Technical Note

Arthroscopic Removal of Loose Glenoid Component in Anatomic Total Shoulder Arthroplasty

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Abstract: Aseptic glenoid component loosening after anatomic total shoulder arthroplasty remains an important cause of late clinical failure and revision surgery. We present here the surgical technique of all-arthroscopic removal and glenoid bone grafting. Arthroscopic removal of a loose glenoid component and bone grafting of the glenoid defect without dermal allograft preserves glenoid bone stock and obviates the need for multiple suture anchors to hold the graft in place.

Glenoid component loosening after anatomic total shoulder arthroplasty is a well-known complication and the leading cause of late arthroplasty failure leading to revision surgery.[1-4] Potential causes of glenoid component loosening include but are not limited to infection, poor bone quality, imperfect glenoid bone preparation, eccentric glenoid loading otherwise known as the "rocking horse phenomenon," rotator cuff insufficiency or soft-tissue imbalance, and aseptic loosening.[5-7] Clinical presentations are variable and symptoms nonspecific. Patients may present with increasing pain after a pain-free period, loss of motion, and clicking or other mechanical symptoms.[7]

Evaluation of the potentially loose glenoid component includes an infection workup, orthogonal plain radiographs, computed tomography with or without intra-articular contrast,[8,9] and direct visualization using arthroscopy if previous workup has been equivocal.[6,7] Treatment options for aseptic glenoid loosening include revision with a new glenoid component, removal of the glenoid component for conversion to a hemiarthroplasty with or without glenoid bone grafting, and revision to reverse shoulder arthroplasty.[10]

Isolated glenoid component removal can be an attractive option in some settings. The morbidity of glenoid component removal is low relative to a more complex revision, such as revision to reverse shoulder arthroplasty, which might include removing a well-fixed humeral stem.[11] Although glenoid component removal was original described as an open revision surgery, performed through the same deltopectoral exposure as for the index total shoulder arthroplasty, it also can be performed arthroscopically. The latter offers several advantages, including less soft-tissue dissection while preserving the subscapularis tendon.

Several case studies have reported on arthroscopic removal of a loose glenoid component, but most have not incorporated arthroscopic bone grafting of the glenoid defect.[12,13] We report here on the surgical technique of all-arthroscopic removal of a symptomatic and loose glenoid component followed by all-arthroscopic glenoid bone grafting.

Patient Evaluation, Imaging, and Indications

Patients with a loose glenoid component after anatomic total shoulder arthroplasty often present with progressive pain over the posterior joint line with or without mechanical symptoms of clicking or catching. The differential diagnosis for insidious-onset pain after anatomic shoulder arthroplasty also includes chronic rotator cuff attrition or failure and prosthetic joint infection (PJI). Patients with rotator cuff attrition often present with painful elevation and nocturnal pain and may lose completely the ability to

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elevate their arm (pseudoparalysis) if the subscapularis is involved substantially. Patients with a loose glenoid component may present with weakness, especially if the component has worn thin because of pain inhibition or increased slack in the rotator cuff muscles, but often strength remains well preserved. Patients with a shoulder PJI typically present with more constant and severe pain that may have been present since surgery.

Work-up should support the diagnosis and rule out other, potentially confounding, diagnoses. Physical examination may reveal posterior joint line and glenohumeral crepitus. Plain radiographs should demonstrate good glenohumeral register to help exclude subscapularis failure or a chronic rotator cuff tear and may demonstrate some glenohumeral joint space narrowing. Some glenoid components contain metal markers imbedded in the keel or peg(s) and plain radiographs may demonstrate a change in position of these markers, relative to previous radiographs.[14] Diagnostic ultrasonography is an excellent tool to rule out a rotator cuff tear after anatomic shoulder arthroplasty and should be employed whenever there is a concern over symptomatic rotator cuff dysfunction. Serologies including complete blood count with differential, erythrocyte sedimentation rate, and quantitative C-reactive protein should be obtained to help rule out PJI, but these are frequently normal in patients with PJI caused by low-virulence organisms. Additional workup may include joint aspiration, under fluoroscopic or ultrasonographic guidance, for cultures and bio-marker assays, such as alpha-defensin. Finally, a computed tomography scan with intra-articular contrast may be performed when there is suspicion for a loose glenoid component. Contrast extravasation behind the glenoid component is diagnostic for a loose component but false negatives are frequent.[8]

Treatment for a mildly symptomatic loose glenoid component may be supportive, including activity modification and analgesics, unless or until the component completely dislocates, in which case symptoms of locking and motion loss typically mandate surgery. However, the treatment of a symptomatic loose glenoid component is typically surgical and may involve arthroscopic or open glenoid component removal, with or without bone grafting, or revision to reverse shoulder arthroplasty when there is concern over present and future rotator cuff function. Patients with good rotator cuff function are offered the option of arthroscopic glenoid component removal so that the subscapularis is not violated. If an open glenoid component removal is needed, this may be attempted through the rotator interval in a subscapularis-sparing technique. However, patients with increased laxity after glenoid component removal may benefit from upsizing to a slightly thicker humeral head component to improve joint stability and rotator cuff tension. Glenoid component reimplantation is difficult after removing a loose all-polyethylene component because typically the peg holes had widened and coalesced into a large cavitary defect.[15]

Surgical Technique

The surgery is performed at Mercy Health-Cincinnati SportsMedicine and Orthopaedic Center with the patient under a general anesthetic and after preoperative regional anesthesia. An examination under anesthesia is performed, and the patient is placed in the beach-chair position, which allows for easy conversion to an open procedure if necessary. A diagnostic arthroscopy is performed using a 30° arthroscope through a standard posterolateral viewing portal (Fig 1A). The anterior portal is established using an outside-in technique through the rotator interval, often in line with the previous deltopectoral incision. Diagnostic arthroscopy is completed, including a careful evaluation of the articular side of the rotator cuff, as this may otherwise alter the surgical procedure. The glenoid component is probed from the anterior portal, and a switching stick technique is used to bring the arthroscope anteriorly to evaluate the posterior structures. The subacromial space is also explored to rule out a bursal-sided rotator cuff tear or adhesions. This may be performed before or after glenoid component removal but before bone grafting.

Shoulder arthroscopy after anatomic total shoulder arthroplasty should include an intra-articular, subacromial, and subdeltoid evaluation of all relevant structures.[6] The subscapularis and posterosuperior rotator cuff tendons are evaluated from both surfaces. Gentle probing of the glenoid component is performed, from both anterior and posterior portals if needed, to confirm that the glenoid component is grossly loose (Fig 1B). Intraoperative biopsies for culture are obtained from the anterior and posterior compartments, from behind the loose glenoid and from the subacromial space. Synovial tissue and any additional suspicious material are obtained for culture using an arthroscopic grasper as well as a motorized arthroscopic shaver connected to a Lukens trap. Extensive synovitis may be present and a through debridement should be carried out with either an arthroscopic shaver or an electrocautery.

The rotator interval is debrided and expanded to facilitate component removal. The peri-glenoid tissue was also debrided to facilitates this. An arthroscopic elevator is used to free the glenoid from adjacent soft tissues. A half inch curved osteotome is used to bisect the glenoid component horizontally, anterior to posterior (Fig 1 C and D). The anterior portal is elongated to facilitate insertion of the osteotome and extraction of

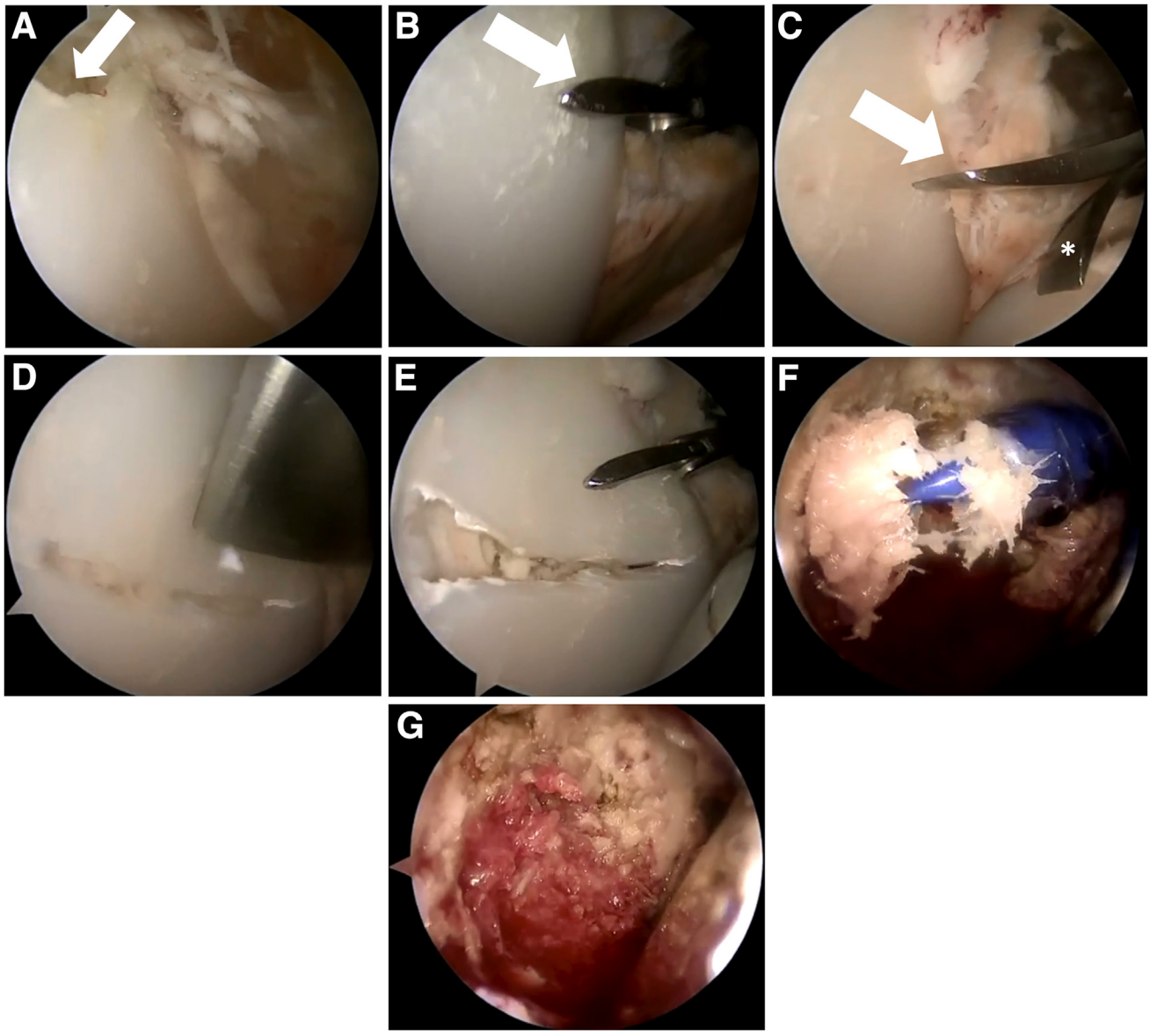

Fig 1. (A) View of the glenoid implant from the posterior portal. Note the thinning of the implant superiorly (arrow). (B) Grasping the loose component with a grasper (arrow) to demonstrate complete separation from the bony glenoid. (C) Osteotome placement before transecting the glenoid implant. Note the osteotome (arrow) and its reflection on the humeral head implant (*). (D) Transecting the glenoid implant using the osteotome. (E) Using a grasper for piecemeal removal of the glenoid implant. (F) Dry arthroscopy demonstrating shuttling of bone graft substitute into the defect with cannula and trocar. (G) View from posterior portal demonstrating completed bone grafting of the cavitary glenoid defect.

the glenoid component (Fig 1E). The component can be sectioned further as needed.

The peri-glenoid tissue and debris over the glenoid face is thoroughly debrided with a motorized arthroscopic shaver and electrocautery. Small polyethylene and/or cement fragments and debris often remain and these should be removed. A thorough debridement of the glenoid face facilitates an accurate assessment of the amount of glenoid bone loss. All glenoid debridement as well as glenohumeral and subacromial space evaluation should be performed prior to bone grafting, which is typically the last step in surgery.

Glenoid component removal may leave behind a variable glenoid defect or defects. Small peg holes are uncommon, but if present these can be ignored, and may permit subsequent glenoid component reimplantation as needed. Large uncontained defects are uncommon unless the glenoid component was originally mispositioned or loosened following sudden trauma. These defects are best addressed through open revision surgery that includes glenoid reconstruction using bulk allograft or autograft, or revision to reverse shoulder arthroplasty in 1 or 2 stages. In contrast, a large, contained cavitary defect is ideal for arthroscopic glenoid bone grafting.

Table 1. Pearls and Pitfalls of Arthroscopic Removal of a Loose Glenoid Component

Complete the diagnosis arthroscopy and biopsy for cultures before removing glenoid component.
Use an osteotome to bisect glenoid component horizontally. Make additional cuts as needed.
Enlarge the anterior portal as needed to accommodate glenoid component fragments.
Use a large grasper to securely grab fragments. A cannula helps dilate a path through the soft tissues.
Remove all loose cement and tissue from glenoid defect prior to bone grafting. Send biopsy for culture.
Turn off arthroscopic fluid before bone grafting.
Use a plastic cannula and trocar to aid in delivering bone graft.
Use an 18-gauge spinal needle and syringe or arthroscopic shaver with low suction to remove any accumulating fluid during bone grafting

To perform the arthroscopic glenoid bone grafting the arthroscopic fluid inflow is first turned off and excess fluid is suctioned from the joint. The large glenoid defect is filled with bone graft substitute (ViviGen, 10cc, DePuy Synthes, Warsaw, IN) delivered through an 8.25-mm × 9-cm cannula (Arthrex, Naples, FL). The cannula's diaphragm is removed to facilitate delivery of the bone graft substitute to the glenoid surface using the cannula trocar (Fig 1F). An arthroscopic elevator or narrow bone tamp helps to compress the bone graft and fill in the bone defect (Fig 1G). Covering and containing the bone graft using human dermal allograft has been reported,[16] but we use the existing humeral head component to contain and compress the bone graft. The success of this technique requires good register between the humeral head and glenoid face. After completing the grafting of the glenoid defect, all instruments are removed and the portals, including the longer anterior portal, are closed in a layered fashion. Several pearls and pitfalls of arthroscopic loose glenoid component removal and glenoid bone grafting are summarized in Table 1.

Postoperatively, patients typically wear a sling for 3 weeks to help consolidate the bone graft. Physical therapy is initiated at 1 week postoperatively, beginning with passive range of motion and transitioning to active range of motion as tolerated after 2 to 3 weeks. Stretches are initiated at 6 weeks' postoperatively, followed by strengthening and a graduated transition to full activities. At 3 to 6 months' postoperatively, patients are released to full activities as tolerated, including golf and moderate weight training. Plain radiographs are obtained at 1 week and at 6 to 8 weeks and should demonstrate good register between hemiarthroplasty and glenoid after removal of the glenoid implant and bone grafting (Fig 2 A and B).

Discussion

Glenoid component loosening after anatomic total shoulder arthroplasty presents a significant challenge for treating orthopedic surgeons.[10,11] Patients presenting with a painful anatomic total shoulder arthroplasty, especially posterior joint line pain accompanied by mechanical symptoms, should be evaluated for glenoid component loosening. Underlying concurrent problems, such as PJI and rotator cuff insufficiency, also should be ruled out. History, clinical examination, radiographs, advanced imaging, laboratory analysis, and possible diagnostic arthroscopy are all critical steps in the evaluation process.[6]

Surgical interventions may involve revision to a new glenoid component, removal of the glenoid component, or conversion to reverse shoulder arthroplasty.[10,17]

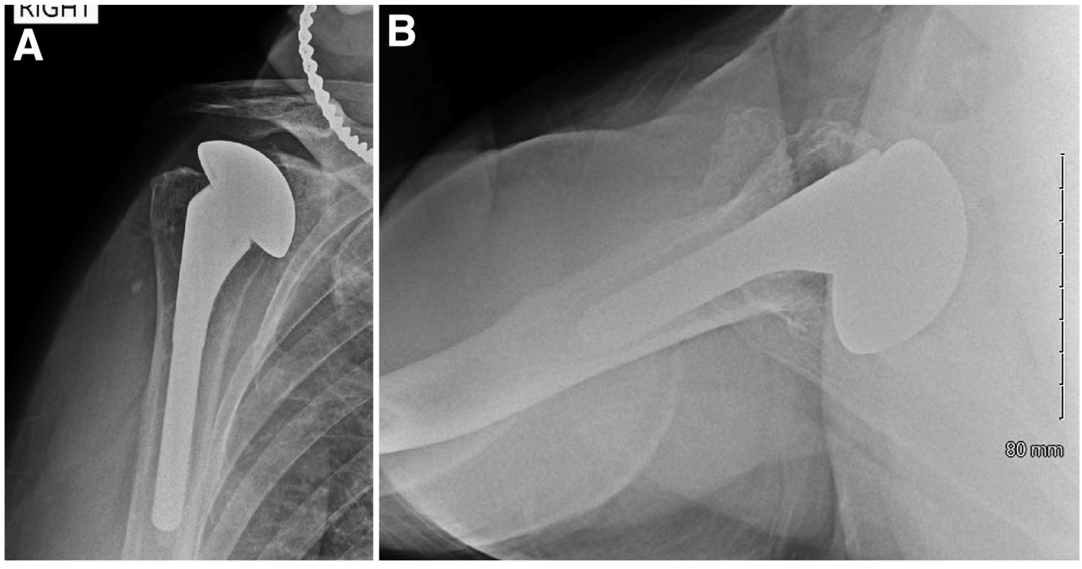

Fig 2. Postoperative true anteroposterior (A) and axillary-lateral (B) radiographs at 8 weeks demonstrating bone graft remodeling and maintenance of glenohumeral register.

Table 2. Advantages/Disadvantages of Arthroscopic Glenoid Component Removal and Bone Grafting

Advantages	Disadvantages
Lower morbidity option compared with open glenoid component removal and bone grafting	Glenoid component removal slackens the rotator cuff tendons, causing weakness and dysfunction
Low morbidity evaluation of glenoid component in equivocal cases	Diagnostic value of cultures obtained by arthroscopy may be inferior to open biopsy[20]
Minimally invasive subscapularis-sparing technique accelerates the recovery	Bulk bone grafting of uncontained defects is not possible
Enables concurrent biopsy for cultures from joint capsule and subacromial space	
Enables concurrent evaluation of the rotator cuff and subscapularis	
Bone grafting helps improve glenoid bone stock for any subsequent revision surgery	

Each treatment option carries inherent risks and benefits so that treatment should be tailored to each patient. Revision to reverse shoulder arthroplasty is appropriate when there is associated cuff insufficiency and/or pseudoparalysis, concurrent humeral sided problems, or massive glenoid bone loss. Replacement of the glenoid component is a consideration, but this is often impractical because a loose glenoid component often leaves a cavitary glenoid defect that precludes reimplantation.[15] Consequently, glenoid component removal along with bone grafting is an attractive option.

When comparing open versus arthroscopic removal of a loose glenoid component, arthroscopic treatment offers several distinct advantages. The subscapularis is preserved and, overall, there is far less tissue dissection. Arthroscopic glenoid component removal can be combined with biopsy for intraoperative cultures and bone grafting of the cavitary glenoid defect without the morbidity of an open procedure. In addition, it does not preclude staging component reimplantation at a later date.[6,18] Raphael et al.[19] retrospectively evaluated glenoid component replacement versus removal and demonstrated similar patient-reported outcomes. The 5 patients who underwent arthroscopic glenoid component removal had better outcomes than the 3 patients who underwent open component replacement, but the differences did not reach statistical significance because of the small sample size.[19]

Previous case studies have described glenoid removal without grafting whereas others have suggested bone grafting with or without the use of a biologic graft such as human dermal allograft.[12,13,16] We reason that compression from the humeral head component maintains the bone graft within the glenoid cavity, without the need for a biologic graft. This simplifies the procedure and preserves the peripheral glenoid bone stock, as dermal allografting requires placing suture anchors in the center and periphery of the native glenoid, diminishing the glenoid bone stock and complicating any future revision surgery. The advantages and disadvantages of arthroscopic glenoid component removal with bone grafting are summarized in Table 2.[20]

A systematic review evaluating outcomes after arthroscopic removal of loose glenoid components has been reported by Ozdag et al.[13] The authors summarized 6 studies (2 case reports and 4 retrospective case series) including 25 patients. They reported improvements in pain and overall range of motion, as well as a low overall complication rate, with only 2 of 25 undergoing revision to reverse shoulder arthroplasty for continued pain and dysfunction. The authors acknowledged that most patients were older, with mean age of 75 years, and had modest functional demands, but they concluded that arthroscopic removal of loose glenoid components can be an effective way to decrease pain, improve function, and regain motion.[13]

The diagnosis of glenoid loosening can be made radiographically by the presence of substantial or progressive radiolucency, or by a shift in glenoid component position, as demonstrated by serial radiographs.[21] According to Deutsch et al.,[22] radiographic markers suggesting a loose glenoid component include complete radiolucent lines $\geq$2 mm, progression of radiolucent lines on serial radiographs, cement fragmentation, and component migration. However, in some cases the presentation may be more subtle and without the classic radiographic findings, so that maintaining a heightened index of clinical suspicion is important.

Aseptic glenoid component loosening after anatomic total shoulder arthroplasty remains an important cause of late clinical failure and revision surgery. We present a multifaceted, minimally invasive surgical technique for diagnosis and treatment. Arthroscopic bone grafting of the glenoid defect without dermal allograft preserves glenoid bone stock and obviates the need for multiple suture anchors to hold the graft in place. Longer clinical follow-up along with comparative study of patient series will be needed to fully understand the potential benefits of arthroscopic glenoid component removal and determine the optimal patient population.

Disclosures

All authors (R.Z., S.J.M., C.M.F., S.S.H.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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