osteotomy will be needed, and it dictates the approach.
- Review preoperative radiographs (Figs. 1-A through 2-B).
- Identify the patient properly in the preoperative holding area and confirm that the correct extremity has been marked.
- Have the patient brought into the operating room and place him or her on the operating table in the supine position.
- Adhere to sterile operating procedures and perform preoperative time-out procedures.
- Administer general endotracheal anesthesia (endotracheal or laryngeal mask) and prophylactic antibiotics if needed.
- Place the patient in the lateral decubitus or supine position on the operating table with the injured arm elevated over a padded radiolucent arm table to ensure that it can be flexed beyond 100°, carefully pad and stabilize all appropriate prominences adequately, and remove any pressure from the axilla and peroneal nerve areas.
- Position a fluoroscopic C-arm unit according to the surgeon's preference from the same side of the patient and confirm anteroposterior and lateral views of the elbow prior to draping.
- Prepare and drape the injured upper extremity from the fingertips up to the shoulder in the usual sterile fashion.
- Place a sterile pneumatic tourniquet on the upper aspect of the arm and inflate to 250 mm Hg, after exsanguinating the arm with either an Esmarch bandage or HemaClear self-exsanguinating type of tourniquet.

Fig. 1-A

Fig. 1-B

Fig. 2-A

Fig. 2-B

Figs. 1-A and 1-B Preoperative radiographs of a 20-year-old man who sustained an acute fracture of the left lateral humeral condyle in a motor vehicle accident. **Fig. 1-A** Anteroposterior radiograph shows the left lateral humeral condylar fracture with extension of the fracture line into the articular surface between the capitellum and the trochlea. **Fig. 1-B** Cross-table view of the elbow shows a concomitant acute comminuted fracture at the junction of proximal one-third and distal two-thirds of the left ulna.

Figs. 2-A and 2-B Preoperative radiographs of a 90-year-old woman who had a right lateral humeral condylar fracture following a fall. **Fig. 2-A** Anteroposterior radiograph shows a minimally displaced fracture of the lateral condyle of the humerus without evidence of dislocation. **Fig. 2-B** Articular radiograph of the elbow joint.

Step 2: Approach to the Fracture

Make a lateral incision, expose the lateral distal part of the humerus, identify the ulnar nerve if necessary, visualize the fracture fragments, and debride the fracture site.

- Make either a midline posterior incision slightly radial to the olecranon or a lateral incision approach to the lateral condyle.
- Incise the deep fascia in line with the skin incision.
- Stay dorsal to the intermuscular septum and dorsal to the lateral ligaments. As long as this is taken into consideration, the radial nerve is protected by the musculus brachialis and brachioradialis. When dissecting more proximally, identify and protect the radial nerve.
- Choose a posterior or lateral approach to the elbow. When a posterior approach is chosen, make full-thickness flaps both medially and laterally to reflect back the triceps tendon and muscle belly, and to expose the distal part of the humerus.
- Elevate the triceps off the medial and lateral intermuscular septa.
- When a medial and lateral paratricipital approach or an olecranon osteotomy is planned, identify the ulnar nerve proximally along the medial border of the triceps and dissect it free from the cubital tunnel distally. Protect it for the entire procedure. No dissection is needed when only the lateral approach is used.
- If a lateral approach to the elbow is preferred, develop the interval between the extensor carpi ulnaris and anconeus muscles distally and between the triceps and brachioradialis and extensor carpi radialis longus proximally.
- When an extended approach to the radiocapitellar joint is necessary, be aware of the posterior interosseous nerve (PIN) when dissecting distally along the radial neck. Pronation of the forearm will further aid in protecting the PIN.
- Perform a longitudinal capsulotomy from the lateral humeral epicondyle to the radial head and expose it anteriorly and posteriorly to gain sufficient visualization of the radiocapitellar joint.
- Visualize the fracture fragments by elevating the triceps and anconeus muscles off the posterior aspect of the lateral column.
- Perform a distally pointed chevron olecranon osteotomy for comminuted fractures, to expose the fracture and to allow stable fixation.
- Debride the fracture site and ensure that no intra-articular fracture components are missed.
- Avoid excessive stripping of the lateral and posterior condylar fragment(s) to avoid osteonecrosis; nonunion; lateral ulnar collateral ligament disruption; and disruption of the blood supply, resulting in insufficient nutrition to the bone to allow for healing.
- Reconstruct the intercondylar comminution prior to reducing the lateral condylar fragment.

Step 3: Reduction of the Fracture

Reduce the fracture and fix it temporarily.

- Manipulate and realign the fracture by realigning the metaphyseal fracture lines. Kirschner wire joysticks can be helpful in manipulating the condylar fragments. Place a fracture clamp, if needed. Under direct visual control, reduce and provisionally fix the distal fragment to the shaft with smooth Kirschner wires at least 1.5 mm in diameter and/or reduction forceps to ensure anatomic restoration of the distal humeral articulation, while making sure that Kirschner wires do not interfere with subsequent plate or screw placement.
- Utilize independent lag screws, if needed.
- Consider using headless screws for securing large articular fragments with adequate bone quality.

Step 4: Plate Fixation of the Fracture

Determine the plate length; position the plate posterolaterally, posteriorly, or laterally; insert screws; remove provisional Kirschner wires; and obtain intraoperative images.

- Perform fixation of lateral unicondylar distal humeral fractures with plates placed according to 1 of 3 techniques based on the anatomic location: posterior, posterolateral, or lateral.
 - Plate placement should be decided on the basis of the specific fracture pattern for optimal stabilization.
 - When plate and screw fixation is chosen, then determine the plate length that provides sufficient fixation proximal to the fracture lines utilizing the AO preoperative planner template.
- The most common technique in our facility is to use a lateral plate.
- Contour the plates to bend anteriorly following the anterior bend of the lateral column.
- In a patient managed with a posterolateral plate, place the posterolateral distal humeral plate on the posterolateral aspect of the distal end of the humerus with the distal portion covering the nonarticulating part of the capitellum, and with the lateral support extending over the most protruding tip of the lateral epicondyle, just proximal to the lateral collateral ligament insertion⁷. Make sure it does not interfere with the muscle origins⁸.
- Ensure preliminary fixation of the plate with a cortical screw and do not tighten the screw.
- Drill a pilot hole across the fracture site in the condylar mass.
- Subsequently, measure the length of the screw and insert distal screws.
- Anchor the shaft of the posterolateral plate proximally to the bone using 2.7-mm locking and/or cortical screws with a 2.0-mm drill, while avoiding the olecranon fossa and the articular surface⁸.
- Obtain anteroposterior and lateral images under C-arm fluoroscopy throughout the procedure to confirm the anatomic reduction, hardware placement, and gross alignment.
- Place remaining screws.
- Remove the provisional Kirschner wire fixation.
- In patients with a large osseous defect, place an apatite-based calcium phosphate bone cement into large defects of the lateral condyle if there is little cancellous bone left after fixation. The use of allograft should also be taken into consideration to fill voids.
- Irrigate the wound copiously.
- Depending on the surgeon's preference, repositioning of the olecranon osteotomy can be performed using the following techniques^{9,10}:
 - A 6.5-mm cancellous bone screw over a washer in combination with a figure-of-8 tension-band technique;
 - Two smooth 0.045-in (1.143-mm) oblique Kirschner wires in combination with tension band wires;
 - A 3.5-mm cortical lag screw in combination with tension band fixation;
 - One-third tubular-hook-plate osteosynthesis for olecranon osteotomies.
- Take the elbow through a range of motion for flexion-extension and pronation-supination to ensure that it is stable without evidence of dislocation, impingement, or migration of the fracture fragments (Video 1).

Video 1 A demonstration of the operative procedure in a patient managed with a posterior approach without osteotomy, in whom the fracture fragments are reduced and held with screws and 2 parallel Kirschner wires in combination with a posterior figure-of-8 wire loop as a tension band. The ultimate fixation is achieved by a dynamic compression plate. Finally, the stability and range of motion is assessed intraoperatively.

Step 5: Final Radiographic Imaging

Make anteroposterior and lateral radiographic images to confirm reduction and adequate anatomic alignment of the elbow and the position of the hardware.

- Obtain final radiographic images under C-arm fluoroscopy to confirm reduction of the fracture, adequate anatomic alignment of the elbow, and the position of the hardware with no substantial protrusion of the joint (Figs. 3-A through 4-B).

Fig. 3-A

Fig. 3-B

Fig. 4-A

Fig. 4-B

Figs. 3-A and 3-B Postoperative radiographs of the patient in Figures 1-A and 1-B who was managed with open reduction and internal fixation of the humeral lateral condylar fracture as well as screw plate fixation of the comminuted proximal ulnar fracture. **Fig. 3-A** Anteroposterior radiograph.

Fig. 3-B Lateral radiograph.

Figs. 4-A and 4-B Postoperative radiographs of the patient in Figures 2-A and 2-B who was managed with open reduction and internal fixation of the right distal humeral intra-articular fracture in nearly anatomic alignment using 2 partially threaded screws. **Fig. 4-A** Anteroposterior radiograph.

Fig. 4-B Articular radiograph.

Step 6: Closure of the Wound

Deflate the tourniquet, irrigate the wound, and apply postoperative dressings.

- Deflate the tourniquet while obtaining hemostasis.
- Irrigate the surgical wound copiously.
- Place a drain, if needed.
- Close the wound in layers from deep to superficial, utilizing buried interrupted number 2-0 and/or 3-0 Vicryl suture (polyglactin; Ethicon) subcutaneously and staples or nylon sutures to close the skin. Secure the ulnar nerve to deeper tissue to avoid ulnar nerve subluxation around the medial epicondyle. If the nerve might be at risk of injury, consider transposition of the nerve. Ensure that the ulnar nerve stays mobile and free without any signs of compression.
- Apply sterile dressings.
- A well-padded long posterior splint may be applied to maintain the elbow in 90° of flexion and neutral forearm rotation. A splint is needed only when there is a multifragmentary fracture or if the surgeon prefers further immobilization.
- Turn the patient supine, awaken and extubate the patient, and have the patient transferred to the recovery room.

Results

The detailed outcome for a cohort of 24 patients who underwent this procedure has been reported elsewhere⁶. The results for 20 patients with complete data who were followed from 16 to 144 months were good to excellent for 80% of the patients, fair for 10%, and poor for 10%. The functional outcome score for the patients, according to the Quick Disabilities of the Arm, Shoulder and Hand questionnaire, was a mean (and standard deviation) of 12 ± 13.

The mean score on the American Shoulder and Elbow Surgeons questionnaire was 87 ± 15 , and the mean score on the Mayo Elbow Performance Index was 88 ± 14 at the final follow-up.

The reoperation rate was 29% (7 patients), and the additional operations were performed for combined reasons. The most common reasons for reoperation were implant removal (7 patients), contracture release (3), and ulnar nerve transposition (3).

Pitfalls & Challenges

- Hardware irritation
- PIN problems
- Ulnar nerve problems
- Inadequate fixation
- Screws protruding into the joint
- Elbow contracture is a feared complication, and aggressive physical therapy should be initiated as soon as fracture stability allows.
- Check intraoperative range of motion to avoid missing a mechanical block or crepitus from the intra-articular position of a screw.

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