Push-Pull Locking Plate versus Traditional Locking Plate in Proximal Humeral Fractures: A Finite Element Analysis Study

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Purpose: Varus angulated fractures of proximal humerus treated with locking plates have a high risk of failure. The push-pull principle (an apical pulling subchondral suture anchor combined with a locking plate with downward directed locking screws) has clinically shown lower varus recurrence and secondary screw penetration rates. However, this technique was applied by intraoperatively adapting T-LPs (traditional locking plates). To standardize this method, a 'push-pull 'dedicated design is needed. The FEA (finite element analysis) study compares the biomechanical performance of a novel PP-LP (push-pull locking plate) with a T-LP.

Methods: A defect below the humeral head mimicked a 2-part fracture. All boundary conditions were identical for the 2 plates. The pull mechanism for the PP-LP was simulated as a force vector between the head apex anchorage point and the proximal plate end (pre-tension). Axial compression, torsion bending and compression bending were simulated. The stress distributions (SDs) on bone, plate, and screws were calculated.

Results: SDs on the proximal humerus were more homogeneous for the push-pull model, showing less unloaded areas of the screws: the number of elements returning von Mises stress lower than 0.05 MPa was 57.45% lower for PP-LP compared to T-LP for axial compression, 1.21% for torsion bending, and 78.82% for compression bending. Similar patterns were found in the plate. SDs on the distal humerus were similar for both plates.

Conclusion: This FEA study showed a more homogeneous SD on the screws with the push-pull principle in all set-ups compared to the T-LP. This mechanism mag explain the clinically observed lower failure rate.