INTRODUCTION:
Fractures of the proximal humerus are a common occurrence in the elderly accounting for up to 10% of all fractures in patients over 65 years of age. In cases where ORIF is deemed necessary, successful internal fixation is sometimes difficult to achieve due to the osteopenia of proximal humeral bone, which is common in this patient population. Recent biomechanical and clinical studies have investigated augmentation of osteopenic bone with PMMA or calcium phosphate cement to improve fixation with blade plates and non-locking plates for proximal humeral fractures. Synthes 3.5mm LCP Proximal Humerus Locking Plates (LP) were compared against the Synthes 3.5mm 90° Cannulated LC-Angled Blade Plate (BP) for fixation of surgically simulated (i.e. osteotomized)11A3 fractures. In each case the articular surface of the humeral head was potted to the mid-level of the anatomical neck, so as to not involve the plate fixation; the proximal fragment was held fixed. For bending tests, each humeral shaft was cyclically loaded in a cantilever fashion so as to produce a bending moment of 0 to 7.5Nm at the fracture site. Vertical displacement of the distal fragment at the loading point was continuously monitored. Torsional tests involved cyclic loading of the humeral shaft to ± 3 Nm of axial torque while monitoring peak-to-peak angular rotation of the distal fragment. Bending specimens were monitored in 1000 cycle increments to 10,000 cycles and torsional specimens were monitored similarly to 5000 cycles while variations in distal fragment displacement and angular rotation with loading were monitored, respectively. Mean displacement and angular rotation data for each of the test groups were used to quantify component loosening and/or cutout at each 1000 cycle increment. Subsequent to cadaveric specimen tests, three pairs of Sawbones synthetic humeri with simulated fractures were plated using the same locking plates and blade plates and specimens were tested using the torsional loading protocol. These tests were performed to assess the appropriateness of using synthetic specimens for simulating proximal humerus fracture fixation in elderly patients.

RESULTS:
Locking plates provided significantly increased stability compared to blade plates when the constructs were loaded torsionally. Mean peak-to-peak distal fragment angular rotation increased from 7.00 deg to 8.10 deg over the cyclic loading period (i.e. 1 to 5000 cycles) for LPs while BPs angular displacements increased from 19.23 deg to 34.40 deg over the same number of cycles. (See Fig.1) The mechanism of blade plate construct loosening involved "cutting-out" of the blade and proximal fragment screws in the cancellous bone. The locking plate was significantly more stable than the blade plate at each 1000 cycle increment throughout the test period (P< 0.02). There was no significant difference in biomechanical stability between the two types of plates for the bending load protocol. For both types of plates, mean distal fragment bending displacements increased from 1000 to 10,000 cycles (0.78mm to 1.76mm for LPs versus 1.40mm to 2.92mm for BPs) but these results were not significantly different. In all cases, the plates acted like tension members with regard to the bending load direction. Torsional stability tests in synthetic humeri demonstrated no significant differences in the performance of the two types of plates. In fact, both types of plates performed nearly identically and test results were highly repeatable. Torsional stability results for the LPs in cadaveric specimens was statistically similar to results using synthetic humeri.

DISCUSSION:
The present study demonstrated that the LCP locking plate demonstrated a significant improvement in proximal humerus biomechanical stability when compared to a similarly-sized blade plate under torsional loading conditions in cadaveric specimens obtained from an elderly population. Distal fragment angular rotation, indicative of construct loosening due to torsional loading was 2.5X to 4X greater with the BPs as compared to LPs with continuous cyclic loading. Both types of plating systems performed similarly in cadaveric specimens for bending loads where the plate acts as a tension member. Synthetic humeri constructs using BPs and LPs demonstrated no significant difference under the same torsional loading conditions. This strongly demonstrates that when comparing different methods of fracture fixation, the synthetic specimens are not an appropriate model for bone obtained from an elderly population.

REFERENCES:

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