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Glenosphere dissociation after reverse shoulder arthroplasty

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Background: Reverse shoulder arthroplasty (RSA) is gaining popularity for the treatment of debilitating shoulder disorders. Despite marked improvements in patient satisfaction and function, the RSA complication rate is high. Glenosphere dissociation has been reported and may result from multiple mechanisms. However, few RSA retrieval studies exist.

Methods: We reviewed our RSA database and identified patients with glenosphere dissociation between 1999 and 2013. Prosthesis type, glenosphere size, and contributing factors to dissociation were noted. Five retrieved implants were available for analysis, and evidence of wear or corrosion on the Morse taper was documented. Further, we biomechanically investigated improper Morse taper engagement that may occur intraoperatively as a potential cause of acute dissociation.

Results: Thirteen patients with glenosphere dissociation were identified (0.5 months to 7 years postoperatively). Glenosphere size distribution was as follows: 32 mm (n = 1), 36 mm (n = 4), 40 mm (n = 6), and 44 mm (n = 2). Incidence of dissociation was correlated to glenosphere size ($P < .001$). Taper damage was limited to fretting wear, and there was minimal evidence of taper corrosion. Biomechanically, improper taper engagement reduced the torsional capacity of the glenosphere-baseplate interface by 60% from 19.2 ± 1.0 N-m to 7.5 ± 1.5 N-m.

Conclusion: We identified several mechanisms contributing to glenosphere dissociation after RSA, including trauma and improper taper engagement. Limited evidence of corrosive wear on the taper interface was identified. Although it is rare, the incidence of glenosphere dissociation was higher when 40- and 44-mm glenospheres were implanted compared with smaller glenospheres (32 and 36 mm), probably because of the larger exposed surface area for potential impingement.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Reverse shoulder arthroplasty; Morse taper; dissociation

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Since Food and Drug Administration approval in 2004, reverse shoulder arthroplasty (RSA) has gained increasing acceptance as a surgical treatment in elderly patients with rotator cuff disease and accompanying shoulder pain and dysfunction.[6] Owing to its success in addressing cuff tear arthropathy, indications for RSA are quickly expanding to include massive cuff tears without glenohumeral arthritis, proximal humerus fractures, and as a salvage procedure for failed hemiarthroplasty or anatomic shoulder replacement.[5,8,18,25] Despite multiple reports that RSA alleviates pain while improving patient satisfaction and shoulder function, the procedure is associated with a relatively high complication rate, with literature reports being variable and ranging upward of 20% for primary surgeries to >40% for revision procedures.[22] Reported postoperative complications include but are not limited to instability, acromial fracture, periprosthetic fracture, glenoid component loosening, and scapular notching.[4,22,25]

A design feature common to all commercially available RSA implant systems is a baseplate component with a Morse taper feature onto which the glenosphere is seated intraoperatively. A modular connection placed in a biologic environment with repetitive exposure to mechanical stresses during functional activities renders the interface subject to in-service damage that may be manifested as mechanical wear, corrosion, chemical degradation, fatigue, and mechanical overload. These damage mechanisms may potentiate glenoid component dissociation, which, although rare, has been reported as a postoperative complication in the shoulder arthroplasty literature.[7,16,17] Whereas retrieval studies in the total hip and knee replacement literature have cited mechanical wear and corrosion as predominant and contributing agents to revision surgery,[10,12,15] we are unaware of any RSA retrieval studies. Therefore, the goal of our study was to present our case series of acute and chronic RSA prosthesis dissociations and to discuss our examination of the Morse taper interface retrieved at the time of revision surgery. The mechanisms responsible for acute and chronic dissociation vary and are likely multifactorial. We explore, through biomechanical testing, improper Morse taper engagement and mechanical compromise of the glenosphere-baseplate interface as an explanation for acute prosthesis dissociation.

Materials and methods

We retrospectively reviewed our RSA patient database and identified patients with glenosphere dissociation between May 1999 and July 2013. Operative notes were reviewed, confirming the type of prosthesis and implant sizes. A thorough chart review was performed to determine timing of the dissociation and the presence or absence of a traumatic event. Patients who met the inclusion criteria had plain film imaging demonstrating a reverse prosthesis with baseplate-glenosphere dissociation. Patients who had their index procedure performed at an outside institution or implant designs that were used before Food and Drug Administration approval of the device were excluded from statistical analysis. Basic statistical analysis was performed by Fisher exact test to determine if any correlation exists between incidence of dissociation and glenosphere size.

Table I Modified Goldberg Score[10] for visual assessment of taper junction in retrieved RSA implants

Damage	Score	Criteria
Minimal	1	Fretting on <10% of the surface and no corrosion damage
Mild	2	Fretting on >10% of the surface and/or corrosion attack confined to one or more small areas
Moderate	3	Fretting on >30% of the surface and/or aggressive local corrosion attack with corrosion debris
Severe	4	Damage over the majority (>50%) of the surface with severe corrosion attack and abundant corrosion debris

Retrieval analysis

The taper interfaces were evaluated with gross observation and macrophotography. For semiquantitative assessment, we used the Modified Goldberg Score,[10] in which the taper junction was assessed and given a score of 1 to 4 based on the extent of fretting wear and corrosion observed (Table I).

Biomechanical study

We measured the effect of improper Morse taper engagement using a series of axial distraction and torsional experiments (Fig. 1) of glenosphere-baseplate constructs (RSP; DJO Global, Vista, CA, USA) with simulated impingement between the glenosphere (size = 36 mm neutral) and underlying bone. Sawbones test blocks (Model #1522; Pacific Research Laboratories, Vashon, WA, USA) were used to simulate the glenoid. The baseplate was assembled into the block in accordance with the manufacturer's instructions and instrumentation kits in combination with four 22-mm-long peripheral locked screws.

Pilot experiments were undertaken to create a repeatable impingement test model (Fig. 2). Because of its circular design, our laboratory setup was modeled to replicate the clinical scenario of impingement between the underside of the glenosphere and underlying glenoid that may occur superiorly or inferiorly to the periphery of the RSP baseplate (Fig. 3). A single 22-mm-long locking screw (DJO Global) was inserted into the test block immediately adjacent to the rim of the circular baseplate. We chose to simulate 3 conditions of impingement (mild, moderate, and severe), which we equated to the number of screw threads visible and protruding from the top of the Sawbones test block. Specifically, 3 visible threads served as the severe impingement model, whereas a single visible thread was considered the mild impingement condition in our test setup. Initially, the screw was inserted such that all 3 locking threads were protruding from the top of the test block (severe impingement). Visually, in this condition, the top of the screw head was flush with the top side of the baseplate. Thereafter, proper seating of a 36-mm neutral glenosphere onto the baseplate's taper was attempted.