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The effect of glenoid bone loss on reverse shoulder arthroplasty baseplate fixation

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Background: Glenoid bone loss is commonly observed during primary and revision reverse shoulder arthroplasty. Glenoid baseplates are often implanted with incomplete glenoid bone support. The purpose of this study was to evaluate the glenoid component fixation of the glenoid baseplate with variable amounts of incomplete coverage.

Methods: Twenty-eight polyurethane trabecular bone surrogates were instrumented with the same center screw–type glenoid baseplate with 4 peripheral 5.0-mm locking screws in a glenoid bone loss model consisting of 25%, 50%, 75%, and 100% coverage. Each construct was tested through a 55° arc of motion with both compressive and shear forces across the glenosphere. Baseplate micromotion was recorded throughout 10,000 cycles for each model.

Results: There was no significant difference in baseline micromotion between the 4 experimental groups ($P = .099$). In the 25% baseplate coverage group, 3 of 7 exhibited micromotion above the 150-μm threshold (624.5, 469.1, and 712.1 μm) during cyclic loading. After 10,000 cycles of loading, the 25% coverage group exhibited significantly more micromotion than the 50% ($P = .049$), 75% ($P = .026$), and 100% ($P = .040$) coverage groups. There was no significant difference between the 100%, 75%, and 50% coverage groups ($P = 1.00$).

Conclusions: Glenoid baseplate fixation in the setting of glenoid bone loss is no different when 50%, 75%, or 100% of the baseplate is supported by glenoid bone. Bone loss resulting in only 25% coverage results in significantly greater micromotion, often above the 150-μm threshold.

Level of evidence: Basic Science Study, Biomechanics.

Keywords: Reverse shoulder arthroplasty; glenoid baseplate; glenoid bone loss; glenosphere

Glenoid bone loss is commonly encountered during primary and revision reverse shoulder arthroplasty (RSA). It has been reported that as many as 38% of RSAs are performed in the setting of abnormal glenoid wear, with posterior and superior defects representing the predominant deformities.[4] Inferior tilting of the baseplate, which has

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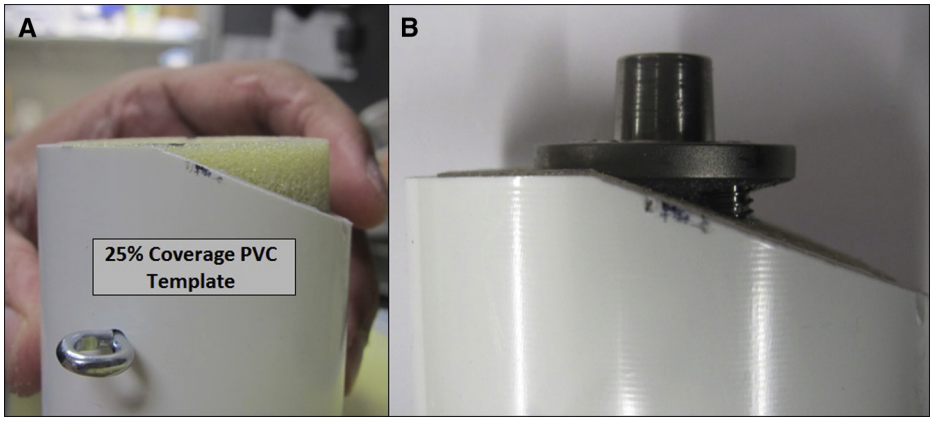

Figure 1 (**A**) Polyvinylchloride template used to create the 25% bone coverage specimens. (**B**) Foam cylinder in polyvinylchloride tube after sanding and baseplate placement.

been shown to be beneficial for improving fixation, providing optimal implant stability, and reducing scapular notching,[5,6,15,19] may lead to further uncovering of the superior aspect of the glenoid baseplate. During preparation of the bone-deficient glenoid, the surgeon is typically left with the decision to ream farther medial until a flush concentric surface is created, to bone graft the defect, or to implant the baseplate with some degree of incomplete coverage.

Eccentric reaming until a flush surface with the preferred inclination and version is created might be considered ideal. However, with further medial reaming of the glenoid, the bone volume continues to decrease and may compromise the ability to achieve stable implant fixation.[9,21] In addition, medialization has the potential to lose the stabilizing effects of lateralization and to increase the risk of instability. Bone grafting of the defect has become an attractive option to aid in correction of the glenoid morphology without the need for excessive reaming and medialization of the component.[11,13,14,26] Ultimately, the glenoid baseplate must be implanted with sufficient fixation to facilitate osseous integration to the native glenoid. Unfortunately, the proper amount of native glenoid bone required to support glenoid baseplate fixation has not yet been defined.

The purpose of this study was to evaluate RSA glenoid component fixation in a surrogate glenoid bone loss model simulating differing percentages of the glenoid baseplate unsupported by native bone. The hypothesis was that increasing amounts of glenoid bone loss would result in progressively increasing amounts of baseplate micromotion.

Materials and methods

Twenty-eight synthetic trabecular bone surrogate cylinders (Sawbones Model #1522-12, rigid cellular foam; Pacific Research Laboratories, Vashon, WA, USA) with a nominal density of 0.32 g/cm^3 (ASTM F1839-08) were used in the current investigation. This density was chosen as an intermediary between poor-quality (0.24 g/cm^3) and good-quality (0.48 g/cm^3) cancellous bone used in studies of similar scope.[21] On receipt of the foam test blocks (40 × 130 × 180 mm), each was machined into cylinders measuring 44.5 mm in diameter and 40 mm in height in preparation for instrumentation.

This study used the glenoid components of a single RSA system (RSP; DJO Global, Austin, TX, USA). The baseplate of this system consists of a single central 6.5-mm lag screw in combination with 4 peripheral screw holes, which can be used in locked or nonlocked fashion. For this study, we evaluated RSA glenoid component fixation in a glenoid bone loss model simulating 4 differing percentages of the glenoid baseplate unsupported by native bone using 7 cylinders per baseplate coverage group: (1) 100% baseplate coverage (control), (2) 75% baseplate coverage, (3) 50% baseplate coverage, and (4) 25% baseplate coverage. The amount of foam cylinder removed to simulate the various baseplate coverage conditions was accomplished with 3 polyvinylchloride tubing templates and a belt sander (Fig. 1). Foam removal was performed in a dry environment. Use of the polyvinylchloride sanding templates served to ensure repeatability regarding the amount of foam removed within each experimental group (Fig. 2). The pattern of superior glenoid wear simulation was chosen on the basis of clinical experience as patients with rotator cuff arthropathy, and thus candidates for a reverse shoulder replacement, often present with radiographically evident superior glenoid erosion.[12]

All baseplates were fixed perpendicular to the bone block substitutes by the manufacturer's recommended technique. Briefly, a 2.5-mm drill was used to define the trajectory for the baseplate's central screw. A 6.5-mm tap was used to create the threads for the central screw. With the tap still in place, a reamer was used to create the circumferential concavity required to accommodate the underside of the baseplate, which was then inserted and tightened to a maximum torque of 3.5 N-m (Model DID-04 Digital Torque Screwdriver; Imada, Inc. Northbrook, IL, USA). Peripheral fixation of the baseplate to the synthetic tissue surrogate was accomplished with 4 locked screws of 22 mm in length. This length was determined by a retrospective analysis of a consecutive series of 100 RSA surgeries using the same glenoid baseplate, an analysis of which identified an average peripheral screw length of 21 mm. Given that the blocks in the experimental wear groups were prepared before baseplate instrumentation and