

Surgical Treatment of Bicolumn Distal Humeral Fractures: Relevant Anatomy and Classification

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Abstract

Intercondylar or bicondylar distal humeral fractures involving both the medial and lateral columns are complex periarticular injuries that are challenging to treat. Understanding the normal elbow anatomy and classification systems that describe injury patterns provides the basis for the successful treatment of these complex humeral fractures.

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Intercondylar or bicondylar distal humeral fractures that involve both the medial and lateral columns have long been recognized as complex periarticular injuries that are both difficult to treat and have the potential to result in substantial permanent disability of the upper extremity. Fortunately, advancements in understanding these complex periarticular fractures and improvements in fracture fixation implants have resulted in a more optimistic approach to these injuries.

Anatomy

The distal humerus is composed of lateral and medial bony columns that diverge distally, with the trochlea situated between them to form a stable triangular construct (Figure 1). In the coronal plane, the medial column diverges approximately 45° from the axis of the humerus and extends distally to approximately the axis of rotation of the trochlea. The lateral column diverges approximately 20° from the humeral axis and extends almost to the

level of the distal aspect of the articular surface of the trochlea. Anteriorly, the lateral column includes the capitellar articular surface. There is a depression between the columns on the posterior aspect of the olecranon fossa into which the proximal tip of the olecranon fits when the elbow is fully extended. Anteriorly,

there are similar but smaller depressions for the coronoid process and the radial head.

The humeral ulnar articulation of the elbow joint functions as a hinge with an axis of rotation that passes through the distal articular portion of the humerus. The axis of the trochlea is in slight valgus and creates the carrying angle of the elbow. The trochlear axis also is slightly internally rotated relative to the transverse axis of the distal humerus. The articular portion of the distal humerus is angled anteriorly approximately 45°. Because of its complex articular anatomy, the elbow is a very constrained joint.

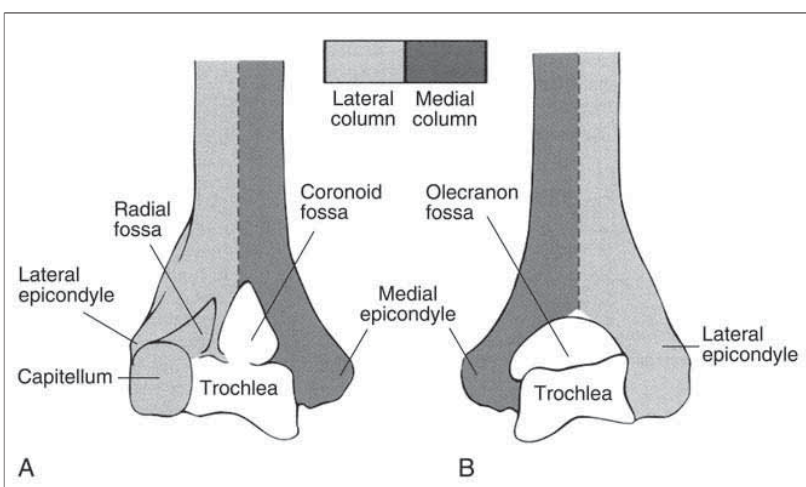


Figure 1 Anterior view (A) and posterior view (B) of the columnar skeletal anatomy of the distal humerus.

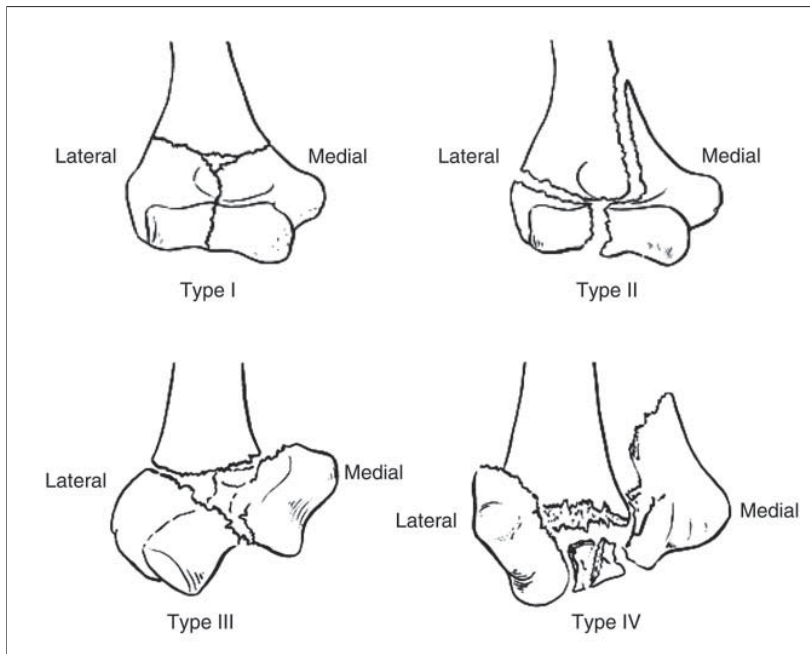


Figure 2 The Riseborough and Radin classification of intercondylar distal humeral fractures. (Adapted with permission from Riseborough EJ, Radin EL: Intercondylar T fractures of the humerus in the adult: A comparison of operative and non-operative treatment in twenty-nine cases. *J Bone Joint Surg Am* 1969;51:130-141.)

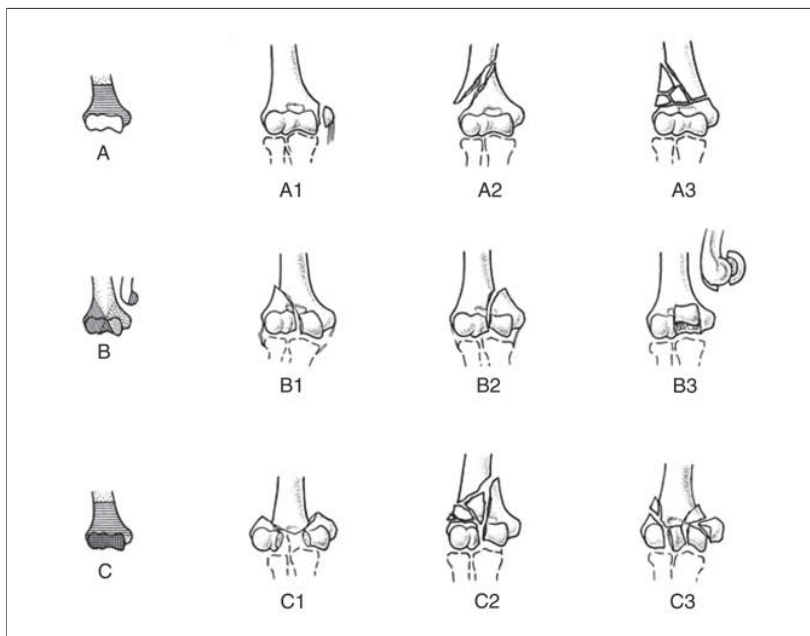


Figure 3 The AO/Orthopaedic Trauma Association classification of distal humeral fractures. (Reproduced with permission from Müller ME, Nazareon S, Koch P, Schaftsker J: *Comprehensive Classification of Fractures of Long Bones*. Berlin, Germany, Springer-Verlag, 1990, p 330.)

The articulation of the distal humerus with the proximal ulna and the radial head, in conjunction with the ligamentous structures of the elbow, results in a stable joint. The most important ligamentous structures are the lateral ligament complex, including the lateral ulnar collateral ligament, and the medial collateral ligaments. The medial collateral ligaments and the radial head are the major restraints to valgus instability. The lateral ligament complex provides stability against varus supinating rotational forces. Injuries to these structures can result in various degrees of elbow instability and resulting clinical ramifications.

Fracture Classification

Early classifications of distal humeral fractures focused on the condylar anatomy. Fractures were typically described as supracondylar, condylar, transcondylar, or bicondylar. Riseborough and Radin¹ further classified intercondylar fractures as type I, nondisplaced; type II, with articular displacement but not rotated in the frontal plane; type III, with articular displacement and significant rotatory deformity; and type IV, with severe comminution of the articular surface and wide separation of the humeral condyles (Figure 2). Current classification of distal humeral fractures is based on the columnar anatomy. Single-column distal humeral fractures are relatively rare and include both lateral or medial fractures. Bicolumn fractures are much more common. The AO/Orthopaedic Trauma Association classifies bicolumn fractures as type C1, C2, and C3 injuries that represent increasingly severe articular comminution² (Figure 3).

Mehne and Matta describe a system that differentiated various types

of bicolumn fractures. It was believed that this system would assist in preoperative planning^{3,4} (Figure 4). High and low T-type fractures are differentiated by the level of the transverse component relative to the olecranon fossa. The Y-type fracture has oblique rather than transverse fracture limbs. The H-type fracture results in complete separation of the trochlea from the columns. In medial and lateral lambda fractures, one of the fracture limbs is directed distally, and there is little distal bone available for fixation at the opposite column. Multiplane fractures are more complex variations of a T-type fracture, with additional fracture in the coronal plane.

Summary

A complete understanding of normal elbow anatomy, injury patterns, and fracture management provides the basis for successful treatment of complex bicolumn distal humeral fractures.

References

1. Riseborough EJ, Radin EL: Intercondylar T fractures of the humerus in the adult: A comparison of operative and non-operative treatment in twenty-nine cases. *J Bone Joint Surg Am* 1969;51:130-141.

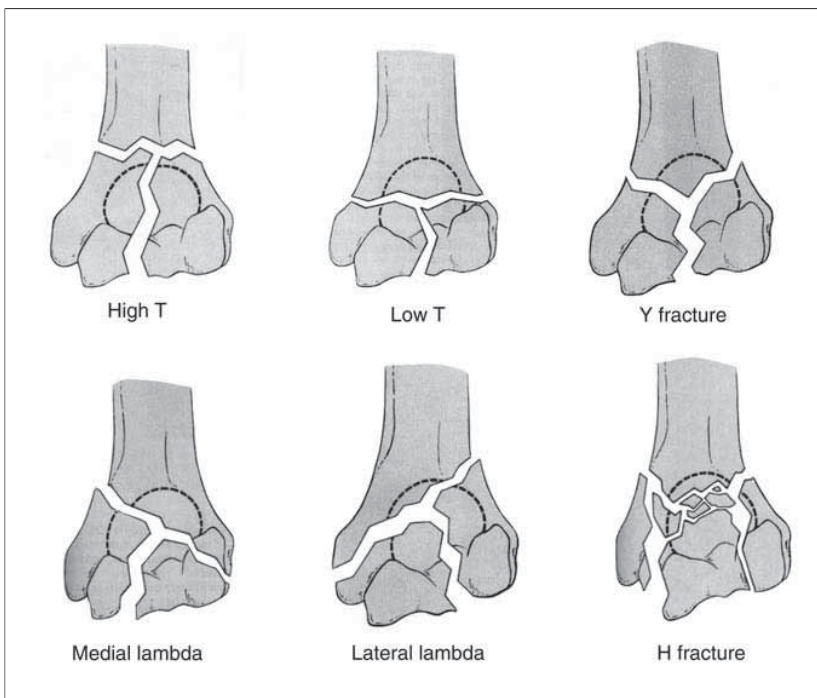


Figure 4 Mehne and Matta classification of bicolumn distal humeral fractures.

2. Fracture and dislocation compendium: Orthopaedic Trauma Association Committee for Coding and Classification. *J Orthop Trauma* 1996; 10(suppl):1-154.
3. Jupiter JB: Complex fractures of the distal part of the humerus and associated complications. *Instr Course Lect* 1995;44:187-198.
4. Mehne DK, Jupiter JB: Fractures of the distal humerus, in Browner BD, Jupiter JB, Levine AM, Trafton PG (eds): *Skeletal Trauma: Fractures, Dislocations, Ligamentous Injuries*. Philadelphia, PA, WB Saunders, 1992, pp 1146-1176.

