While relatively uncommon injuries, intraarticular fractures of the distal humerus continue to provide operative challenges to the surgeon in order that such complications as nonunion, malunion, decreased motion, and instability, are minimized.

One way to accomplish this is to enhance the stability of the plate and screw fixation construct. The long established technique of orientation of two plates relatively perpendicular to each other (90–90) has recently been challenged on both biomechanical and clinical perspectives by the concept of parallel plate application.

This fixation strategy focuses on maximizing stability between the distal fragments and the shaft of the humerus at the metaphyseal level. According to O’Driscoll this can be achieved by following a set of eight technical objectives:

1. Every screw should pass through a plate.
2. Each screw should engage a fragment on the opposite side that is also fixed to a plate.
3. As many screws as possible should be placed in the distal fragments.
4. Each screw should be as long as possible.
5. Each screw should engage as many articular fragments as possible.
6. The screws should lock together by interdigitation within the distal fragment, thereby creating a fixed-angle architecture that provides stability to the entire distal humerus.

7. Plates should be applied such that compression is achieved at the supracondylar level for both columns.
8. Plates used must be strong enough and stiff enough to resist breaking or bending before union occurs at the supracondylar level (Fig 1a–h).

This review will investigate the evidence for both plating techniques for the treatment for complex distal articular humeral fractures.

Materials and methods
The studies considered for possible inclusion in the current review were identified in a search (MeSH), in MEDLINE (National Library of Medicine, Bethesda, MD), EMBASE (Elsevier, Amsterdam, the Netherlands) and the Cochrane review for randomized controlled trials (Wiley InterScience, Hoboken, NJ) for the word distal humerus fractures and the key words plating, perpendicular or parallel. The bibliographic citations for each of the articles ultimately selected were also examined to identify any other acceptable studies that were not captured by the database searches. Furthermore, a grey literature search was conducted in an effort to identify all available literature that may not have been identified by the database searches. Selection of core articles was restricted to original research in the English language with human subject that examined the different plating orientations of distal humeral fractures. Randomized controlled and retrospective studies were included while animal studies, review articles, commentary, editorial, or letters were excluded.
Results
Clinical evidence: While there are numerous reports on internal fixation of distal humeral fractures, they are for the most part retrospective studies using a single plating technique. Unfortunately no prospective studies specifically comparing both methods, exist up to the present time.

While the placement of plates nearly perpendicular to each other was promoted early on by the AO group the biomechanical study of Hellet and Hotchkiss added credibility to this technique (Fig 2a–e and 3). A number of subsequent clinical studies revealed nearly 75–85% good to excellent results with 90–90 plating. A long term follow-up study at a mean of 19 years after injury by Doornberg concluded that the long term results of open reduction and internal fixation of 19 Type C fractures of the distal part of the humerus treated with perpendicular orientation are similar to those reported in the short term. They suggested that the results are durable over time.

The clinical experience with parallel plating has not been as extensive or with longer follow up, however current reports reveal no evidence of failure of the fixation and comparable clinical results as with 90–90 plating.

Biomechanical evidence: Which technique is more stable? Several biomechanical studies compared parallel plating with perpendicular 90–90 orientation, concluding that parallel plating with additional use of bolts was favorable to perpendicular plating. Their observations were supported by Arander who concluded that, parallel plating was superior to the perpendicular...
lar orientation although they expressed concern that placing a plate lateral can be technically difficult. Jacobson concluded that perpendicular plate orientation was strongest in the sagittal plane while Korner stated that perpendicular plating had increased stiffness to torsional and anteroposterior bending forces. Schwartz found similar stabilization among both plate orientations. How do the results of stability testing relate to physiologic loading? Wong tested both fixation methods and concluded that both methods may be above the threshold necessary for early motion and predictable fracture healing, rendering the marginal strength of parallel plating clinically unimportant. Kimball found that the risk of delayed union or nonunion increased by the extensive subperiosteal elevation with parallel plating orientation. Schutzer tested the perpendicular plate orientation with different plate types and concluded that implant choice was not critical in good bone quality. Korner showed that locking plates have a substantial advantage in poor bone quality or if significant metaphysical comminution is present. Otherwise they concluded that there was no difference in plate type and that plate position is critical.

**Discussion**

Although some biomechanical evidence may favor parallel orientation, the real take home message may be that both orientations are strong enough to be able to mobilize the elbow after fracture fixation. Additionally it should be noted that biomechanical evidence raises as many questions as solutions. Some biomechanical studies fail to actually resemble the true clinical setting, and often have low samples sizes and a lack of statistical power.

From a clinical perspective, there are not sufficient data to make valid comparisons. Several different outcome measures are used; fractures types vary and non-homogenous patient selections have been reported.

Long term follow-up for parallel plating and clinical trials are needed to compare different plate orientation. Until then both fractures orientations seem adequate enough to treat complex distal articular humeral fractures and the choice should be made by fracture specifications and surgeon’s preference.

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**Figure 2a–e** The AO technique: Reconstructing a multifragmentary distal humeral fracture.

**Figure 3** Fixation with two anatomically precontoured perpendicular plates.
Suggested reading


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