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ORIGINAL ARTICLE

# What can be learned from an analysis of 215 glenoid component failures?

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**Background:** Glenoid component failure is a prevalent mechanical complication of anatomic total shoulder arthroplasty. The objective of this study was to identify surgeon-controlled factors that may be addressed to reduce the rate of glenoid component failure that is sufficiently symptomatic to merit surgical revision.
**Methods:** We reviewed the clinical and radiographic features of 215 total shoulder arthroplasties that we revised for symptomatic glenoid component failure.
**Results:** Glenoid component failure was associated with poor patient self-assessed shoulder function (mean Simple Shoulder Test score, 3.0 ± 2.7). These shoulders often showed multiple failure modes; 72% had glenoid component loosening, 69% had polyethylene wear, 51% had glenohumeral decentering, and 25% had humeral component loosening. Metal-backed/hybrid and keeled glenoid designs had higher rates of loosening ($P = .010$), malposition ($P = .007$), dislocation ($P < .001$), and early failure ($P = .044$) in comparison to pegged designs. Glenoid components with cement on the backside were more prevalent among those revised sooner than 5 years after the index surgery ($P < .001$).
**Conclusions:** Glenoid component failure remains a major cause of poor patient outcomes after total shoulder arthroplasty. The occurrence of severe glenoid component failure might be reduced by paying attention to glenoid component design and insertion technique, restoring the normal balance of the humeral head in the center of the glenoid, and considering a reverse total shoulder when the shoulder is unstable because of soft tissue deficiency.
**Level of evidence:** Level IV; Case Series; Treatment Study


**Keywords:** Total shoulder arthroplasty; arthroplasty failure; glenoid loosening; glenoid wear; subluxation; decentering; surgical revision

Glenoid component failure is a prevalent mechanical complication of anatomic total shoulder arthroplasty.[3,4,18] The glenoid component can fail by aseptic or septic loosening, wear, fracture, dissociation, and dislocation.[18] The actual rate of glenoid component failure may be underestimated for several reasons, especially if surgical revision is used as the end point. First, glenoid component failure is usually recognized after the traditional 2-year follow-up period has concluded.[12,24,39] Second, patients with loose glenoid components may choose to accept their symptoms rather than undergo a revision.[6] Third, revision, if performed, may be performed by a surgeon other than the one performing the index arthroplasty, making the failure less likely to be reported.

This study was approved by the Institutional Review Board of the University of Washington: No. 00001281.

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Attempts to lessen the rate of glenoid component failure need to be guided by a better understanding of the factors commonly associated with these failures. However, whereas reports of glenoid component failure are numerous, there have been few attempts to assess the patient and shoulder characteristics as well as the technical aspects that may have contributed to the failure.

With the goal of informing possible approaches for improving the survivorship of total shoulders, we reviewed >20 years of experience with shoulder arthroplasties requiring surgical revision for glenoid component failure at a tertiary referral shoulder center. Although the investigation of patients coming to our center for surgical revision cannot yield the relative importance and rates of different potential risk factors because of the lack of data on the shoulders not having revision, we were able to use the available information to determine the features commonly associated with total shoulders having surgical revision because of glenoid component failure. We then used this information to suggest means by which the incidence of glenoid component failure might be reduced.

## Materials and methods

This is retrospective cohort study of patients with failure of prosthetic glenoid components for whom we performed revision surgery. Between January 1991 and January 2017, 983 patients had been entered into our longitudinally maintained institutional database as having revision surgery for any type of shoulder arthroplasty. Of these revisions, 350 (36%) were performed for failed total shoulder arthroplasty, 359 (37%) for failed hemiarthroplasty, and the remainder (274 [28%]) for other types of arthroplasty. Of the revised total shoulders, 248 (71%) were performed for glenoid component failure. We reviewed the medical records and pre-revision radiographs taken within the 3 months before revision surgery. Thirty-three shoulders (13%) were excluded because of inadequate radiographs, leaving 215 total shoulders with failed glenoid components for the final analysis. For these patients, we recorded patient demographics (age, gender, and laterality), date of index and revision arthroplasty, and interval between index and revision arthroplasty as well as pre-revision patient self-assessment with visual analog scale pain scores and Simple Shoulder Test (SST) scores.

One of the authors reviewed all pre-revision anteroposterior Grashey and axillary radiographs[13,19] for each patient to assess glenoid component characteristics, humeral component characteristics, and glenohumeral relationships at the time of revision surgery; previous studies have documented good to excellent inter-rater and intra-rater reliability with the methodology used in this analysis.[13,34] Glenoid components were categorized into pegged, keeled, and metal-backed or hybrid designs. Radiographic glenoid radiolucencies were graded by the Lazarus classification (Tables I and II).[16] Glenoid components were defined as loose if a complete lucent line ≥2 mm was present.[21,35,38,39] The presence of backside cement was recorded if cement was visible between the back of the glenoid component and the bony glenoid face on any radiograph; we did not attempt to quantitate the amount of backside cement. Glenoid malposition was defined as positioning of the central peg or keel >5 mm from the center point of a line connecting the anterior and posterior glenoid edges on the axillary view or superior and inferior glenoid edges on the Grashey view. The presence of glenoid component wear was recorded if there was ≤2 mm of space between the glenoid face and the humeral head component on 2 orthogonal views.[5]

**Table I** Lazarus classification of lucencies around a keeled component

| Grade | Finding |
|---|---|
| 0 | No radiolucency |
| 1 | Radiolucency at superior and/or inferior flange |
| 2 | Incomplete radiolucency at keel |
| 3 | Complete radiolucency (≤2 mm wide) around keel |
| 4 | Complete radiolucency (>2 mm wide) around keel |
| 5 | Gross loosening |

**Table II** Lazarus classification of lucencies around a pegged component

| Grade | Finding |
|---|---|
| 0 | No radiolucency |
| 1 | Incomplete radiolucency around 1 or 2 pegs |
| 2 | Incomplete radiolucency (≤2 mm wide) around 1 peg only, with or without incomplete radiolucency around 1 other peg |
| 3 | Complete radiolucency (≤2 mm wide) around 2 or more pegs |
| 4 | Complete radiolucency (>2 mm wide) around 2 or more pegs |
| 5 | Gross loosening |

Humeral stem lucencies were determined in the 7 Gruen zones[20,31,32]; a loose component was defined as obvious subsidence[33,37] or presence of osteolysis ≥2 mm in 3 or more Gruen zones.[21,36]

The anterior-posterior and superior-inferior glenohumeral relationships were measured as described previously.[13] On each of these views, a circle was constructed congruent to the articular surface of the humeral head component. The shortest distance between this circle's center and a line perpendicular to the center of the glenoid component was measured. This distance was divided by the diameter of the circle and converted to a percentage. Humeral decentering on the glenoid was defined as a value >5%. Any shoulder with glenohumeral decentering >25% was excluded from the determination of glenoid wear because of the inability to properly assess the space between the glenoid face and the humeral component. In this retrospective study, we were unable to measure wear on retrieved components.

Medical records were reviewed to collect information about presentation of "obvious" infection, including symptoms of wound drainage, sinus tract formation, and purulent joint fluid. Intraoperative culturing results were also reviewed, including the number of culture specimens taken, the duration of culture observation, the number of positive cultures, and the degree of positivity of each culture.[1] A shoulder was considered to have significantly positive cultures if 2 or more specimens were culture positive for the same bacterial species.

### Statistical analysis

Descriptive statistics were used to characterize the demographics of the patients; means and standard deviations were presented for