<blockquote type="cite"><blockquote type="cite">Biomechanical Evaluation of Shoulder Prosthesis Stem Length on Failure Due to Torsional Loading </blockquote> </blockquote>

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INTRODUCTION:

Shoulder arthroplasty is becoming increasingly common. With evolving implant designs, multiple humeral stem options exist for the surgeon to choose from. New stemless and short stem systems are modular, remove less native bone stock, and better adapt to patient anatomy. It has been suggested that shorter stem implants may be protective against periprosthetic fracture, however this has not been mechanistically evaluated. Therefore, this study aimed to biomechanically test synthetic humeri with long stem, short stem, and stemless arthroplasty components in a torsional manner to evaluate their response to loading and characterize failure.

METHODS:

Twenty-four synthetic humeri were implanted with long stem, short stem, or stemless uncemented prosthesis, 8 in each group. Humeri were mounted in a custom testing jig with a morse taper interfacing with a mechanical testing system. After a 20N axial force, specimens were torsionally loaded to failure at 15 degrees/sec, with 50Hz collection. Torque versus rotation curves were generated for each specimen, and stiffness, yield, ultimate strength, and failure load were measured. ANOVA and post hoc pairwise comparisons were used to assess effect of stem type on mechanical test variable. The association of the stem type with fracture type was analyzed by a Fisher's Exact test. Statistical significance was set at $P < .05$.

RESULTS:

During torsional loading, long stem implants were significantly stiffer than short or stemless implants. The angle of implant yielding was similar across stem designs, however stemless implants had a lower yield torque. This correlated with a decreased yield energy in stemless compared to short stems as well. Maximum torque and failure torque was also significantly higher in short and long stem implants compared to stemless. Failure occurred at the metaphyseal implant-bone interface with no distal fracture propagation.

DISCUSSION AND CONCLUSION:

Periprosthetic fractures in shoulder arthroplasty are a concern in low energy trauma, and stem design likely plays a significant role in early implant-bone failure. Our results suggest stemless implants under torsional load fail at lower stress and are less stiff than stemmed implants, and small changes in stem length can alter mechanics of the implant. The failure mechanism of stemless implants through metaphyseal cancellous bone at lower torque emphasizes the effect bone quality has on implant fixation. There is likely a balance of torsional stability to survive physiologic loads while minimizing diaphyseal stress and risk of periprosthetic fracture. This combined with revision and fixation options represent decisions the surgeon is faced with when performing shoulder arthroplasty.