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ORIGINAL ARTICLE

Proximal ingrowth coating decreases risk of loosening following uncemented shoulder arthroplasty using mini-stem humeral components and lesser tuberosity osteotomy

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Background: Mini-stem humeral component (MSHC) use during total shoulder arthroplasty (TSA) provides bone preservation and ease of revision. MSHCs rely solely on proximal metaphyseal fixation; some early reports have demonstrated an unacceptably high rate of early loosening. To our knowledge, no study analyzing the effect of proximal porous coating on MSHCs has been performed.
Methods: We performed a retrospective review of consecutive patients who underwent anatomic TSA using coated or uncoated MSHCs with minimum 2-year follow-up. Postoperative radiographs were assessed for risk of or frank stem loosening, subsidence, and presence of radiolucencies. Range of motion, outcome scores (visual analog scale pain, American Shoulder and Elbow Surgeons, and Single Assessment Numeric Evaluation), and any complications were noted.
Results: We analyzed 68 shoulders with a mean follow-up of 27.3 months (range, 24-50 months). Of these, 34 had proximal coating and 34 were uncoated. In the coated group, no stems loosened, 1 (2.9%) subsided, and 7 (20.6%) developed radiolucencies. In the uncoated group, 1 stem (2.9%) became aseptically loose (requiring revision after 26 months), 7 (20.6%) were judged at risk of loosening (2 because of subsidence), and 15 (44.1%) developed radiolucencies. There was also an increased risk of proximal medial humeral radiolucencies among uncoated MSHCs. There were no significant differences in final range of motion or outcome scores.
Conclusion: MSHC use is appropriate for TSA, achieving desired pain relief and functional improvement. Overall, component loosening appears uncommon at early follow-up; however, uncoated stems appear to be at greater risk of loosening and developing radiolucencies. Selecting an MSHC with proximal porous coating may decrease the risk of implant-related complications.
Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Shoulder; arthroplasty; stem; proximal coating; outcomes; loosening; hardware failure

Duke University Medical Center Institutional Review Board approval was given for retrospective analysis of patient data without individual informed consent (study number Pro00053203). All data collection and analysis were performed with the board's approval.

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Shoulder arthroplasty, indicated in cases of end-stage glenohumeral osteoarthritis, is a safe and effective surgical intervention with a long-standing history of success. Since the first reported results on shoulder arthroplasty by Neer over 40 years ago,[20] improvements in technique and implant design have led to survival rates above 90% after 10 years.[29] Traditionally, standard-length stemmed humeral components, originally requiring cement fixation but now reliant solely on press-fit diaphyseal fixation, have been used in total shoulder arthroplasty (TSA), with high success rates and low rates of implant loosening or failure (Fig. 1). However, humeral deformity and existing total elbow arthroplasty can be contraindications to traditional, diaphyseal press-fit stems.[14] Furthermore, stress shielding, a phenomenon that occurs when there is decreased loading of an area of peri-implant bone after joint arthroplasty, leading to osteopenia and bone resorption, has often been observed in implants with diaphyseal cortical fixation.[17,19]

Recently, a fourth-generation implant[11] using mini-stem humeral components (MSHCs) has emerged as a solution to avoid the previously mentioned limitations of the traditional-length stemmed humeral prosthesis (Fig. 1). MSHCs, which are exclusively reliant on proximal metaphyseal fixation, are purported to provide several benefits. Among these are the removal of less humeral bone stock, increased overall bone loading leading to decreased stress shielding, simplified revision, and relative ease of treatment of periprosthetic fracture.[14,26] Although studies assessing the long-term effect of this proximal metaphyseal fixation on humeral component failure rates have yet to be performed, early results with MSHCs have shown mixed results—some comparable with those of traditional long-stem components[14] and some with an implant loosening rate up to 8.7% and an unacceptable revision rate at 24 months.[3]

The desire to avoid cementation of implants during arthroplasty to shorten procedural time, avoid potential cardiopulmonary effects of polymethylmethacrylate,[6] simplify potential future revisions, and potentially create a direct bond between the patient's bone and the implant has driven implant design in both TSA and total hip arthroplasty (THA).[1,13]

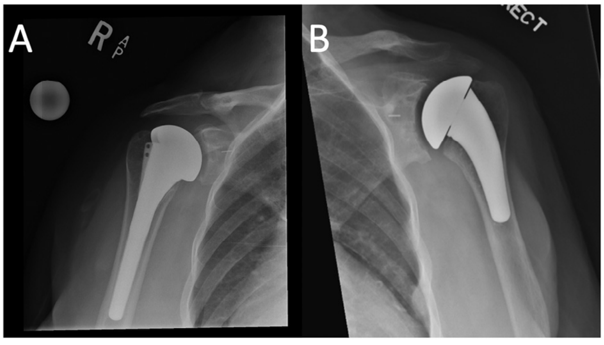

Figure 1 Bilateral shoulder radiographs showing right shoulder with standard long-stem humeral implant (A) and left shoulder with mini-stem humeral component (B).

Stems using proximal ingrowth coating were developed to enhance humeral fixation using a biological approach. In the THA literature, it is well accepted that porous, proximal coating leads to bony ingrowth and improved implant stability, with an optimum pore size of 50 to 400 μm.[2,13] Titanium alloys are most widely used for this coating because of their biocompatibility with and similar modulus of elasticity to bone,[10] characteristics believed to be beneficial in decreasing stress shielding. Short-term to midterm results for traditional-length stemmed humeral implants using proximal ingrowth coating have been encouraging, with few radiolucencies and no humeral loosening, subsidence, or radiographic risk of loosening at a mean of 52 months.[28] Similar results have been identified with THA, for which the use of circumferential proximal ingrowth coating led to decreased osteolysis, minimal radiolucencies about the coated surface, and no femoral component loosening or failure at a mean of 10 years.[1]

This is the first study to compare the short-term (minimum 2-year follow-up) results of anatomic shoulder arthroplasty using MSHCs with and without proximal porous coating. We hypothesized that MSHCs with proximal porous ingrowth coating would exhibit superior radiographic outcomes compared with MSHCs without proximal coating and that the coated MSHCs would result in clinical and radiographic outcomes as good as or better than the published results of more established techniques.

Methods

Participants

This retrospective cohort study evaluated patients treated for a variety of surgical indications (Table I) by 2 shoulder and elbow fellowship–trained surgeons (P.S.J. and G.E.G.) at either of 2 medical centers. Patients aged between 18 and 99 years who were treated with anatomic TSA (Current Procedural Terminology code 23472) performed by either surgeon between March 2011 and March 2014 were eligible. Minimum postoperative follow-up for radiographic and outcome analysis was 24 months. The same postoperative rehabilitation protocol was provided to all patients, who were instructed to adhere to it while under supervision of a qualified physical therapist. For the first 6 weeks postoperatively, patients were instructed to remain in a sling, with removal only for dressing, bathing, and performing supine, passive, well arm–assisted range-of-motion (ROM)

Table I Indications for index operation

Indication for TSA	n
Primary OA	57
Post-traumatic OA	5
AVN	4
Chronic instability	2
Total	68

AVN, avascular necrosis; OA, osteoarthritis; TSA, total shoulder arthroplasty.