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Osteoarthritis: Overcoming the Slippery Slope

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Shoulder arthroplasty for osteoarthritis can be challenging because of eccentric posterior wear of the glenoid, glenoid retroversion, and concomitant posterior subluxation of the humeral head. Various techniques are available to restore a centered head: anterior capsulectomy, preferential anterior glenoid reaming, offset humeral head components, anteversion of the humeral component, posterior capsule plication sutures, and the use of a dual-radius glenoid prosthesis, in which the internal (articular) radius is designed to match the curvature of the humeral head prosthesis, while the external (nonarticular) radius corresponds to the overall size of the glenoid.
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Total shoulder arthroplasty has been shown to be effective in relieving pain and restoring function in patients with debilitating shoulder arthritis.[1-4] However, primary osteoarthritis can be challenging to manage with a total shoulder arthroplasty because of eccentric posterior wear of the glenoid with concomitant posterior subluxation of the humeral head.[5] This causes laxity of the posterior capsule, thus potentially compromising the optimal tensioning of the surrounding soft tissue envelope.

For these reasons, the outcomes of total shoulder arthroplasty in patients with posterior glenoid wear (Walch B2 glenoid) and subluxation have been traditionally poor.[6] Reasons for failure often include asymmetric loading of the humeral head component onto the glenoid polyethylene causing a "rocking horse" effect and recurrence of the posterior subluxation. This leads to early loosening of the glenoid component.

Bone loss is also another road block to a successful arthroplasty. Unlike the acetabulum in total hip arthroplasty, the glenoid vault is extremely small.[7] With arthritis, you get eccentric wear, subsidence of the humeral head posteriorly, and loss of volume because of the posterior erosion.[5,8] This eccentric wear makes retraction difficult and implantation challenging.

The size of the glenoid vault may be markedly compromised after glenoid preparation in patients with eccentric wear and retroversion. A smaller glenoid prosthesis is typically needed to fit inside the reduced glenoid vault, but its radius of curvature often does not match the humeral head radius of curvature.

The ideal mismatch between the radius of curvature of the glenoid and the humeral head is currently unknown (Fig 1). In the case of a nonconforming glenoid prosthesis design, eccentric point contact stress occurs at one location, which leads to increased wear. (Fig 2A). While the nonconforming design allows for some translation of the humeral head, linear point contact wear would still occur at the new translated contact point (Fig 2B). Conversely, in a conforming glenoid design, the contact is distributed throughout the entire glenoid prosthesis (Fig 3A), thereby reducing point contact stresses. Polyethylene wear still occurs, however, at the periphery of the prosthesis as the humeral head translates with forward elevation (Fig 3B).

Dual-radius glenoid prostheses, in which the internal (articular) radius is designed to match the curvature of the humeral head prosthesis while the external (nonarticular) radius corresponds to the overall size of the glenoid, can help restore a centered head in these challenging cases with posterior wear and posterior subluxation.[9] The glenoid articular surface provides a central conforming zone surrounded by a nonconforming zone. This patented variable conformity helps ensure stability throughout the range of motion, while reducing edge loading and associated wear. Sixteen possible combinations of sizes provide intraoperative flexibility in creating patient-specific glenohumeral articulating solutions (Fig 4).

Preoperative Workup

Significant reduction in glenoid bone available for component fixation due to wear should be identified by radiographs

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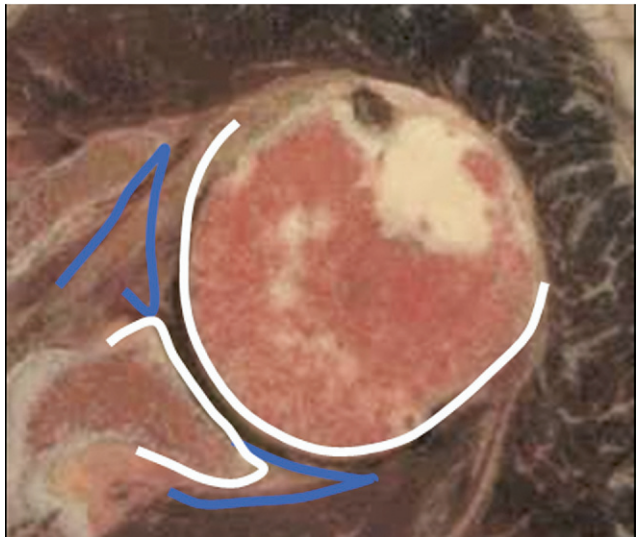

Figure 1 Humeral head diameter and glenoid diameter mismatch. (Color version of figure is available online.)

(Fig 5) and computed tomography (CT) with confirmation intraoperatively. Walch and associates[10] have previously classified glenoid erosions into different types, increasing in severity from A to C. Measurement of the humeral head index (HHI) is also helpful to quantify the posterior erosion as well as to compare with postoperative radiographs. The target range for the index is between 45 to 55% to achieve a centered head (Fig 6). If the HHI is greater than 55%, the humeral head is posteriorly subluxed.[10] If the HHI is less than 45%, then the humeral head is anteriorly subluxed, suggesting a possible subscapularis tear.

Surgical Technique

An extended deltopectoral skin incision is typically utilized. If adhesions are present, blunt finger dissection or a Cobb elevator can be used to separate tissue planes through the deltopectoral interval and clavipectoral fascia staying lateral to the conjoined tendon. The topmost aspect of the pectoralis major insertion can be released to augment exposure to the glenoid.

The anterior portion of the coracoacromial ligament can be excised next to facilitate superior exposure. This is then followed by the release of all adhesions in the subdeltoid and subacromial spaces with an elevator, with care to avoid injury to branches of the axillary nerve that travel on the surface of the subdeltoid fascia. This step is essential to optimize glenoid exposure and increase postoperative range of motion.

Further releases can also be performed between the strap muscles and the pectoralis major and the subscapularis to allow adequate muscular excursion. This allows for increased external rotation and maximizes the joint volume available for larger humeral head sizes and prosthetic glenoid insertion. Care should be taken at this point to identify and protect the axillary nerve (by adducting and externally rotating the arm, which moves the nerve away from the operative field), which courses on the inferior aspect of the subscapularis on its way posterior to the quadrangular space. It is often necessary to release the coracohumeral ligament to improve the excursion of the superior aspect of the subscapularis. At our institution, the tendon is typically released off the lesser tuberosity, leaving a small cuff of tissue for later repair. The release is continued inferiorly onto the shaft of the humerus in a subperiosteal fashion to avoid damaging the axillary nerve and posteriorly above the latissimus dorsi tendon along

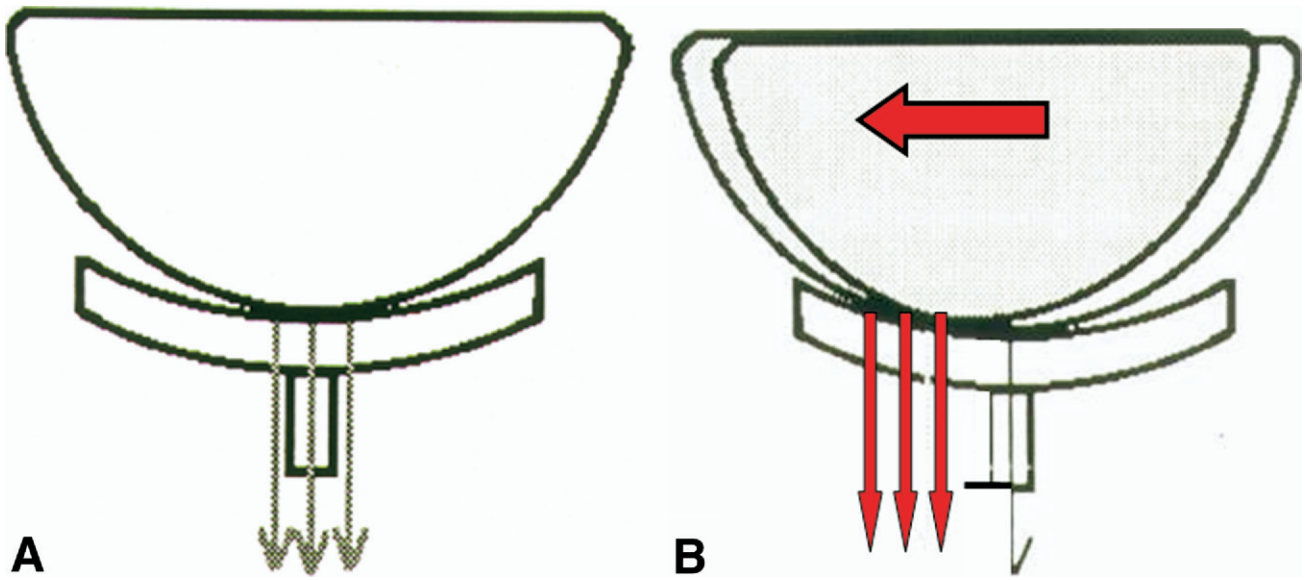

Figure 2 (A) Nonconforming glenoid design with central point contact stress. (B) Nonconforming glenoid design with point contact stress at the periphery as humeral head translates (bottom three thin arrows). (Color version of figure is available online.)