BIOMECHANICAL EVALUATION OF PARALLEL VS PERPENDICULAR FIXATION FOR DISTAL HUMERAL FRACTURES

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INTRODUCTION:
Fractures of the distal humerus remain one of the most demanding challenges in orthopaedic trauma surgery (1,2). Complications have been reported in up to 35% of cases and include implant failure and malunion. The limited number of studies comparing the stability of perpendicular and parallel plate fixation in distal humerus fractures have shown varying results in the literature (3,4). Therefore our objective was to biomechanically compare the perpendicular and parallel plate systems for fixation of supracondylar humerus fracture (type 13A-2 AO classification) in bending and varus torsion.

METHODS:
Forty anatomically accurate artificial humeri (Model 1028, Pacific Research Laboratories, Inc., Vashon Island, WA) were osteotomized 1 cm above the proximal edge of the olecranon fossa to create a supracondylar humeral fracture (AO type 13A-2). Twenty specimens were fixed with congruent elbow plates (Acumed, Hillsboro OR) in a parallel configuration (PAR). Another twenty were fixed in a perpendicular configuration using a pre-contoured posterolateral plate (POS). Ten of each configuration were designated for bending and ten for torsion evaluations.

The proximal and distal portions of each specimen were secured in custom-designed fixtures. Testing was performed on an Instron 1321 biaxial servohydraulic testing equipment (Instron Corp., Canton MA) retrofitted with MTS Teststar IIs digital controller (MTS Corp., Eden Prairie MN). In bending with the humeral shaft horizontal, the Instron actuator shaft loaded the distal fixture via a 12.7mm dia. rod allowing free movement of the distal fragment and simulated extension loading. Loading was applied at 1mm/sec until a 5mm gap was measured at the anterior fracture line. Stiffness from 0 to 100N of load, and load at occurrence of the 5mm gap were evaluated for significance via t-test (p<0.05).

In torsion, the proximal fixture was secured vertically, and the distal fixture attached to the actuator shaft to allow varus rotational loading of the distal fragment. Specimens were rotated at 1deg/sec as far as possible without interference between specimen hardware and fixture (~20 deg). Stiffness from 0 to 5N-m, and torsional resistance at 5deg of rotation were evaluated for statistical significance via t-test (p<0.05).

RESULTS:

Extension Bending:
The parallel construct demonstrated higher stiffness (p<0.02) and greater force to achieve the 5mm gap (p<0.0007) than the perpendicular construct (Figs 1,2). All perpendicular constructs experienced external rotation of the distal fragment (7.6±3.0 deg external), while the parallel plate constructs varied in direction (0.8±11.1 deg external; three internal, seven external rotation), resulting in no differences (p>0.07). Parallel constructs experienced less posterior angulation of the distal fragment (19.3±2.5 deg) than the perpendicular (22.9±1.9 deg) constructs (p<0.002). Permanent bending of the posterior plates as posterior angulation (23.6±2.7 deg) occurred for all perpendicular constructs but none in parallel constructs.

Varus Torsion:
No statistical difference was found in torsional stiffness between the parallel and perpendicular constructs (p>0.07) (Figure 1). However, resisting torque at 5 degrees was higher for the parallel construct than for perpendicular (p < 0.04) (Figure 2).

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REFERENCES

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