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REVIEW ARTICLE

Addressing glenoid bone deficiency and asymmetric posterior erosion in shoulder arthroplasty

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Glenoid bone deficiency and eccentric posterior wear are difficult problems faced by shoulder arthroplasty surgeons. Numerous options and techniques exist for addressing these issues. Hemiarthroplasty with concentric glenoid reaming may be a viable alternative in motivated patients in whom glenoid component failure is a concern. Total shoulder arthroplasty has been shown to provide durable pain relief and excellent function in patients, and numerous methods and techniques can assist in addressing bone loss and eccentric wear. However, the ideal amount of version correction in cases of severe retroversion has not yet been established. Asymmetric reaming is a commonly used technique to address glenoid version, but correction of severe retroversion may compromise bone stock and component fixation. Bone grafting is a technically demanding alternative for uncontained defects and has mixed clinical results. Specialized glenoid implants with posterior augmentation have been created to assist the surgeon in correcting glenoid version without compromising bone stock, but clinical data on these implants are still pending. Custom implants or instruments based on each patient's unique glenoid anatomy may hold promise. In elderly, sedentary patients in whom bone stock and soft-tissue balance are concerns, reverse total shoulder arthroplasty may be less technically demanding while still providing satisfactory pain relief and functional improvements.

Level of Evidence: Review article.

Keywords: Glenoid; posterior wear; shoulder arthroplasty; asymmetric reaming; glenoid version; bone grafting; retroversion; glenoid anatomy

Although total shoulder arthroplasty can provide pain relief and improved function for patients with glenohumeral arthritis,[80] surgical treatment in severe cases can present a number of different challenges to the surgeon. Often, the glenoid is worn medially with eccentric posterior wear,[74] which leads to decreased bony support and surface area for glenoid component implantation (Fig. 1). Early loosening may occur as a result of inadequate bone stock, poor initial fixation, and component malposition, leading to rocking-horse loosening.[50] Because failure of the glenoid component is one of the most common modes of failure for total shoulder arthroplasties,[19,48,50] considerable effort has gone into understanding the risk factors for early loosening and developing new methods and techniques for preventing failure.

Because of the increased risk of glenoid loosening and failure in patients with severe glenohumeral arthritis in whom bone stock and glenoid version are compromised,

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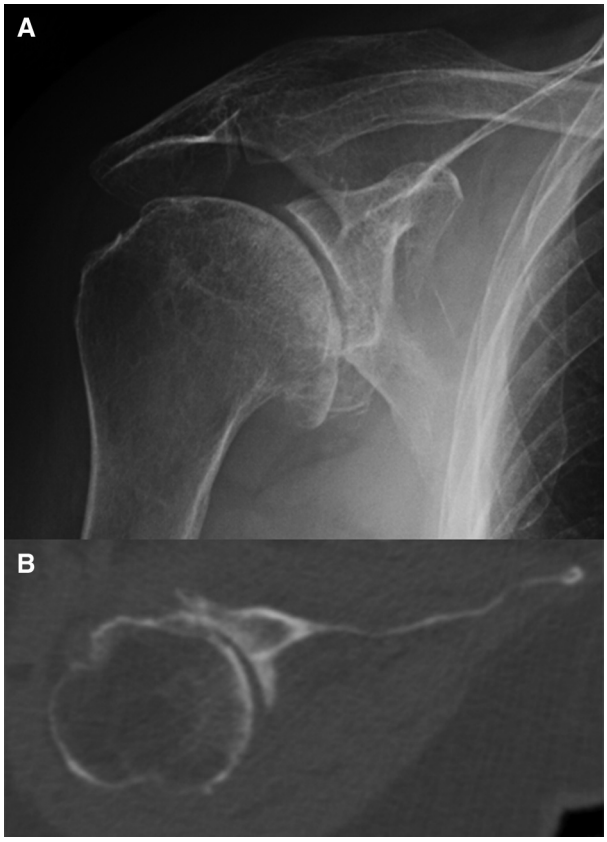

Figure 1 Plain film (**A**) and axial CT cut (**B**) showing severe glenohumeral arthritis with joint line medialization and eccentric posterior wear.

current clinical decision making for the surgeon faced with these unique challenges is difficult. Whether to even implant a glenoid component is controversial, particularly in patients who are young and have severe bone loss. In this article, the various methods for addressing glenoid bone deficiency, medialization, and posterior glenoid wear are reviewed. Hemiarthroplasty with and without glenoid resurfacing is addressed, and various techniques and implants for addressing the glenoid during total shoulder arthroplasty are reviewed, including bone grafting, asymmetric reaming, and specialized glenoid implants.

Glenoid anatomy

Prosthetic design and surgical considerations related to glenoid anatomy are based on numerous studies focusing on the glenoid height, width, inclination, and version (Tables I and II).[7,8,35,43,47] For some of the parameters, there exist a broad range of results that reflect varying methodologies for measuring glenoid size and orientation. There is considerable range in glenoid version, particular with associated pathology (Table II). The ''normal'' range of glenoid version varies anywhere from 2° of anteversion to 8° of retroversion in most studies,[8,12,13,20,47,69] whereas arthritic shoulders generally have greater than 11° of retroversion.[4,12,13,20,69] More recent studies using 3-dimensional measurement techniques on computed tomography (CT) have reported native glenoid version of approximately 7°.[21,30,69]

There currently is no consensus regarding the ideal method for measuring glenoid version. Many studies have used the angle between the scapular axis and the glenoid articular surface to directly measure glenoid version,[4,20,60,65] whereas more recent studies have proposed a glenoid vault model as another method to define a patient's native glenoid version.[21,69] Furthermore, the definition of the scapular axis has been variable in the literature and can lead to significantly different measurements of glenoid version, especially in the presence of posterior wear.[63] Descriptions by Saha[65] and by Randelli and Gambrioli[60] propose using the general axis of the scapula body, whereas Friedman et al[20] defined the scapular axis as the line between the tip of the medial border of the scapula and the center of the glenoid fossa.

It is generally accepted that glenoid version on CT scans or magnetic resonance imaging is more accurate than plain radiography in the majority of cases[33,61] because of the dependence of the measurement on the orientation of the x-ray beam in relation to the plane of the scapula.[55] However, variations in gantry angle at the time of image acquisition during a typical 2-dimensional CT scan also lead to variations in version measurements.[21] When one is measuring the glenoid version by standard 2-dimensional CT, the scout view of glenoid orientation must be neutral, and the glenoid articular surface must be perpendicular to the axis of the gantry. Measurements of version may vary as much as 10° with minor rotation of the scapula in relation to the glenoid articular surface.[4,6] More recent studies have used 3-dimensional CT scans that define the plane of the scapula and the plane of the glenoid articular surface in 3 dimensions, eliminating the effect of gantry angle and allowing for more accurate measurement of glenoid version and inclination.[21,30,43,69] These techniques have also led to the development of a standardized, 3-dimensional glenoid vault model, which has been shown to be a highly consistent and conserved shape across normal individuals and can be used to estimate native glenoid version and inclination in both non-pathologic and pathologic shoulders.[11,21,30,68,69]

Posterior erosion and retroversion

Walch et al[74] devised a classification system for glenoid morphology that is based on the architecture and patterns of posterior wear in glenohumeral arthritis (Fig. 2). In type A glenoids, the humeral head is centered, and glenoid erosion is central. The severity of the erosion is either minor (type A1) or major (type A2). In type B glenoids, the posterior margin of the glenoid is involved. In type B1, there is joint space narrowing posteriorly, subchondral sclerosis, and osteophyte formation. In type B2, the glenoid is posteriorly eroded with excessive retroversion and the development of