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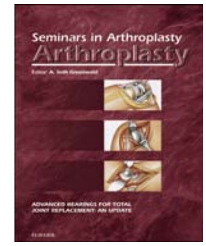

Managing glenoid bone loss in total shoulder arthroplasty: Role of augmented patient-specific implants

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ABSTRACT

Total shoulder arthroplasty has been shown to generate good to excellent results for patients with osteoarthritis and a functioning rotator cuff. However, a major complication after primary total shoulder arthroplasty is loosening of the glenoid component, which has been shown to be commonly associated with glenoid retroversion. This article highlights the importance of correcting the glenoid version and reviews various techniques, such as eccentric reaming, posterior bone grafting, reverse shoulder arthroplasty, and augmented glenoid implantation to address glenoid retroversion in the setting of total shoulder arthroplasty.

1. Introduction

Total shoulder arthroplasty (TSA) has become a reliable procedure for pain relief in patients with osteoarthritis (OA) and a functioning rotator cuff, with many studies showing good to excellent outcomes in 85–95% of patients [1]. These promising results, and the aging population, have led to a 2.5-fold increase in TSAs performed in the decade preceding 2011 [2].

With the rapid growth in primary total shoulder arthroplasties, a thoughtful consideration of factors that affect the longevity of the implants has become very important. Although TSA generally gives reliable pain relief in addition to functional improvement, a recent systematic review of non-constrained arthroplasties demonstrated a 22.6% overall rate of complications, increasing to 29.6% in studies with >5 years of follow-up [3]. The most common complication associated with TSA was shown to be glenoid implant loosening, accounting for up to 25% of all complications [1,3].

While many factors, such as implant–glenoid size matching, pressurized cementing technique, and all-Polyethylene components have shown decrease glenoid loosening [4–6], many believe correction of glenoid retroversion to be an integral part of lowering the still unacceptably high rate of 13.7% [3]. Placement of the glenoid component in a retroverted position has been shown to increase the contact forces across the joint and stress the bone–cement–component interface [7–9]. Excessive glenoid component retroversion has been implicated in up to 46% of glenoid failures [10].

Many approaches have been used to correct glenoid retroversion including eccentric reaming of the glenoid in order to lower the anterior high-side, posterior bone grafting, reverse

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shoulder arthroplasty, augmented glenoid components, and more recently eccentric humeral components [11–14]. Each have had varying amounts of success in different patient populations but many offer limited follow-up of small cohort groups. This review highlights the importance of glenoid version in the setting of TSA while also exploring the techniques used to correct version and their results in the peer-reviewed literature.

2. Prevalence, classification, and how to measure

Walch et al. [15] showed that 41% of patients with primary OA have glenoid retroversion, which he classified based on the percentage of humeral head subluxation and the amount of glenoid retroversion. Bercik et al. [16] further clarified and expanded this classification system, adding the B3 (monoconcave and posteriorly worn, with at least 15° of retroversion or at least 70% posterior humeral head subluxation, or both) and D (anteversion or anterior humeral head subluxation of greater than 10%) glenoid types to constitute the most commonly used system today (Fig. 1).

Three-dimensional (3D) computed tomography (CT), preferably with cuts in the scapular plane, has been shown to be the gold standard to assess glenoid version and humeral head subluxation [17–20]. Studies have validated their use and shown 3D CT reconstructions to be superior to standard CTs in both healthy and arthritic glenoids [21]. Recent studies have highlighted the importance of referencing humeral head subluxation in relation to the scapular spine, rather than the glenoid. Most patient-specific implant programs will calculate the glenoid version and humeral head subluxation based on an average of the many cuts taken to produce the 3D CT [22]. Preoperative determination of the amount of deformity allows for planning and confirmation of required equipment, such as asymmetric reamers or reverse shoulder arthroplasty instrumentation, to perform some type of correction.

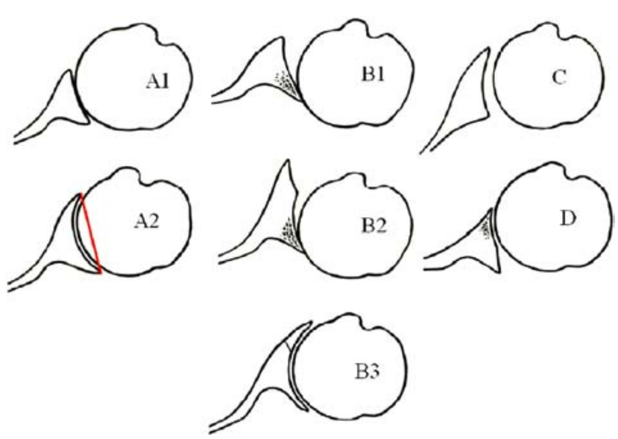

Figure 1 – A modified schematic representation of glenoid types by Walch classification. (Reprinted with permission from Bercik MJ, Kruse K II, Yalizis M, et al: A modification to the Walch classification of the glenoid in primary glenohumeral osteoarthritis using three-dimensional imaging. J Shoulder Elbow Surg 25:1601–6, 2016.)

In addition, the importance of preoperative rather than intraoperative assessment of glenoid retroversion was recently emphasized by Chan et al. [23], who showed that erosion patterns, especially in B3 glenoids, can conceal larger degrees of deformity.

3. The importance of version

As previously mentioned, glenoid component loosening is the number one complication following TSAs [1,3]. Glenoid malpositioning has been shown to be an independent predictor of glenoid component loosening, thought to be from increased micromotion from edge loading of the retroverted component [7,24–26]. Irrespective of loosening, preoperative glenoid retroversion has been shown to be a negative predictive factor of clinical outcomes in both hemiarthroplasty and total shoulder arthroplasty [27,28].

Though the literature does not offer a definitive answer, it is generally recommended to correct retroversion to 10° or less. Finite element studies have shown that placement of the glenoid in greater than 10° of retroversion leads to decreased contact area and increased stress across the joint, and a seven-fold increase in micromotion [24,29]. While cadaveric studies have shown posterior humeral head subluxation and eccentric loading of the glenoid with retroversion greater than 2.5°, achieving this in-vivo is somewhat difficult, if not impossible in shoulders with significant posterior glenoid wear due to overly tight anterior soft tissue structures [30].

More recent studies have called into question the importance of correcting glenoid retroversion, with Service et al. [31] showing no difference in clinical or radiographic outcomes for glenoid components inserted in greater than 15° of retroversion versus less than 15°, at a 2-year follow-up . Hussey et al. [32] observed no clinical differences in patients with preoperative eccentric glenoid wear but did note twice the rate of radiographic glenoid loosening at an average follow-up of just over 4 years.

While these studies suggest that correction of glenoid version may not have clinical importance in the short and even intermediate term, the lack of long-term clinical follow-up at this point forces us to rely on biomechanical, radiographic, and older clinical studies to determine when correction of glenoid version should be performed. In addition, while correcting glenoid version seems to be important in increasing implant longevity, the amount and quality of the remaining bone stock also plays an integral role [33].

4. How to correct retroversion: eccentric reaming

Eccentric reaming has been the most popular means of correcting glenoid version as it allows for the use of standard equipment and instrumentation. A pin is placed into the glenoid perpendicular to the desired glenoid version, and the anterior glenoid is reamed until the reamer begins to contact the glenoid posteriorly. The amount of bone resection and quality of remaining bone as well as the decrease in soft tissue tensioning from medialization of the glenoid are limitations to the amount of correction that can be achieved