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Correction of acquired glenoid bone loss in osteoarthritis with a standard versus an augmented glenoid component

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Background: The magnitude and anatomic consequences of pathologic acquired glenoid retroversion and posterior bone loss that can be surgically corrected with a standard versus an augmented glenoid component have not been studied extensively in a surgical patient population.

Materials and methods: Twenty-nine patients with glenohumeral osteoarthritis, acquired posterior bone loss, and increased retroversion were studied by use of a three-dimensional computer surgical simulation. For each case, amount of medialization was measured as the linear distance from the lateral aspect of the glenoid vault model to the center of the articular implant surface. Simulation of implant placement at 0° or 6° was performed with use of a standard glenoid having a uniform thickness and an asymmetric thickness augmented component.

Results: An increased amount of medialization was seen with the standard glenoid, 8.3 ± 4.1 mm, compared with 3.8 ± 3.3 mm with use of the augmented glenoid implant ($P < .001$). When glenoid retroversion was corrected to 0°, pathologic version was shown to have strong and significant relationship to the amount of medialization for both the standard ($R^2 = 0.825$) and augmented ($R^2 = -0.68$) glenoid implant. There was an increased ability to correct greater amounts of pathologic version with less medialization by use of an augmented step glenoid compared with a standard anchor peg glenoid.

Discussion: Correction of moderate to severe glenoid retroversion by asymmetric reaming cannot always be done with use of a standard component, and if it is done, it will result in greater medialization of the joint line. Use of an augmented component can allow complete correction of retroversion and minimize the effect of medialization.

Level of evidence: Anatomy Study, Imaging and Computer Modeling.

Keywords: Shoulder osteoarthritis; severe glenoid bone loss; total shoulder replacement

Total shoulder arthroplasty has proved to be successful in providing pain relief and restoring range of motion for patients with glenohumeral osteoarthritis.[4,10,14,18,19,23,31] Long-term survival of glenoid components, however,

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remains the most common reason for late failure due to loosening and wear.[17,27,29] The literature demonstrates that glenoid component malposition is associated with excessive retroversion, early component lucent lines, and component loosening.[11,15,16,23] Excessive glenoid component retroversion is correlated with greater amounts of preoperative glenoid retroversion with incomplete correction of retroversion, particularly when standard glenoid components are used.[11,16,27,30] Posterior glenoid bone loss and static posterior humeral head subluxation have been shown to independently predispose the patient to eccentric loading of the glenoid component and early glenoid loosening.[5,7,8,27,28]

Two of the most commonly employed surgical interventions to correct posterior glenoid bone loss and pathologic preoperative retroversion are asymmetric anterior glenoid reaming and posterior glenoid bone grafting.[21,26] Correction of glenoid retroversion of more than 15° to 20° by reaming the high side is associated with perforation of the parts of the glenoid component responsible for fixation of the component.[12,20] Excessive reaming also results in removal of the cortical bone and has been suggested to be a cause of increased glenoid component loosening.[27,32]

In recent years, augmented glenoid components have been designed and commercialized to treat severe glenoid bone loss (DePuy Warsaw, IN, USA; Smith & Nephew, Memphis, TN, USA; Exactech, Gainesville, FL, USA). Previous wedge-shaped augmented components with metal-backed design (Smith & Nephew, Memphis, TN, USA) demonstrated a high failure rate. Clinical evaluation of the metal-backed components with either augmented or nonaugmented design has shown excessive polyethylene wear that was attributed to the use of a thin polyethylene component on a metal backing.[22] Given these results, there is more interest in the use of an all-polyethylene augmented component to manage moderate to severe glenoid retroversion.[26]

We hypothesized that we could define the consequences of correction of glenoid retroversion by use of a nonaugmented and augmented component and thereby define when an augmented component may be beneficial in terms of complete correction of disease, decreased peg perforation, less medialization of the joint line, and less removal of bone.

Methods

The preoperative computed tomography (CT) scans of 29 patients indicated for total shoulder arthroplasty for treatment of osteoarthritis were used in this study. There were a total of 24 men and 5 women in the study cohort, with an average patient age at surgery of 66.9 years. The average pathologic retroversion was −20.9° ± 10° with a range of 4.5° to 43°. In all patients, the pathologic glenoid retroversion was acquired by bone loss. We excluded all patients having a type C Walch classification of glenoid morphology consistent with developmental abnormality.

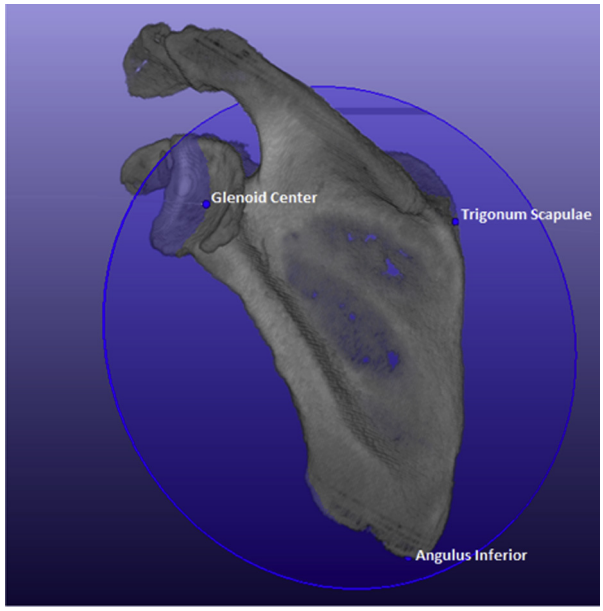

Figure 1 The plane of the scapula was defined by 3 points, one placed at the inferior angle of the scapula body, a second at the scapula trigonum, and the third in the center of the glenoid fossa such that a line from this point to the scapula trigonum is in the center of the glenoid vault and defines the center line of the scapula.

All CT scans were performed with a Siemens (Sensation 64, Definition DS or AS+) scanner (Siemens Healthcare, Forchheim, Germany) using a single-energy CT protocol with 140 kVp, 300 mAs with dose modulation 0.6 mm collimation, effective pitch 0.9, B40 (medium) reconstruction kernel, reconstructed slice thickness 0.6 mm, and slice increment 0.6 mm. Three-dimensional reconstructions of preoperative CT images were performed by image analysis software (Cleveland Clinic, Cleveland, OH, USA). The plane of the scapula was defined by 3 points, one placed at the inferior angle of the scapula body, a second at the scapula trigonum, and the third in the center of the glenoid fossa such that a line from this point to the scapula trigonum was in the center of the glenoid vault (Fig. 1).[25-27] Three points were placed on the glenoid to define a plane that best represented the average version and inclination of the glenoid fossa. These points were approximated to the superior glenoid, the anterior inferior glenoid, and the posterior inferior glenoid in the area of greatest bone loss not including osteophytes (Fig. 2). The angle between the plane of the scapula and plane of the glenoid was the measured retroversion angle. Estimation of the premorbid native glenoid joint line before pathologic bone loss was defined with use of the glenoid vault model as previously described.[3,9,24,25] The amount of bone loss was defined as the linear distance in millimeters from the most lateral aspect of the glenoid vault model to the pathologic glenoid (Fig. 3).

Solid computer models of a commercially available standard and augmented glenoid component (DePuy Global APG and Step Tech APG, Warsaw, IN, USA) are contained within the software and allowed placement of each glenoid component at either 0° or 6° of retroversion with complete back side contact (Fig. 4). The augmented component types were available as 3-mm, 5-mm, and 7-mm augmentation (Fig. 5). The standard nonaugmented