Addressing Glenoid Erosion in Reverse Total Shoulder Arthroplasty

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Abstract
Severe glenoid wear is technically problematic, has a higher complication rate, and inferior results in the setting of shoulder arthroplasty. This paper introduces four basic strategies for treating glenoid erosion with a reverse shoulder arthroplasty which include: 1. eccentric reaming, 2. bone grafting of glenoid, 3. reaming and bone grafting, and 4. using augmented baseplates. The benefits and shortcomings of each of these techniques are discussed.

The reverse shoulder arthroplasty has many advantages over anatomic shoulder arthroplasty when dealing with severe glenoid defects. Augmented baseplates are new and allow the surgeon to treat various different glenoid defects with preservation of glenoid subchondral bone.

Glenoid bone erosion is a challenging preoperative variable in shoulder arthroplasty that is often inadequately addressed with current techniques and implants. In primary, non-constrained shoulder arthroplasty, glenoid bone erosion has been shown to have a negative effect on outcomes. Moreover, resurfacing the moderately to severely deficient glenoid by use of techniques, such as structural bone grafting, is technically difficult and characterized by a relatively high rate of complications. In reverse shoulder arthroplasty glenoid bone erosion is encountered frequently in patients with rotator cuff tear arthropathy, the primary indication for reverse shoulder arthroplasty. In this patient population, 39% show acquired glenoid bone defects. Although bone deficiency may occur in any location on the glenoid, it most commonly occurs on the posterior and superior portions, with approximately 9% of all reverse shoulder arthroplasty patients showing superior wear of the glenoid.

Classifications
Osteoarthritis is the most common reason for primary shoulder arthroplasty and is characterized primarily by posterior glenoid bone loss. Walch and coworkers have classified such glenoid defects as follows: A1, concentric; A2, concentric and centrally eroded; B1, posteriorly subluxated; B2, posteriorly eroded and subluxated; and C, retroverted (hypoplastic). Favard and colleagues have created a classification scheme to describe glenoid wear in the setting of rotator cuff arthropathy with 4 grades as follows: E0, no wear; E1, concentric wear; E2, superior wear; and E3, superior and inferior glenoid erosion. Levigne and associates have created a classification system of stages to describe glenoid wear of rheumatoid arthritis, a less common indication for reverse shoulder arthroplasty. The stages are as follows: Stage 1, intact or minimally deformed subchondral bone; Stage 2, wear reaches the foot of the coracoid; and Stage 3, wear goes beyond the foot of the coracoid.

Current Solutions
Surgical solutions addressing the glenoid in reverse total shoulder arthroplasty have been adapted from primary shoulder arthroplasty. They are asymmetric reaming, bone grafting, combined asymmetric reaming and bone grafting, and augmented baseplate components. Augmented designs used in primary shoulder arthroplasty have become unpopular due to bad experiences and designs. However, recently several redesigned anatomical augmented glenoids have been introduced into the market, but it is too early to know if these implants will be more successful than the augmented implants used in the 1990s. The most
commonly used technique in primary and reverse shoulder arthroplasty to address glenoid erosion is asymmetric reaming. Another technique commonly used by surgeons is asymmetric reaming and bone grafting. Both of these techniques can be used to restore glenoid orientation (tilt and version). Each technique is associated with its own advantages and disadvantages.

Eccentric reaming is a straightforward technique with a number of advantages. It is simple, adds no additional cost, and adds very little time to the procedure. The “high side” is reamed to the depth of the worn side of the glenoid. The amount of asymmetric reaming possible is limited by the size of the remaining glenoid. The disadvantages include removal of additional glenoid bone and joint line medialization. This can lead to compromised implant fixation as a result of peg penetration, loss of subchondral bone volume, and downsizing of the glenoid component. Walch and coworkers have demonstrated in primary shoulder arthroplasty significant increases in radiographic loosening and subsidence of aggressively reamed glenoids as compared to those glenoids that were not. In primary shoulder arthroplasty, several studies have recommended that the upper limit of retroversion correction is 10° to 15°. There are currently no guidelines to address the glenoid with superior wear.

In cases of severe glenoid wear, bone grafting is commonly used to correct glenoid orientation (tilt). Autograft versus allograft selection, defect shape and status, as well as staging are factors that must be considered by the surgeon. The use of bone grafting not only helps preserve remaining glenoid, but also adds to the bone stock. In primary arthroplasty the humeral head is often used as autograft. Allografts are commonly used; they eliminate the risk of donor-site morbidity, however, they add the potential risk of disease transmission. Bone grafting allows for correction of glenoid inclination and version without medializing the joint line. However, graft resorption leading to poor functional results is an additional risk.

Numerous investigators have suggested strategies for dealing with glenoid bone loss in reverse shoulder arthroplasty. However, few studies have examined the
clinical results.\textsuperscript{17} Thus, techniques that preserve subchondral glenoid bone and minimize glenoid reaming may prove to be superior and provide long-term fixation (Figs. 1 and 2).

**Future Directions**

Augmented glenoid components have been studied and continue to evolve in the setting of posterior wear in primary shoulder arthroplasty.\textsuperscript{3,19} Currently, bone grafting remains the recommended technique for addressing severe glenoid wear with reverse shoulder arthroplasty.\textsuperscript{1,17,18} Indications for bone grafting and the best technique remain to be defined. The clinical results of the use of augmented baseplates for reverse shoulder arthroplasty have yet to be reported. Recently, Roche and associates\textsuperscript{20} have reported the biomechanical testing results of fixation of superior augmented glenoid baseplates compared to standard glenoid baseplates. A superior glenoid defect was created and was corrected with either eccentric reaming with implantation of a standard glenoid baseplate or off-axis reaming with implantation of a superior augment glenoid baseplate. No differences in baseplate displacement were observed either before or after cyclic loading between groups (Fig. 3).\textsuperscript{20}

**Conclusions**

While new techniques and implants are being developed, it appears that augmented glenoid baseplates may be a viable alternative to asymmetric reaming, bone grafting, or combined asymmetric reaming and bone grafting. This novel off-axis reaming technique offers the potential to preserve inferior cortical bone and maintain a greater implant-to-bone contact area, potentially improving long-term glenoid fixation. The elimination of a structural graft using the augmented baseplate also eliminates a mode of failure, which is resorption of the graft or nonunion of the graft with subsequent baseplate loosening. Additionally, a posterior augmented baseplate can preserve anterior bone, correct version, and make placement of the glenospheres easier.

**Disclosure Statement**

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**References**