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ORIGINAL ARTICLE

Platform shoulder arthroplasty: a systematic review

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Background: Platform shoulder arthroplasty systems may allow conversion to a reverse total shoulder arthroplasty (RTSA) without removing a well-fixed, well-positioned humeral stem. We sought to evaluate the complications associated with humeral stem exchange versus retention in patients undergoing conversion shoulder arthroplasty with a platform shoulder arthroplasty system.

Methods: PubMed, MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and Embase were searched from database inception through October 9, 2016, for all articles comparing humeral stem retention versus exchange during conversion RTSA or that pertained to conversion RTSA with stem retention alone. All studies were screened in duplicate for eligibility. A methodologic quality assessment was completed for included studies. Pooled outcomes assessing complications, operative time, blood loss, and reoperations were determined.

Results: We included 7 studies (236 shoulders), including 1 level III and 6 level IV studies. Pooled analysis demonstrated significantly higher overall complications (odds ratio, 6.89; 95% confidence interval [CI], 2.48-19.13; $P = .0002$), fractures (odds ratio, 4.62; 95% CI, 1.14-18.67; $P = .03$), operative time (mean difference, 62.09 minutes; 95% CI, 51.17-73.01 minutes; $P < .00001$), and blood loss (mean difference, 260.06 mL; 95% CI, 165.30-354.83 mL; $P < .00001$) with humeral stem exchange. Stem exchange was also associated with increased risk of reoperation ($P = .0437$).

Conclusion: Conversion arthroplasty with retention of the humeral stem is associated with lower overall complications, blood loss, operative time, and reoperations in comparison with stem exchange.

Level of evidence: Level IV; Systematic Review

Keywords: Platform arthroplasty; modular arthroplasty; convertible arthroplasty; conversion shoulder arthroplasty; total shoulder arthroplasty; reverse total shoulder arthroplasty; shoulder

We did not need institutional review board or ethical committee approval.

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The number of shoulder arthroplasty procedures has demonstrated significant growth over the past decade,[8,18,19,28,32] with primary procedures increasing by more than 200% and revision procedures increasing by more than 300%.[8,18] The need

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for revision shoulder arthroplasty procedures is expected to further increase given expanding indications for primary procedures coupled with an increasingly active patient population. Component loosening or insufficiency of the rotator cuff following anatomic total shoulder arthroplasty (TSA) resulting in instability, pain, or decreased function may necessitate revision arthroplasty.[1,11,15-17,22,30,33,39] In addition, hemiarthroplasty (HA) procedures performed for fracture management may require revision because of tuberosity resorption, nonunion, or malunion.[2,21,23]

In cases of failed shoulder arthroplasty when anatomic revision is not optimal, revision to a reverse total shoulder arthroplasty (RTSA) may be used to establish a stable fulcrum to improve shoulder biomechanics and provide inherent stability. RTSA is an effective procedure for fracture sequelae and revision arthroplasty.[3,12,27,31,34]

Platform shoulder arthroplasty systems may allow for conversion of a TSA to an RTSA without necessitating the removal of a well-fixed, well-positioned humeral stem. Revision arthroplasty requiring exchanging a cemented or uncemented humeral stem is technically challenging and associated with high rates of iatrogenic fracture,[11,16] loss of proximal humeral bone stock, prolonged operative time,[7,9,37] increased blood loss,[7,9,37] high reoperation rates,[16,22] and other complications.[25,33]

The purpose of this systematic review was to comprehensively review the available literature evaluating conversion shoulder arthroplasty from either an HA or TSA to a reverse prosthesis. Specifically, we sought to evaluate the difference between humeral stem exchange and retention regarding blood loss, operative time, and complications in patients undergoing revision shoulder arthroplasty to an RTSA. Our hypothesis was that humeral stem retention would be associated with lower blood loss, operative time, and complications compared with revision procedures requiring stem exchange.

Materials and methods

This study was conducted according to the methodology described in the *Cochrane Handbook for Systematic Reviews of Interventions*[14] and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[24]

Eligibility criteria

We included studies that (1) compared humeral stem retention versus exchange during conversion shoulder arthroplasty from either an HA or TSA to an RTSA or that pertained to conversion RTSA with stem retention alone, (2) had a minimum of 10 patients in whom the humeral stem was retained, and (3) had a minimum of 6 months of postoperative follow-up. There were no restrictions regarding the indication for primary or revision shoulder arthroplasty, previous treatment for shoulder pathology, publication date, or language of publication. The exclusion criteria consisted of case reports, editorials, reviews, expert opinion articles, and basic science papers.

Identification of studies

A systematic literature search of potentially eligible trials was conducted in CINAHL (Cumulative Index to Nursing and Allied Health Literature), PubMed, MEDLINE, and Embase from the database inception date through October 9, 2016. Investigators with methodologic and content expertise developed and performed the search. Medical Subject Headings (MeSH) and Emtree headings and subheadings were used in various combinations in Ovid and supplemented with free text to increase sensitivity. The PubMed search included articles published online ahead of print. A manual search of related references and cited articles was also performed. We searched conference proceedings from the previous 3 years and ClinicalTrials.gov to identify relevant unpublished trials.

Screening and assessment of eligibility

Two reviewers (J.M.K. and P.T.) independently screened the titles and abstracts of all studies for eligibility using piloted screening forms. Duplicate articles were manually excluded. Both reviewers evaluated the full text of all potentially eligible studies identified by title and abstract screening to determine final eligibility. All discrepancies were resolved by a consensus decision requiring rationale with the first author.

Data extraction and assessment of risk of bias

Data were extracted independently and in duplicate by both reviewers (J.M.K. and P.T.) using a piloted electronic data extraction form (Excel; Microsoft, Redmond, WA, USA). If essential data were unclear or not reported, authors were contacted for clarification. Critical outcomes were determined to be blood loss, operative time, and complications. Extracted data included, but were not limited to, year and journal of publication, number of patients, gender, age at the time of surgery, initial operation, demographic information, and reasons for being unable to retain a modular stem.

The 2 reviewers (J.M.K and P.T.) performed an independent assessment of the methodologic quality using the Methodological Index for Non-Randomized Studies (MINORS)[29] tool for all nonrandomized studies. The level of evidence was graded according to the criteria of Wright et al.[38]

Statistical analysis

Interobserver agreement for assessments of eligibility was calculated with the Cohen κ statistic. A κ of 0-0.2 represents slight agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; and greater than 0.80, almost perfect agreement.[20] Interobserver agreement for methodologic quality assessment was calculated using the intraclass correlation coefficient. Both κ and the intraclass correlation coefficient were calculated using SPSS software (IBM, Armonk, NY, USA).

Mean differences (MDs) were used to summarize identical continuous outcome measures, and odds ratios (OR) were used to assess the effect of dichotomous outcomes from individual studies.[14] The MDs were weighted by sample size using the random-effects model based on the inverse variance method.[14] Standard devia-