

Surgical Exposures for Bicolumn Distal Humeral Fractures

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Abstract

The surgical management of fractures of the distal humerus is technically challenging. The goal is to obtain adequate exposure without causing unnecessary morbidity, which can be achieved if the surgeon is familiar with several posterior approaches used to expose bicolumn distal humeral fractures. These approaches begin with a common medial dissection and branch into progressively more extensile exposures.

Instr Course Lect 2009;58:509-514.

The surgical management of fractures of the distal humerus requires an approach that provides adequate exposure of the fracture, can be extended if more exposure is required, and protects the native anatomy, with as little disruption as possible. Several posterior approaches to the distal humerus can accomplish these goals, including the triceps-preserving approach, the olecranon osteotomy, the triceps-reflecting approach (Bryan-Morrey), and the triceps-reflecting anconeus pedicle (TRAP) approach. These approaches all begin from a common initial dissection and branch to more extensile exposures, depending on the fracture configuration and the need to gain better exposure of the articular segment. They vary primarily in the handling of the distal triceps muscle. Although these approaches are not the only means of obtaining exposure of the distal humerus, they are well described in the literature and are ideally suited for the management of bicolumn distal humeral fractures.

Common Aspects of the Surgical Technique

Patient Positioning

The patient can be placed supine with the arm across the chest or in the lateral decubitus position with the arm supported across a padded support; both positions make the posterior aspect of the arm and elbow accessible to the surgeon. The lateral decubitus position is preferred for distal humeral fractures because the arm is maintained on a working base that stabilizes the proximal fragment; the anatomy is viewed in an upright, although reversed, orientation; and gravity acting on the dependent forearm can assist in reducing the fracture. In contrast, the supine position places the arm in space such that the distal fragment needs to be manipulated to align it with a mobile proximal fragment. A roll or pad can be placed under the contralateral hemithorax to prevent the arm from sagging; a sterile arm holder can be used to hold the arm steady across the chest.

A sterile arm tourniquet can be used to provide hemostasis. This is especially helpful during the initial surgical exposure when the ulnar nerve is dissected. If the entire procedure lasts longer than 2 hours, the tourniquet will need to be deflated. Intraoperative image intensification also is helpful for assessing fracture reduction and internal fixation during the procedure. Fluoroscopy is faster than plain radiography, conserves time, and permits easy multiple plane imaging.

Skin Incision

A straight posterior skin incision is made just off the lateral tip of the olecranon (Figure 1). This incision provides excellent exposure and cosmesis, and the slightly lateral position prevents discomfort when leaning on the scar, which can occur with a medial incision. Full-thickness medial and lateral skin and subcutaneous tissue flaps are elevated. These subcutaneous flaps should be limited to the amount of dissection required to obtain adequate exposure. Aggressive subcutaneous flap elevation can lead to a large dead space for hematoma formation and should be minimized.

Management of the Ulnar Nerve

The ulnar nerve is identified on the medial border of the triceps, high in

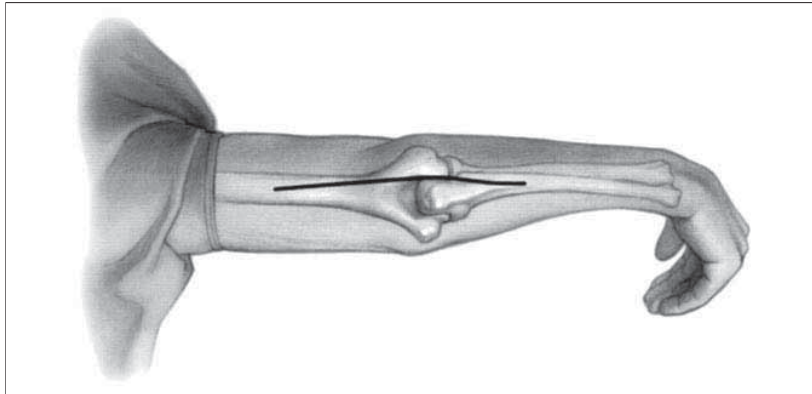


Figure 1 The posterior skin incision is placed off the lateral border of the olecranon to avoid incisional sensitivity postoperatively (Reproduced with permission from O'Driscoll SW: The triceps-reflecting anconeus pedicle (TRAP) approach for distal humeral fractures and nonunions. *Orthop Clin North Am* 2000;31:91-101.)

the arm away from the zone of injury. The ulnar nerve is circumferentially dissected, sparing as much of the vascular supply to the nerve as possible. It is followed distally into the flexor carpi ulnaris muscle to the first motor branches. Proximally, the nerve is freed from the triceps muscle as far as is needed to obtain exposure along the medial aspect of the humerus. It must be carefully protected during the rest of the procedure. At the end of the procedure, the ulnar nerve can be transposed into a subcutaneous position.

Deep Exposure of the Medial Triceps

The initial step in any of these posterior approaches to the distal humerus is exposure of the medial aspect of the triceps and identification of the medial intermuscular septum in the posterior aspect of the elbow. Posterior compartment structures, in particular the triceps muscle, lie posterior to the medial intermuscular septum. With the medial intermuscular septum identified, the medial border of the triceps can be dissected down to its attachment on

the olecranon. A Cobb elevator can be placed across the posterior aspect of the elbow, allowing elevation of the triceps off the posterior capsule. The posterior capsule is excised to expose the supracondylar region and the posterior articular surface. The posterior fat pad also can be excised to prevent it from blocking elbow extension. The fracture pattern can be evaluated, and the most appropriate approach for the fracture configuration can then be determined (Figure 2).

Radial Nerve

The radial nerve may need to be identified and protected when a more proximal exposure of the humerus is required. The radial nerve can be identified on the lateral side as it pierces the lateral intermuscular septum.

Triceps-Preserving Approach

The triceps-preserving approach (triceps on approach) is the author's preferred approach and is ideally suited for treating supracondylar fractures without substantial comminution as well as simple intra-

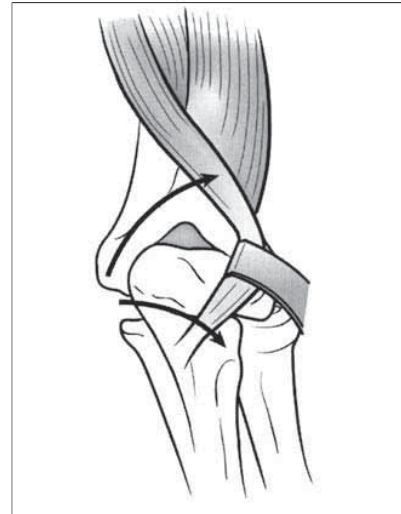


Figure 2 Developing the medial border of the triceps allows evaluation of the fracture configuration. With the triceps retracted laterally and the postero-medial capsule excised, the fracture pattern can be assessed. (Reproduced from Bain GI, Mehta JA, Yeow-Wai L: Surgical approaches for total elbow arthroplasty, in Yamaguchi K, King GJ, McKee MD, O'Driscoll SW (eds): *Advanced Reconstruction: Elbow*. Rosemont, IL, American Academy of Orthopaedic Surgeons, 2007, p 209).

articular fractures without comminution. Depending on the extent of the proximal dissection, the radial nerve may need to be identified as it courses across the lateral humerus posteriorly to anteriorly. The lateral border of the triceps is released to the lateral epicondyle distally. With the medial and lateral aspects of the triceps released down to the epicondyles, the exposure distally is completed by one of two methods.

In the first method, the bilatero-tricipital approach, the lateral and medial dissection to the triceps insertion onto the olecranon is completed.¹ This approach dissects across the anconeus muscle from the lateral epicondyle to the midportion of the greater sigmoid notch of

the ulna and consequently denervates the anconeus muscle. An alternative distal approach to the lateral side continues from the lateral epicondyle along the Kocher interval between the anconeus and the extensor carpi ulnaris (Figure 3). The anconeus, in continuity with the triceps, is swept off the posterior capsule. The posterior capsule below the lateral ulnar collateral ligament is excised to expose the articular surface (Figure 4). The common extensor muscles and a portion of the extensor carpi radialis longus are partially released from the anterior aspect of the supracondylar column and the lateral epicondyle, allowing identification of the lateral column. Care should be taken to protect the lateral collateral ligament complex to avoid iatrogenic elbow instability. Distal dissection on the medial side of the triceps is carried down to the olecranon.

The triceps muscle can be retracted medially or laterally to gain access to the supracondylar region and the articular segment from either direction for fracture reduction and internal fixation. It is critical that the medial trochlea and posterolateral aspect of the radiocapitellar joint be exposed to provide anatomic landmarks for targeting screw placement across the articular segment without violating the articular cartilage.

Extensile Maneuver From the Triceps-Preserving Approach

If the triceps-preserving approach does not provide adequate exposure, the extensile maneuver from this approach is added to an olecranon osteotomy. This is simple to accomplish from the bilaterotricipital approach because the medial and lateral triceps dissection has already been done. If the triceps-preserving ap-

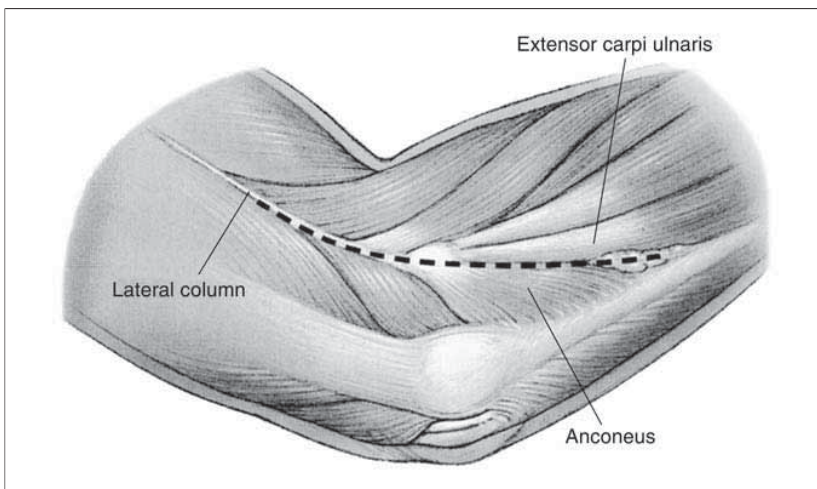


Figure 3 Distal exposure along the lateral elbow continues below the epicondyle in the Kocher interval. (Reproduced with permission from the Mayo Foundation for Medical Education and Research.)

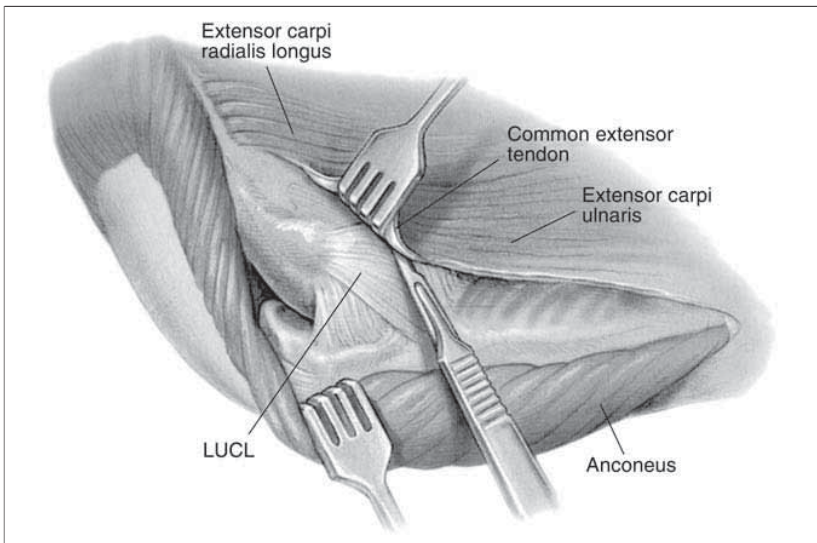


Figure 4 The anconeus in continuity with the triceps is swept off the posterolateral capsule. Excision of the capsule below the lateral ulnar collateral ligament (LUCL) exposes the lateral joint. (Reproduced with permission from the Mayo Foundation for Medical Education and Research.)

proach has developed the Kocher interval distally along the lateral side of the elbow, the osteotomy is made as described in the anconeus flap transolecranon approach² (Figure 5).

A chevron osteotomy with the apex placed distally is preferred. The

osteotomy is begun with a thin microsagittal saw; an incomplete bone cut is made. The osteotomy is placed in the bare area of the greater sigmoid notch to prevent injury to the articular cartilage. The osteotomy is completed through the articular surface

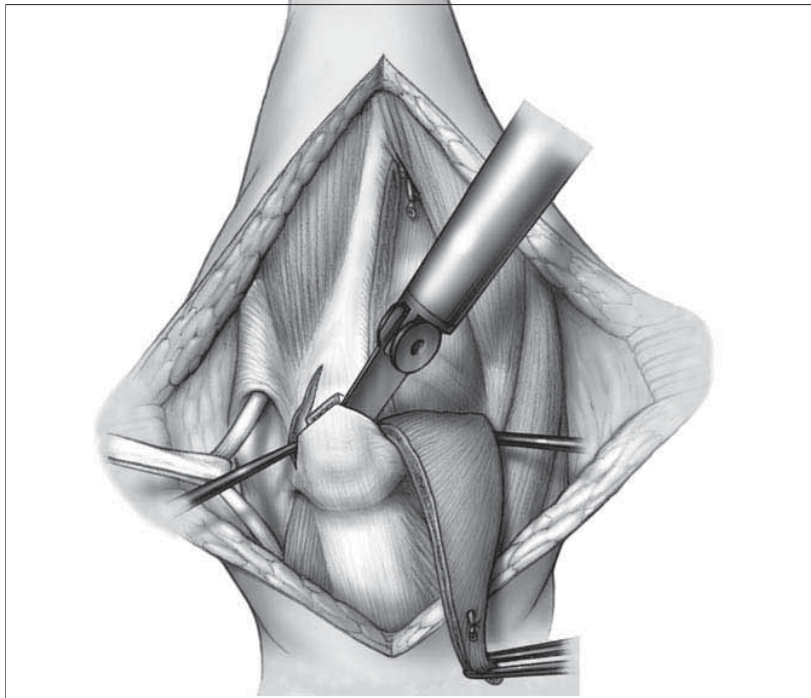


Figure 5 The anconeus flap transolecranon approach. (Reproduced with permission from Athwal GS, Rispoli DM, Steinmann SP: The anconeus flap transolecranon approach to the distal humerus. *J Orthop Trauma* 2006;20:282-285).

with an osteotome by cracking the subchondral bone. This provides irregular surfaces for interdigitation when the osteotomy is fixed. With the osteotomy completed, the olecranon and triceps are reflected proximally. This approach provides extensile exposure of the articular surface of the distal humerus as well as the medial and lateral columns.

The olecranon osteotomy can be fixed with either a figure-of-8 tension band or a dorsal plate and screws. Tension band fixation can be done with two parallel Kirschner wires drilled down the intramedullary canal or obliquely so that they engage the anterior cortex of the ulna distal to the coronoid process. Alternatively, a 6.5-mm cannulated screw can be placed down the intramedullary canal, engaging the ulnar cortex distally. When a longitu-

dinal screw is used, the ulna should be predrilled before the osteotomy. Biomechanical studies are contradictory about the superiority of one method of tension-band fixation over another.³⁻⁶ The tension band is completed with a figure-of-8 wire loop that is passed transversely through the triceps tendon insertion proximally and transversely through a drill hole in the ulna just distal to the coronoid.

Plate fixation of the olecranon osteotomy has been advocated to avoid the complications of the tension-band wire technique.⁷ The plate can be placed before the osteotomy is made. The bone is then prepared for later plate placement and the plate is removed to make the osteotomy; fixation of the distal humerus is performed. The plate is then reapplied using the previously established

screw holes. The need for hardware removal is generally lower for plate fixation than for tension-band wire fixation of the olecranon osteotomy.^{3,6,7}

Triceps-Reflecting Approach

The triceps-reflecting approach (Bryan-Morrey approach) reflects the triceps in continuity with the anconeus from the medial side. From the initial medial triceps exposure, the dissection can be carried distally onto the forearm between the anconeus and the flexor carpi ulnaris using a needle tip cautery or a scalpel. Sharpey fibers at the triceps insertion are released from the ulna in continuity with the anconeus muscle around to the lateral column (Figure 6). The muscles should be dissected from the underlying joint capsule to protect the lateral collateral ligament complex and the lateral ulnar collateral ligament. It is critical that the triceps reflection continue around the lateral column to provide enough exposure of the lateral column for lateral plate placement. The posterolateral joint capsule can be resected below the lateral ulnar collateral ligament to allow exposure of the radiocapitellar joint.

Although many distal humeral fracture patterns can be treated through a triceps-reflecting approach, when the triceps is reflected from medially to laterally, it can bunch along the lateral side of the elbow, making exposure of the lateral supracondylar column more difficult. In addition, exposure of the anterior aspect of the distal humeral articular surface may be limited.

Extensile Maneuver to the Triceps-Reflecting Approach

If the Bryan-Morrey triceps-reflecting approach does not provide

adequate exposure, the extensile maneuver is conversion to a TRAP approach.⁸ The lateral border of the triceps is released to the lateral epicondyle and carried below the elbow in the Kocher interval between the anconeus and the extensor carpi ulnaris (Figure 7). The anconeus, in continuity with the triceps, is subperiosteally elevated from the ulna and reflected proximally (Figure 8).

The TRAP approach provides extensile exposure of the medial and lateral supracondylar column and the articular surface. The advantages of this approach are that the neurovascular pedicle to the anconeus is preserved and provides a long sleeve of tissue for extensor mechanism repair.

Wound Closure

The ulnar nerve can be transposed anterior to the medial epicondyle into a subcutaneous position. This is especially necessary if there is hardware on the medial aspect of the distal humerus that might impinge against the nerve. The wound is closed over a drain, and staples are used for skin closure. A sterile surgical dressing and a thin layer of sterile cotton padding are applied to the elbow, and a cold therapy pad is applied sterily over the thin cotton layer. A bulky soft dressing then is applied over the cotton padding and cold therapy pad. An anterior splint is applied with the arm in relative extension to relieve tension on the posterior skin incision.

Postoperative Care

The arm is elevated on several pillows with the hand above the elbow and the elbow above the shoulder to promote drainage and prevent excessive swelling of the upper extremity. Alternatively, the arm can be suspended from an intravenous pole. The arm should be supported

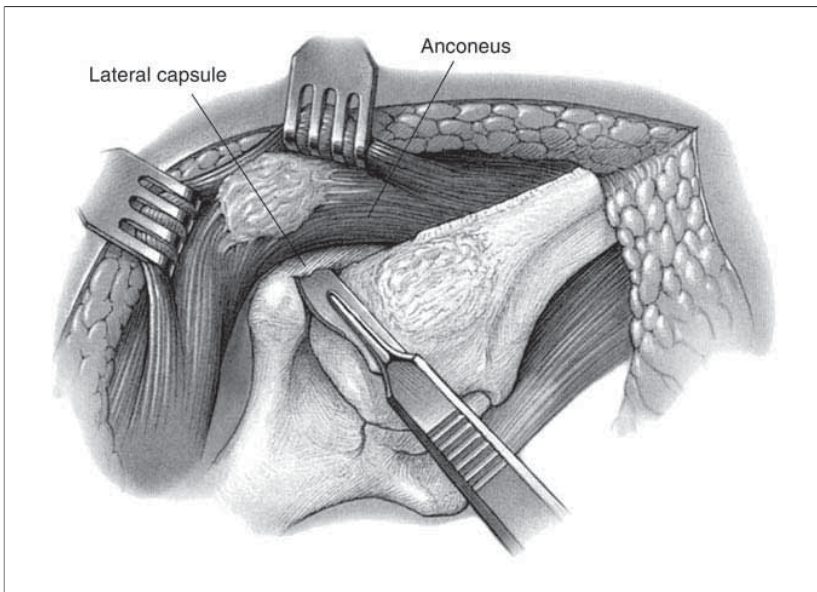


Figure 6 The Bryan-Morrey triceps-reflecting approach. The triceps is reflected from medially to laterally in continuity with the anconeus. (Reproduced with permission from the Mayo Foundation for Medical Education and Research.)

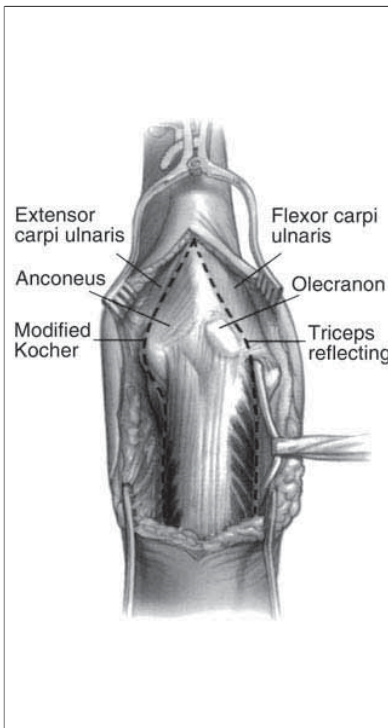


Figure 7 Medial and lateral intervals for the TRAP approach. (Adapted with permission from the Mayo Foundation for Medical Education and Research.)

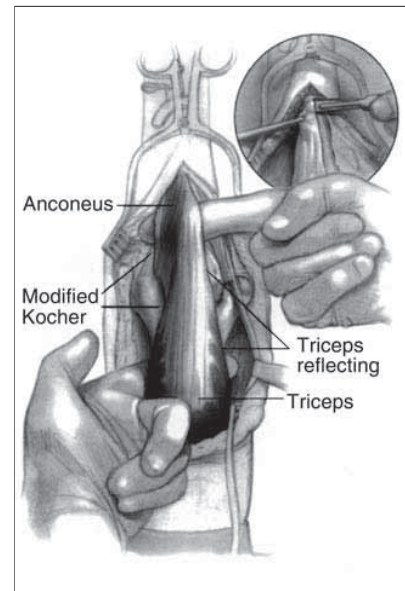


Figure 8 The triceps in continuity with the anconeus can be reflected proximally once the Bryan-Morrey interval is developed medially and an extensile Kocher interval is developed laterally. The neurovascular pedicle to the anconeus is preserved with this approach. (Reproduced with permission from the Mayo Foundation for Medical Education and Research.)

so that the shoulder is not required to help maintain the elevated arm position.

Once the drainage is less than 30 mL for 8 consecutive hours, the dressing and drain are removed, and a range-of-motion protocol is begun. If the triceps was detached from the ulna, active or active-assisted elbow extension is not permitted during the first 6 weeks after surgery; however, active and active-assisted flexion, pronation, and supination are initiated. Forced passive range of motion is not permitted regardless of the approach used because of its association with the development of heterotopic ossification. If the triceps remained attached to the olecranon (osteotomy), active and active-assisted extension is permitted in addition to flexion, pronation, and supination.

Strengthening exercises are not permitted until the postoperative radiographs show evidence of fracture healing. This typically occurs at approximately 8 weeks postoperatively. Additional information on postop-

erative management after open reduction and internal fixation of distal humeral fractures is provided in chapter 51.

Summary

The successful management of distal humeral fractures begins with adequate exposure. Several posterior approaches are available that provide an exposure that can be progressively extended if expanded exposure is required to treat the fracture.

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