Biomechanical Strength of Distal Humerus Plates

The largest competitor to the Mayo Clinic Congruent Elbow Plates to date has been the use of straight recon or DC plates that are contoured in the OR and placed in a 90 degree orientation on the distal humerus. This is the technique that has been taught over the years as “the” way to fix these difficult fractures.

This is no longer the case.

This document contains summaries of two biomechanical papers written on distal humerus fixation as well as biomechanical studies conducted at Acumed on plate placement and plate strength.

The first summary is of an early study that has created an opinion among many surgeons that 90 degree plating is the strongest construct for fixation on distal humeral fractures. This study did not test parallel plating.

The second paper is a less well known paper that should serve to counter this misconception. It found parallel plating to be the best construct for reconstruction of the distal humerus. Following these papers is biomechanical test data from two studies done at Acumed.

The first is a finite element analysis that compared parallel plating to 90 degree plating and found that parallel plating was drastically better in providing stability in the distal humerus.

The second study compared the Mayo Plates against recon and DC plates in their yield and deformation strength. Again, the Mayo Plates performed better than the standard used in the field.

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Parallel vs. Perpendicular Plate Strength
"Internal Fixation of the Distal Humerus: A Biomechanical Comparison of Methods"

Helfet and Hotchkiss
Journal of Orthopaedic Trauma, 1990

Summary:

This paper established 2 plates placed 90 degrees apart is a more stable construct than either 2 crossing screws or a “Y” plate. It did not matter which two plates were used, or whether 1/3 tubular or 3.5mm reconstruction plates, or in what combination.

Many surgeons reference this article when discussing plate stability. It is the reason that plates placed 90 degrees apart has been considered the “gold standard”.

This is a not altogether the case any longer.

This study did not include plates placed in a parallel configuration. At the time of the study there were no parallel plates, like the Acumed Mayo Clinic Congruent Elbow Plates, to compare. Dr. Hotchkiss is currently repeating the study using the Mayo Plates.

This paper is important in that it is largely responsible for the continued belief that 90 degree plates are the strongest.
"Biomechanical Evaluation of Methods of Internal Fixation of the Distal Humerus"

Schemitsch, Tencer and Henley
*Journal of Orthopaedic Trauma, 1994*

**Summary:**

This paper was published 4 years after the Helfet/Hotchkiss paper and appears to be less well known. It was conducted in association with Seattle’s Harborview Medical Center.

The study was designed to determine the relative rigidity of five fixation constructs for the distal humerus using pelvic reconstruction plates and/or the Dupont Plate from Howmedica.

The plate rigidity was equivalent when no gap existed but when a 2mm gap was created, the plate constructs that were parallel (Acumed/Mayo philosophy) provided the greatest rigidity. This is the construct in the second figure from the top on the right where a Dupont Plate was used on the lateral epicondyle and 3.5mm reconstruction plate used on the medial epicondyle.*

This study should help with the misconception that the greatest rigidity is obtained by plates placed 90 degrees apart.

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* Lateral- Dupont Plate
  
  Medial- Nothing

* Lateral- Dupont Plate
  
  Medial- 3.5mm Recon Plate* (strongest)

* Lateral- Dupont Plate
  
  Posterior- 3.5mm Recon Plate

* Medial- 3.5mm Recon Plate
  
  Posterior- 3.5mm Recon Plate

* Lateral- Dupont Plate
  
  Medial- Lag Screw
Acumed conducted a computerized study (FEA) on the placement of distal humerus plates, comparing parallel to perpendicular placement.

The plates in both placements were assumed to be identical in design and material, even though the Mayo plates are stronger than recon plates, and we assumed perfect anchoring in the bone for both, even though the Mayo plates enable longer screws to be used. For example, in the articular fragments a posterior recon plate allows two 12-14 mm screws to be placed vs. two to three 50-60 mm screws in a lateral plate.

We loaded each configuration with 50 lbs of force and measured displacement in three distinct planes with the following results:

**Plate Strength**

Acumed conducted biomechanical testing to measure the strength of the Mayo Clinic Congruent Elbow Plates in comparison to Recon plates which are typically used in the distal humerus at 90°, and DCP plates which are infrequently used for this indication and offer the high mark for plate strength.

To test yield strength, force was applied to the plate by pulling until the plate did not return to its original shape. The more force required to alter the original shape, the stronger the plate.

To test the ability of the plate to withstand major deformation, force was applied in a consistent manner until the plate reached a 90° angle. The more force required to severely alter the original shape, the stronger the plate.

Results showed that the Mayo Clinic Congruent Elbow Plates were 450% stronger than Recon plates in yield strength and 190% stronger in withstanding major deformation.

*Data on file at Acumed*

**Dr. Shawn O’Driscoll, of the Mayo Clinic, has identified torsional stability as the most important measure for proper fixation and early rehabilitation.**