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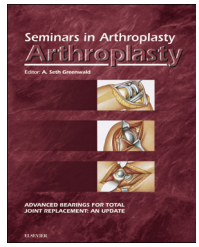

Baseplate placement in failed total shoulder replacement: Builder's choice

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ABSTRACT

Glenoid component loosening has been recognized as one of the common indications for revision surgery after total shoulder arthroplasty. Replacement with a standard glenoid component is sometimes possible when bone loss is minimal and contained within the glenoid vault. If glenoid bone stock is poor, more complex revision strategies include bone graft reconstruction, custom implants, and the use of augmented components. Reverse total shoulder arthroplasty has also developed into a platform for revision surgery. However, surgeons must be aware that when used for revision, complication rates are higher and survival times are shorter. Glenoid revision is technically demanding even for an experienced shoulder surgeon and may lead to early revision failures if done improperly. Shoulder surgeons must have a detailed understanding of expected outcomes, proper indications and current bone grafting techniques when attempting glenoid reconstruction.

1. Introduction

Total shoulder arthroplasty (TSA) is an excellent procedure for patients with an intact rotator cuff who have otherwise failed conservative treatment for painful glenohumeral joint arthritis. Clinical and functional success of conventional TSA is well documented in the literature [1–5]. In nearly 95% of patients, total shoulder arthroplasty is associated with improved shoulder function, pain relief, and overall patient satisfaction [2]. For most prosthetic designs, implant survivorship is estimated at >85% with a minimum follow-up of 15 years [6]. Despite the clinical success of TSA, a meta-analysis by Bohali et al. [7] found the revision burden to be approximately 7% based on long-term studies.

Each year the number of TSA cases continues to rise [8], and, accordingly, the need for revision surgery follows suit. Indications for revision arthroplasty after a failed total shoulder include aseptic loosening, infections, rotator cuff deficiency, implant malpositioning, mechanical complications, osteolysis, and secondary glenoid wear. Revision surgery is complex and often unpredictable, especially in patients with deficient bone stock of the humerus and/or glenoid. Shoulder surgeons must have a detailed understanding of expected outcomes, proper indications, and current bone grafting techniques when attempting complex glenoid reconstructions.

2. Glenoid failure in TSA

A total shoulder prosthesis is anatomic in design with regard to shape and position. The arthritic humeral head is replaced with a metal head and stem; the glenoid is replaced with a

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cemented polyethylene component. Constraint of the prosthesis is minimal and stability is maintained by the soft-tissues, a balance between the rotator cuff and extrinsic shoulder muscles. One common cause of failure following TSA is aseptic loosening of the glenoid component [10–14]. Contributing factors include glenoid morphology, altered joint reactive forces (eccentric loading), malpositioning, and insufficient bony support for the implant [2,6,16]. In primary glenohumeral osteoarthritis, glenoid morphology can vary considerably. The B2 (bi-concave) glenoid [15], with posterior humeral head subluxation, is particularly worrisome as it induces an inherent "rocking-horse" phenomenon which leads to eccentric loading and early glenoid failure [16,17]. Eccentric loading leads to increased stress at the bone/cement/implant interfaces [16], which also occurs with rotator cuff deficiency and humeral head migration.

A variety of surgical techniques have been described to address glenoid deficiency and instability in primary TSA. These techniques include eccentric reaming of the anterior glenoid, posterior bone grafting, and specialized glenoid components with posterior augmentation [2,18–22]. The design of the glenoid component also contributes to the long-term stability of the implant. Many studies have compared mid- to long-term outcomes in patients managed with various glenoid designs [23–25]. At a minimum of 3 years of follow-up, Boileau et al. [23] showed the survival rate for cementless, metal-backed glenoid components was inferior to a cemented all-polyethylene implant.

3. Glenoid bone loss

Glenoid bone loss is frequently encountered during revision surgery and can result from aseptic component loosening, bone loss during prosthesis extraction, and osteolysis [26]. The decision to reconstruct the glenoid begins prior to the revision surgery with a thorough evaluation of radiographs for radiolucent lines, osteolysis, and glenoid component migration [27]. Partial lucency surrounding the implant does not necessarily imply clear instability. Radiographic loosening is defined as lucency of 2 mm or more, that is circumferential, and involves the entire cement mantle [28,29]. During surgery, glenoid bone loss is classified on the basis of location and severity. According to the Antuna classification system [30], defects are located either peripherally (anterior or posterior), centrally, or combined (central and peripheral) [27]. With regard to severity, deficiencies are either mild (involving $<1/3$ of the glenoid rim), moderate (involving between 1/3 and 2/3 of the glenoid rim), or severe (involving $>2/3$ of the glenoid rim) [30]. This classification is relevant in that it guides treatment; mild and moderate lesions are suitable for reimplantation (with or without bone grafting) while severe lesions preclude reimplantation [27].

In cases of aseptic glenoid loosening or failure, revision TSA by reimplantation of a cemented glenoid component is a well-established surgical option. However, reimplantation alone may not solve the problem of recurrent glenoid loosening. Bonnevialle et al. [31] reported an overall rate of recurrent glenoid loosening at 67% in patients treated with reimplantation of an all-polyethylene cemented glenoid component. All of the 10 patients treated with bone grafting at the time of revision surgery were noted to have partial or total osteolysis at the final follow-up.

The unpredictable results following anatomic glenoid revision have led many surgeons to begin using a reverse prosthesis in such a clinical setting. Revision with a reverse total shoulder arthroplasty (RTSA) provides the double benefit of glenoid bone stock reconstruction (fixation of bone graft with baseplate and screws) and also solves the problem of soft-tissue insufficiency and prosthetic instability [32]. The baseplate and screw design seems to achieve better bony fixation when compared to a cemented polyethylene glenoid component. When used as a revision implant, the reverse shoulder prosthesis has been shown to improve patient satisfaction and functional outcomes [33–35]. However, the complication rate following revision RTSA is much higher than that of the primary RTSA for cuff-tear arthropathy [32,35].

In patients with significant central cavitary bone loss of the glenoid, achieving stable fixation of the baseplate implant can be difficult. Alternative screw configurations have been studied. Codsi et al. showed that when compared to the conventional screw placement, aiming the posterior screw into the spine of the scapula and directing the anterior screw below the central peg decreased the micromotion in a glenoid with a cavitary defect by 46% [36]. This configuration reduced micromotion below the critical threshold of 150 μm, the threshold necessary for bone ingrowth and long-term survival of the implant. Superior glenoid erosion after TSA can be seen secondary to rotator cuff deficiency and superior head migration [37]. If left uncorrected during revision surgery, superior erosion can result in superior glenoid tilt and a heightened risk of aseptic loosening. A study by Roche et al. [38] found that regardless of the glenoid reaming technique (standard or off-axis) both standard and superior augmented glenoid baseplates remained well fixed after cyclic loading in a superior-defect model. In order to avoid premature failure, it is particularly important that the baseplate be implanted with a slight inferior tilt, which is mechanically favorable when loading the glenoid bone stock [39].

When reconstructing the glenoid after a failed total shoulder, the humeral head is not available for bone grafting. An alternative is iliac crest bone graft, which has been used as a source of autologous bone graft. Kelly et al. [40] described a technique for graft harvest and fabrication of an iliac crest-baseplate composite. First, the baseplate is implanted directly onto the pelvis. The graft is then cut and fashioned to match the glenoid defect; a cement template of the defect is often made and used as a guide. According to the authors' criteria, 80% of patients were satisfied post-operatively with significantly improved Constant and American Shoulder and Elbow Surgeon (ASES) scores [40]. Another study by Neyton et al. [41] reported on 9 RTSAs using iliac crest autograft. All patients could forward elevate their arm to at least 90° with no evidence of component loosening or graft failure at 2-year follow-up.

Humeral-sided bone deficiency in failed TSA is rarely degenerative, but typically results from the removal of a well-fixed component at the time of revision. A recent study examined the role of RTSA as a revision implant in patients