Biomechanical Comparison of a Novel Circular Glenoid with Peripheral Ring Fixation to a Standard Anchor Pegged Glenoid in Total Shoulder Arthroplasty

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INTRODUCTION: Current standard total shoulder pegged glenoid component designs have a high rate of loosening, which accounts for the most common long term reason for surgical failure. Glenoid design, method of fixation, and implantation version all play a role in component stability. With current designs, 51% of standard glenoid components shift at 2 years. This study aimed to compare the biomechanical stability of a novel circular glenoid with peripheral ring fixation to a standard anchor pegged glenoid. Additionally, we compared the estimated bone removal for the glenoid design types.

METHODS: Biomechanical testing [**Figure 1**] was performed to assess the glenoid with peripheral ring fixation with regards to stability and resistance to "rocking horse" effect, torsional loosening, resistance to torque dissociation, and axial pullout strength. This was compared to historical biomechanical data obtained for a standard anchor pegged glenoid. A 3D CAD model of five different scapula sizes and shapes was also utilized to estimate volume bone removed when using implant specific prep instrumentation for each glenoid system.

RESULTS: Tensile displacement of the ring fixation component after dynamic rocking was 0.060 mm for the medium and 0.022 mm for the XL sized glenoid components requiring an average peak torque of 6.21N-m to dissociate the glenoid with peripheral ring fixation. There was minimal torsional loosening [**Table 1**]. The ring fixation component demonstrated a mean pullout strength of 1367 N compared with 645 N for the standard anchor pegged glenoid component. The peripheral ring fixation glenoid preparation on average took 45% less bone than a standard anchor pegged glenoid.

DISCUSSION AND CONCLUSION: The circular glenoid with peripheral ring fixation demonstrated superior maximum pullout strength and more bone preservation with glenoid preparation when compared to the standard pear-shaped, pegged glenoid components. Compared to published standard pegged glenoid component controls, the glenoid with peripheral ring fixation demonstrated diminished "rocking horse" displacement. Initial biomechanical data is overall promising for this novel glenoid design.

Figure 1. Glenoid and Biomechanical Testing Setup. A) Circular glenoid component with on face and cross-sectional view of peripheral ring fixation. B) "Rocking horse" test: 750N was applied axially combined with humeral head displacement of 90% in both directions, edge displacement was measured. C) Torsional Loosening: humeral head was loaded to 750 N and rotated in a 46 degree arc over 100,000 cycles. D) Torque dissociation: humeral head was loaded to 3024 N and angular displacement was applied at 0.5°/s for 180°, max torque was recorded. E) Axial pullout: specimens were submerged 1 inch into 20 pcf bone block, displacement was applied at 10 mm/min, and axial pullout strength was recorded.

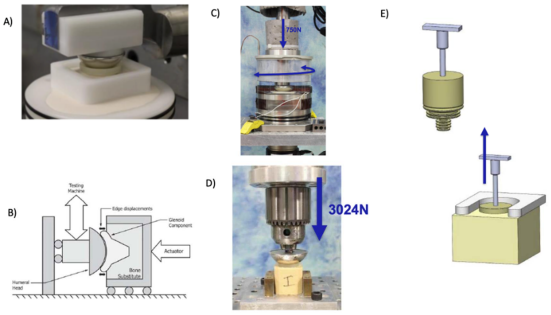

Table 1. Torsional Loosening Assessment: three medium sized circular peripheral ring fixed glenoid components were loaded with a humeral head component rotated through 46 degrees through 100,000 cycles. Glenoid component displacement and final rotation measured.

	Component Displacement		Post-test Glenoid Rotation	
Humeral Head Position	Mean (um)	Standard Deviation	Mean (degrees)	Standard Deviation
1 (-23^0)	6.49	15.30	-0.06	0.01
2 (0^0)	8.75	17.56	0.03	0.07
3 (+23^0)	9.60	24.29	0.03	0.10
4 (0^0)	3.67	18.54	0.01	0.08