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Open Reduction and Internal Fixation With 90-90 Plating of Bicolumn Distal Humeral Fractures

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Abstract

A bicolumn intra-articular fracture is the most challenging distal humeral fracture to treat. Open reduction and internal fixation of these fractures is best achieved using either 90-90 medial-lateral or parallel opposing plates. Either technique can be used to treat most patients, although in some instances, one technique may be preferred over another. The goal of treatment is accurate anatomic restoration and stable fixation that will permit early range of motion.

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The primary goal of surgical treatment of a distal humeral fracture is to achieve stable and accurate bony and articular reconstruction that permits early range of motion, which is the initial component of a rehabilitation process that leads to a functionally successful outcome. Numerous variations of plate and screw fixation have been used and evaluated. Individual variations in fracture pattern and bone quality dictate specific aspects of the surgical approach and internal fixation; in most bicolumn fractures, two plates (medial and lateral) are required.[1-5] These can be oriented parallel on the posterior surface of the humerus, at 90° angles (posterolateral and medial or posteromedial and lateral), or parallel (opposing on the medial and lateral columns). Various plates are available, including semitubular plates, reconstruction plates, dynamic compression plates, and precontoured plates.[6] Recent adaptation of locking screw technology to humeral plating can provide enhanced fixation stability.[7] In addition, cannulated screws, headless screws, Kirschner wires, and resorbable pins can be helpful for the fixation of articular surface comminution.

Surgical Considerations

For most patients, early surgery before the soft tissues become indurated and stiff is preferred. Delayed surgery has been associated with an increased risk of heterotopic ossification. The patient can be positioned supine with the arm across the chest, in the lateral decubitus position, or prone. The best exposure is achieved with a posterior approach. More information on posterior approaches is provided in chapter 47. If a bone graft is needed, the iliac crest can be prepared and draped accordingly.

Early reports of the treatment of distal humeral fractures with closed methods, as well as less stable methods of open reduction and internal fixation (ORIF), were characterized by poor results.[2,8] Watson-Jones[9] believed that even with a perfect anatomic reduction with surgical treatment, the resulting joint movement was not as satisfactory as that achieved with less accurate external reduction. A recognition of these poor results led to the development of modern ORIF techniques that emphasize accurate anatomic repair with stable internal fixation.

Based on clinical experience and mechanical testing studies, 90-90 plating and parallel opposed plating are the best options for ORIF of bicolumn distal humeral fractures.[10] The articular fractures should be reduced first and provisionally stabilized. The articular reduction usually brings the distal aspects of the columns together. The distal aspect of the humerus then is fixed with plates to the distal humeral shaft.

90-90 Plate Fixation

The 90-90 plating technique of distal humeral fracture fixation was developed in response to the failure of parallel posterior plating. Korner and associates[11] compared 90-90 medial-lateral plating with parallel posterior plating and found that the former construct with locking plates provided the greatest stiffness to anterior and posterior bending and torsion and also had the greatest load to failure. They reported that true axial loading of the distal humerus

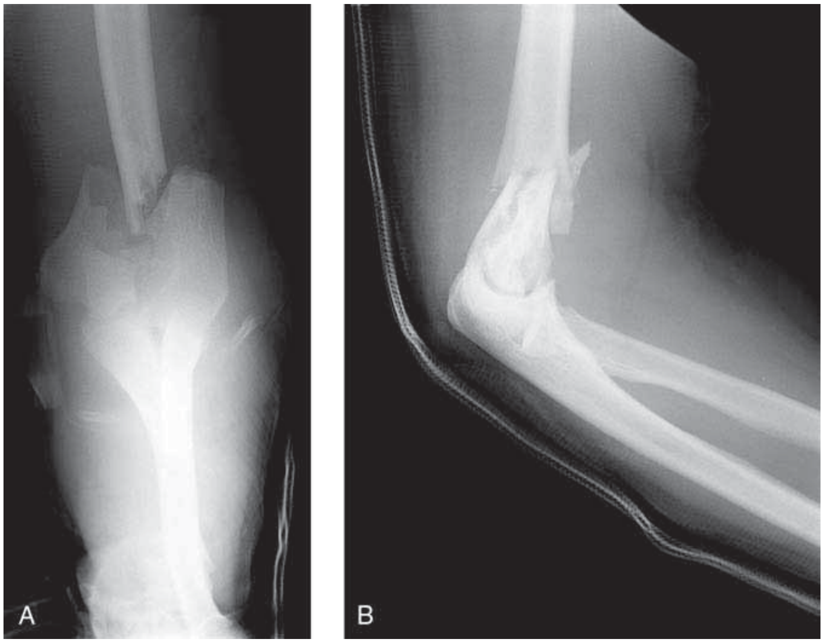

Figure 1 AP **(A)** and lateral **(B)** radiographs of a bicolumn distal humeral fracture.

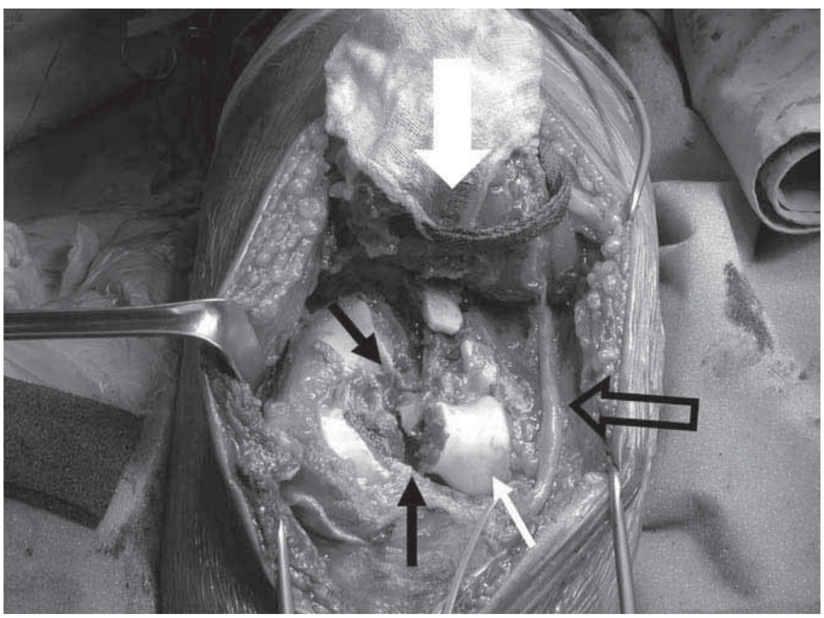

Figure 2 Intraoperative image showing a displaced fracture of the trochlea (*black arrows*), the ulnar nerve (*open arrow*), the medial trochlea (*small white arrow*), and the proximally retracted olecranon (*large white arrow*).

after ORIF is uncommon, and that fixation with a plate in the sagittal plane resists the bending forces that are generated by elbow motion in the normal flexion arc. Helfet and Hotchkiss[12] tested fixation of a supracondylar fracture model with cyclical loading and reported that 90-90 plating with a 3.5-mm reconstruction plate was much stronger (failure at 4,128 cycles) than posterior Y-plate fixation (223 cycles) and crossed screws (75 cycles). Self and associates[13] tested fixation of an intra-articular distal humeral fracture with medial and lateral plates, medial and posterolateral plates (90-90), and medial and lateral plates with bolts. They found that 90-90 medial and posterolateral plates were more rigid than medial and lateral parallel plates. The medial and lateral parallel plates with bolts had the greatest load to failure. Schwartz and associates[14] used an epoxy distal humeral model to compare 90-90 plating with parallel opposing sagittal plating and reported that there were no differences in stiffness in any direction. The latter configuration had lower transverse strains during axial torsion, whereas the former construct had lower longitudinal strain during axial compression. Most recently, Stoffel and associates[10] compared 90-90 plate fixation to medial-lateral sagittal parallel plating using current precontoured locking distal humeral plating systems. They reported that the parallel plating technique provided better stability in compression and external rotation and a greater ability to resist axial plastic deformation. More information on medial-lateral parallel plate fixation is providedin chapter 49.

Surgical Technique

A posterior surgical approach is used to expose complex bicolumn distal humeral fractures (Figures 1 and 2). A midline skin incision directly over the olecranon does not result in wound-healing complications. Olecranon osteotomy provides the best exposure for these fractures and is recommended. A more detailed discussion of posterior surgical approaches is available in chapter 47.

After the fracture is adequately exposed, the distal articular components are reduced (Figure 3). Provisional fixation is maintained with thin Kirschner wires and bone clamps. The intercondylar fragments are fixed with a screw placed from lateral to medial or vice versa. When there is intercondylar comminution, care should be taken to avoid overcompression of the trochlea. If there is bone loss, it can be reconstructed with an autogenous iliac crest bone graft. The use of small (3.5- or 4.0-mm) cannulated screws facilitates this fixation (Figure 4). Once the articular portion is reduced and fixed, it is reduced to the columns. Reduction to the more stable, less comminuted column is done first and stabilized with an obliquely placed Kirschner wire or Steinmann pin. The other column is then reduced and similarly fixed with a provisional pin or wire. The provisional reduction is then checked with either plain radiographs or an image intensifier.

After the provisional reduction and fixation are confirmed, the plates are applied to the distal humerus (Figure 5). Earlier reports of ORIF described fixation using either 3.5- or 2.7-mm reconstruction plates, depending on the distal extent of the fracture. Dynamic compression plates are stronger and also can be used. Recently, precontoured plates and plates with locking screw capability have become available. The lateral plate usually is placed on the posterior surface of the humerus and can be positioned distally up to the posterior edge of the capitellar articular surface (Figure 6). In this position, the plate is wrapped around the posterior surface of the humerus, and the most distal screw can be directed proximally at a 90° angle to the more proximal screws in the distal fragment. Similarly, the medial plate can be wrapped around the medial epicondyle to achieve more distal fixation as required.

A plate is applied to the more stable column first. Once the first plate is partially fixed to the supracondylar aspect of the humerus, the other plate is applied and fixed in place

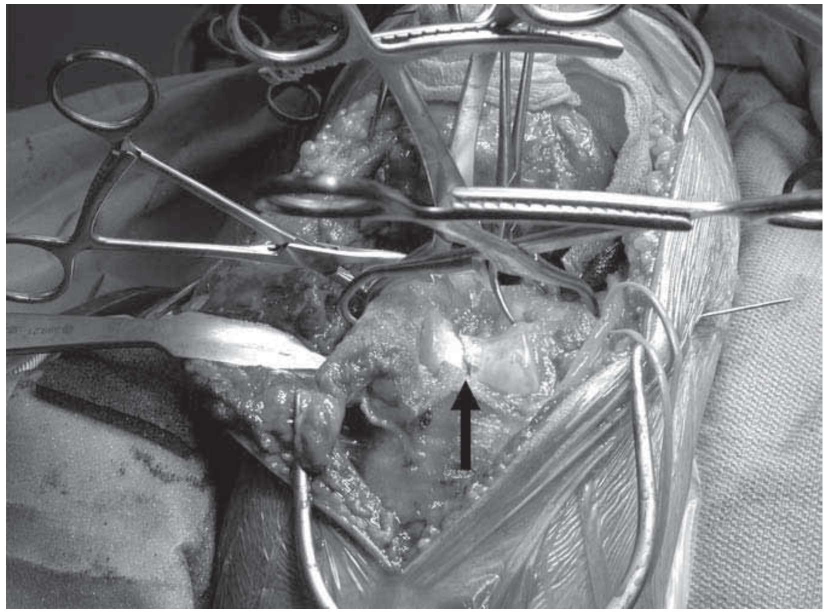

Figure 3 The distal fragments, including the articular portions, are anatomically reduced and stabilized before reduction and fixation of the distal articular portion to the medial and lateral columns. The arrow indicates the reduced trochlear fracture.

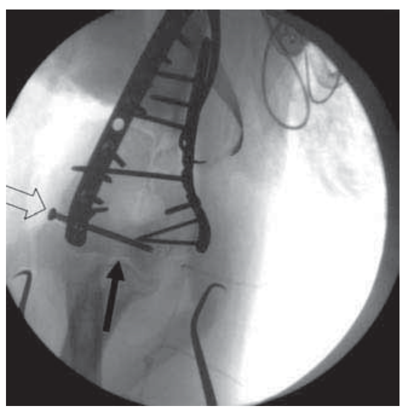

Figure 4 Intraoperative radiograph showing a reduced fracture of the trochlea (*black arrow*). A screw is placed from the lateral aspect of the distal humerus crossing the intra-articular fracture (*open arrow*).

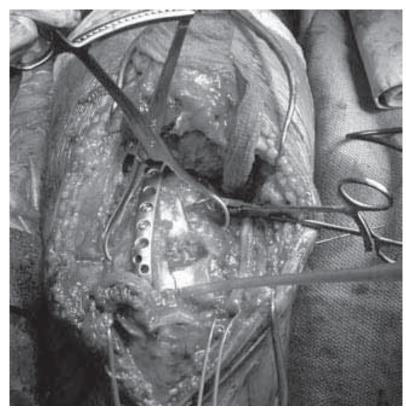

Figure 5 Fixation of the articular segment of the distal humerus to the more proximal aspect of the humerus with the lateral plate.

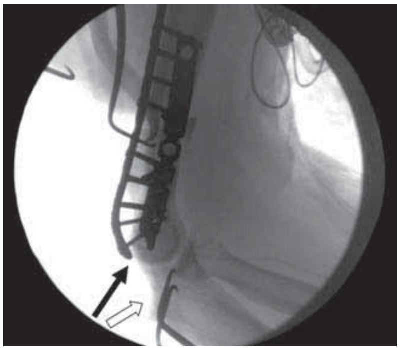

Figure 6 Intraoperative radiograph showing a lateral plate placed on the posterior surface of the lateral column. The plate can be contoured to allow positioning as far distal as the posterior edge of the capitellar articular surface. The black arrow indicates the distal position of the plate. The open arrow indicates the site of the olecranon osteotomy.

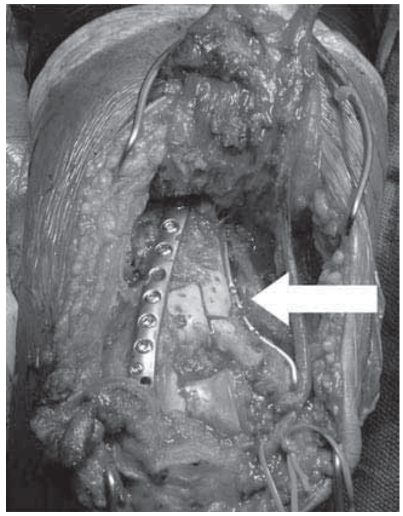

Figure 7 The medial plate (*arrow*) is applied after the lateral plate is provisionally fixed.

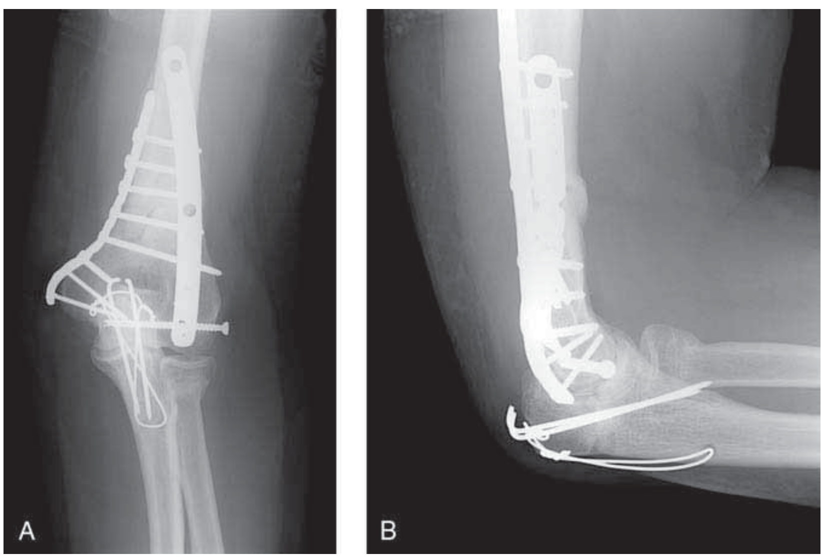

Figure 8 AP **(A)** and lateral **(B)** radiographs of the final construct. Screws from the plates are directed into the distal fragments. The radiographs show healing of the distal humeral fracture and the olecranon osteotomy.

(Figure 7). A single screw is placed through the plate proximal to the metaphyseal column fracture. This screw is left slightly loose so that the plate can be precisely positioned distally. Next, at least one screw is placed through the plate and into the distal humerus. At this point the position of the plate should be finalized. Compression can be applied across the metaphyseal fracture with fracture-reduction clamps or eccentric drilling for the proximal screws and proximal advancement of the plate after the distal screws are set. Ideally, multiple screws are placed through the plates and into the articular fragments (Figure 8). Information on postoperative patient management after ORIF of distal humeral fractures is provided in chapter 51.

Summary

ORIF of bicolumn distal humeral fractures is best achieved with either 90-90 medial-lateral or parallel opposing plates. Regardless of the chosen technique, the treatment goal is accurate anatomic restoration and stable fixation that will permit early range of motion.

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