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ORIGINAL ARTICLE

Effects of cemented versus press-fit primary humeral stem fixation in the setting of revision shoulder arthroplasty

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Background: The influence of primary humeral stem fixation method (cemented or press fit) on intraoperative or postoperative outcomes in the setting of revision shoulder arthroplasty is unknown.

Methods: A retrospective analysis of a prospectively collected cohort of revision shoulder arthroplasty patients from a single tertiary center was performed. Demographic variables, intraoperative data, and 90-day complication rates were compared between cemented and press-fit primary stem fixation cohorts. Follow-up radiographs were graded and compared using a modified Gruen system for humeral lucencies.

Results: Eighty-six primary shoulder replacements (34 hemiarthroplasties, 39 anatomic total shoulder arthroplasties, 13 reverse total shoulder arthroplasties) underwent revision arthroplasty with humeral stem removal between 2004 and 2017. Forty-five patients had cemented primary humeral fixation and 41 had press-fit fixation. The cemented cohort was older than the cementless cohort (66.6 vs. 61.4 years; $P = .03$) but otherwise demonstrated no difference in gender, body mass index, type of primary prosthesis (hemi, total, or reverse), or time between primary and revision operations. The cemented and cementless cohorts showed similar rates of humeral osteotomy (28.9% vs. 29.3%; $P = .97$), operative time (133.5 vs. 121.3 minutes; $P = .16$), and 90-day complication rates (13.3% vs. 9.8%; $P = .61$). Cemented vs. press-fit primary stems also had similar rates of humeral lucencies seen on follow-up radiographs after revision (77.1% vs. 60.6%; $P = .14$).

Conclusion: Humeral stem fixation with or without cement during primary shoulder arthroplasty demonstrated similar operative time, need for intraoperative humeral osteotomy, and postoperative complication rates in the setting of revision arthroplasty.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Shoulder arthroplasty; shoulder replacement; revision shoulder arthroplasty; revision shoulder replacement; reverse total shoulder arthroplasty; humeral stem; cemented stem

Since the increase in popularity of the anatomic total shoulder arthroplasty (TSA) by Neer in the 1970s and the reverse TSA (rTSA) by Grammont in the 1980s, shoulder replacement procedures have remained a mainstay for treatment of advanced degenerative conditions of the glenohumeral

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joint.[1,7,9,10,15,16,25] Outcomes after shoulder arthroplasty are generally excellent,[11,22,23] and as the U.S. population ages, demand for these procedures is expected to increase. In fact, recent evidence shows a 3.7-fold increase in the nationally adjusted population rate of shoulder arthroplasty between 2000 and 2010.[12,17] To optimize primary shoulder arthroplasty outcomes in this era of rising demand, optimal fixation of the humeral component is imperative to avoid aseptic loosening. Options for stem fixation include polymethyl methacrylate cement fixation and cementless press-fit fixation, with or without porous coating or grit-blasted ongrowth surfaces.[12] Cement had been the traditional method of stem fixation for many years, and recent evidence reported that cemented stems demonstrated better 12-, 18-, and 24-month patient-reported outcomes, strength, and forward flexion than uncemented stems.[12] However, other studies have demonstrated equivalent patient-reported and functional outcomes for both cemented and cementless stems,[11,22,23] and since the year 2000, uncemented humeral fixation has become more common because of variability in shoulder joint anatomy, concerns of bone loss, shorter operative time, and efforts to reduce surgical costs.[3,12]

Whereas the decision to perform a cemented or cementless primary humeral stem fixation remains controversial, the increasing demand for primary shoulder arthroplasties in this country portends an increased rate of revision shoulder arthroplasties in the coming decades. Published studies report a revision rate of 11% for hemiarthroplasty and TSA and 10% for reversed arthroplasty.[5,7] A recent study of the National Hospital Discharge Survey database found that revision TSA accounted for 4.6 per 100,000 hospital admissions between 2001 and 2005 but rose significantly to 9.0 per 100,000 between 2006 and 2010.[14] Surprisingly, despite this evidence for a rising burden of revision shoulder replacement, few studies have examined how cemented or cementless primary humeral stem fixation affects outcomes after revision shoulder arthroplasty.

The purpose of this study was to compare the procedure length, need for intraoperative humeral osteotomy, lucencies on postoperative radiographs, and postoperative complications of patients with cemented or cementless primary shoulder arthroplasties undergoing revision. Considering the effort needed for cement removal in revising a cemented primary stem as opposed to a cementless stem, we hypothesized that the cemented primary stem cohort would experience longer operative times, an increased need for intraoperative humeral osteotomy, an increased rate of postrevision radiolucencies, and an increased 90-day complication rate compared with the cementless primary stem cohort.

Materials and methods

The authors performed a retrospective cohort study using a prospectively collected data registry of shoulder arthroplasty patients from a single tertiary referral center from 2004 to 2017. Patients with a primary or secondary diagnosis of failed primary shoulder replacement were included for analysis. Revisions of oncologic prostheses, revisions that did not involve humeral stem removal, and revisions of short-stemmed or stemless primary implants were excluded. Three fellowship-trained surgeons (blinded for submission) performed all revisions.

Before revision surgery, all patients received a thorough workup including symptom assessment, physical examination, radiographs, and laboratory analysis. All operations were performed with the patient in a semi–beach chair position after a combination of regional and general anesthesia. A prior deltopectoral skin incision and approach were used for all patients. All primary components were removed. If needed to facilitate stem or cement removal, a vertical humeral osteotomy was performed that was later repaired with cerclage wiring. Revision implants were chosen as standard of care. Specifically, for cases with low concern for infection, a hemiarthroplasty (Zimmer Bigliani/Flatow Shoulder System; Zimmer, Warsaw, IN, USA) was implanted for patients with insufficient glenoid bone stock, an anatomic TSA (Zimmer Bigliani/Flatow Shoulder System) was implanted for patients with an intact rotator cuff, and an rTSA (Zimmer Trabecular Metal Reverse Shoulder System) was implanted for patients with a compromised rotator cuff. All cases concerning for infection (elevated erythrocyte sedimentation rate or C-reactive protein level) underwent removal of primary components followed by tissue culture, irrigation and débridement, and custom antibiotic-impregnated cement spacer placement. Infected cases subsequently underwent an open biopsy after approximately 6 weeks of targeted intravenous antibiotics to confirm eradication of the infection before reimplantation of a revision prosthesis as guided by the same indications. All final revision implants were cemented in place.

Demographic variables including age, body mass index, and gender as well as primary implant type, operative time, need for humeral osteotomy, and complications occurring within 90 days of revision implant placement were obtained and compared between groups. The operative time was obtained from the institution's operative record and was defined as time of incision to time of closure. The need for intraoperative humeral osteotomy was obtained from the operative report. For infected cases, as it involves a 3-stage explantation and reimplantation, the operative time and osteotomy rate from the first stage (primary implant removal with antibiotic spacer placement) were analyzed. Complications that occurred within 90 days after revision prosthesis placement (after reimplantation for infected patients) were obtained from the electronic medical record and clinical notes, including need for revision surgery, wound complications, infections, nerve palsies, and instability. Furthermore, follow-up radiographs obtained between 10 and 14 months after final revision prosthesis placement, which included standard anteroposterior and axillary lateral views, were assessed for humeral radiolucent lines. These lucencies were graded by an author blinded to the patient's history and indication for revision. Lucencies were graded on a modified Gruen system previously applied in the literature.[21] These grades include none, incomplete <2 mm, incomplete >2 mm, complete <2 mm, and complete >2 mm.

Continuous demographic variables and outcomes were compared between cemented and cementless groups and assessed for differences in variance using a 2-sample variance comparison test. The appropriate Student *t*-test (2-sample equal variance or 2-sample unequal variance) was then performed on these continuous variables. Categorical demographic variables and outcomes were compared using Pearson χ^2 test. All statistical analysis was per-