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Total shoulder arthroplasty with an anteriorly augmented glenoid component for glenohumeral osteoarthritis with anterior glenoid bone loss: a case report

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Glenoid bone loss often occurs in glenohumeral osteoarthritis. The Walch classification system is used to describe glenoid morphology in primary glenohumeral osteoarthritis.[22] Although posterior bone loss such as Walch type B commonly occurs with glenohumeral osteoarthritis, anterior bone loss is rare. Recently, Bercik et al[1] reported a modification of the Walch classification in which they added type D glenoid to include anterior bone loss.

The management of anterior bone loss has not been established because the treatment of glenoid bone loss has focused on posterior bone loss. Asymmetric reaming and bone grafting have been previously described for the management of glenoid bone loss. These techniques can be used to address anterior bone loss, although excessive bone removal can cause the medialization of the joint line and reduction of bone stock.[9,16] Poor graft incorporation and failure of fixation can also lead to glenoid loosening and poor clinical outcomes.[7,20,21] Augmentation of the glenoid component can correct the glenoid version by removing less bone and can restore the native joint line and muscle length.[15] Only a few clinical studies have reported on the posteriorly augmented glenoid component as a treatment for posterior bone loss.[6,14] For anterior glenoid bone loss, a posteriorly augmented glenoid component enables to be used in the opposite side. Only 1 case report has been published on the treatment of anterior glenoid bone loss with an anteriorly stepped augmented component.[10]

Here, we report a case of glenohumeral osteoarthritis with Walch type D glenoid morphology and the treatment with an anteriorly augmented wedge-shaped glenoid component. This case shows that the anteriorly augmented glenoid component restored the glenoid version and alignment, and that the navigation system enabled us to place the component as planned.

Case report

A 76-year-old man complained of progressive pain around the right shoulder and restriction of shoulder function over the past decade. He did not have a history of anterior shoulder instability or a rotator cuff tear including an isolated subscapularis tear. Physical findings showed a clearly restricted active range of motion with flexion of 90 degrees, abduction of 90 degrees, external rotation of 20 degrees, and internal rotation at the level of the buttock. The American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form shoulder score was 23 of 100 points, the University of California, Los Angeles score was 12 of 34 points, and the constant score was 31 of 100 points.

Radiographic results showed osteoarthritis of the glenohumeral joint with an anteroinferior subluxation of the humeral head. (Fig. 1, A and B). Computed tomography (CT) showed anteroinferior glenoid bone loss (Fig. 2, A and B). Three-dimensional modeling showed a biconcave glenoid articular surface with the paleoglenoid positioned posteriorly and the neoglenoid positioned anteriorly (Fig. 2C). The glenoid version was 11 degrees of anteversion, and the inclination of the glenoid was 11 degrees of inferior inclination. Magnetic resonance imaging showed an intact rotator cuff and mild atrophy of the supraspinatus muscle (Fig. 3, A and B).

The treatment options were discussed with him. Given his age, condition of the rotator cuff, and the glenohumeral joint and a glenoid morphology, we considered that total shoulder arthroplasty (TSA) was an appropriate option. However, we recognized

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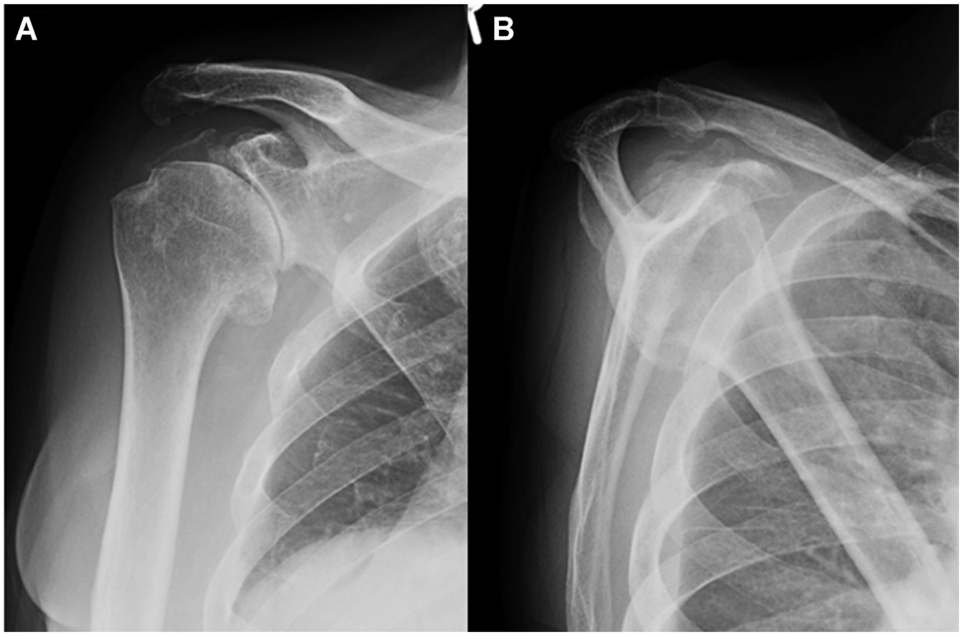

Figure 1 Preoperative radiographs of the right shoulder: (**A**) Grashey view and (**B**) trans-scapular Y view.

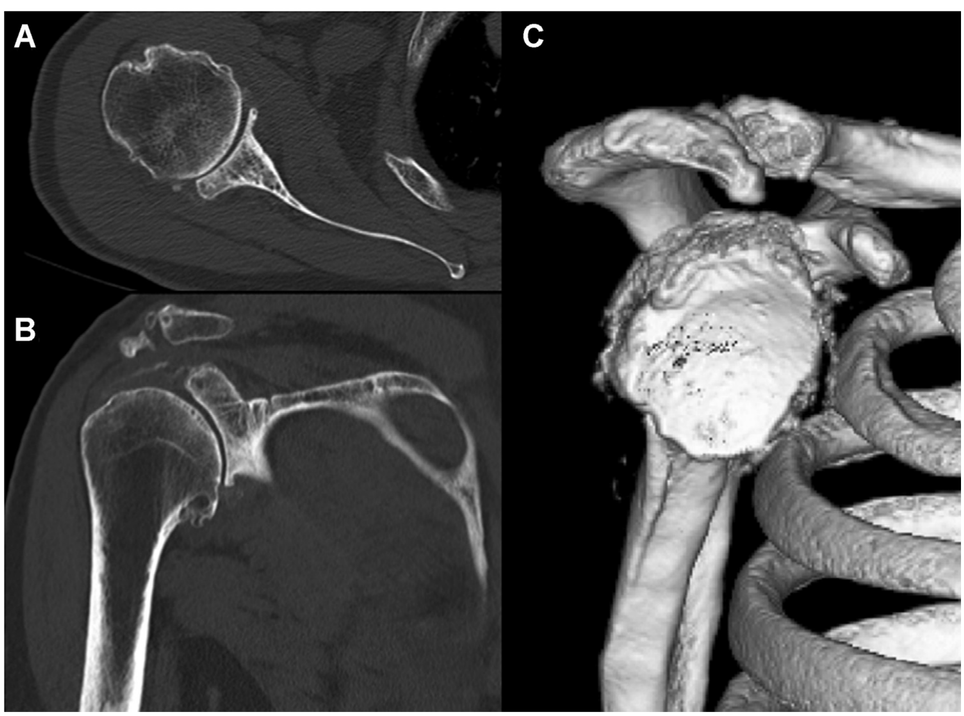

Figure 2 Preoperative computed tomography images of the right shoulder demonstrate anterior glenoid bone loss. (**A**) Axial view, (**B**) coronal view, and (**C**) three-dimensional model of the glenoid.

that excessive bone removal might be needed to correct the glenoid version and inclination, which would result in medialization of the glenohumeral joint line. We were unsure whether a bone graft could be placed rigidly with a glenoid component because of the potential for graft bone resorption and failure of fixation. If these occurred, we reasoned that he could expect little improvement in his shoulder function. We then considered the use of an augmented glenoid component to correct the version with minimal glenoid reaming. Reverse shoulder arthroplasty was another treatment option; however, his rotator cuff was intact, and atrophy of the rotator cuff muscles was mild to moderate. Because we thought the anteriorly augmented glenoid component was able to be implanted, we finally decided to perform TSA using an anteriorly augmented glenoid component.

CT-based planning software was used to decide the location of the glenoid component. CT images in the axial plane using 0.625-mm continuous slices were imported into the navigation software (ExactechGPS v1.4.1; BlueOrtho and Exactech, Gières, France).

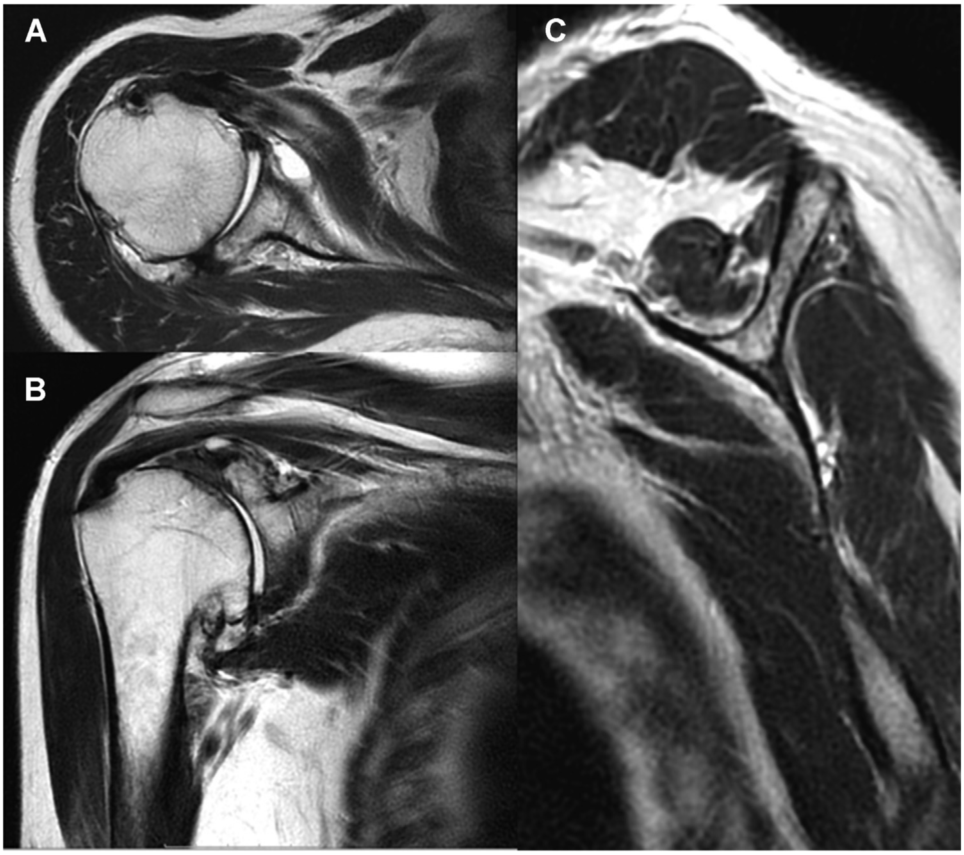

Figure 3 Preoperative magnetic resonance imaging of the right shoulder. (**A** and **B**) T2 axial and coronal images demonstrate intact rotator cuffs. (**C**) T1 sagittal image demonstrates mild atrophy of the supraspinatus muscle.

Because the software cannot incorporate an anteriorly augmented component, we placed the standard glenoid component virtually to produce 8 degrees of gap between the component and the anterior glenoid rim as an anteriorly augmented component. The glenoid component was planned to place at neutral version and 6 degrees of inferior inclination.

The glenohumeral joint was exposed through a deltopectoral approach, and a subscapularis tenotomy was performed. There was no evidence of rotator cuff tendon tear. The condition of the subscapularis tendon was sufficient to repair tendon-to-tendon suture. The glenoid was evaluated and we found the anteroinferior bone loss. TSA was undertaken using the Equinoxe Shoulder System (Exactech Inc., Gainesville, FL, USA). Based on the preoperative planning, the 8-degree anteriorly augmented glenoid component was placed using the navigation system. The component features a press-fit center bone cage and three cemented peripheral pegs (Fig. 4, A and B). After registration of the glenoid, the cage peg hole was drilled using the navigation system. The opposite drill guide handle interfered to place the guide on the glenoid. Therefore, the standard drill guide was placed with a slight anterior gap and three holes for metallic peg caps were created. (Fig. 5A). After the peg holes were filled with cement, the glenoid component was placed (Fig. 5B). The humeral head resection was performed in 30 degrees of retroversion, and the humeral stem was fixed without cement. After the implantation, the subscapularis tendon was repaired using No. 2 nonabsorbable sutures. An abduction pillow was applied

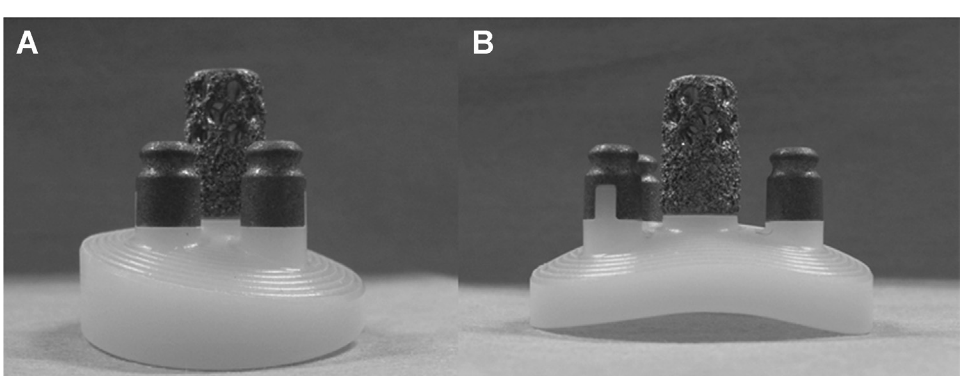

Figure 4 (**A**) Wedge-shaped augmented glenoid component. (**B**) Center bone cage and three peripheral metallic pegs.

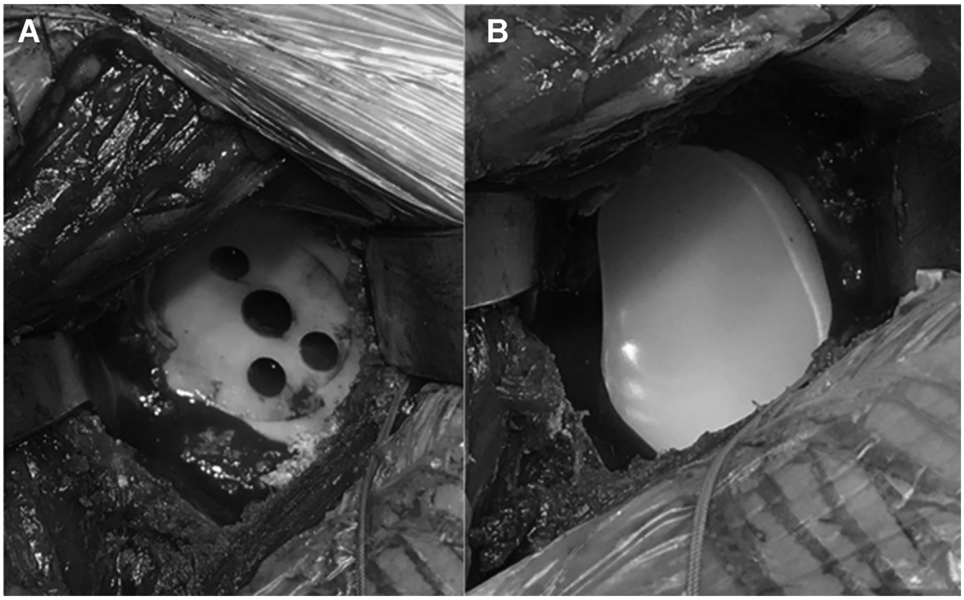

Figure 5 Photographs of the right glenoid. (**A**) A cage peg hole was drilled using the navigation system, and three holes were then created for the metallic peg caps using a standard drill guide. (**B**) The anteriorly augmented glenoid component was placed.

for 3 weeks postoperatively. Passive motion exercises were permitted starting at 3 days postoperatively and active range of motion exercises were permitted at 3 weeks postoperatively.

At his most recent follow-up 18 months after surgery, he had no pain in the right shoulder. The active range of motion had improved to 150 degrees of flexion, 150 degrees of abduction, 45 degrees of external rotation, and L4 for internal rotation (Fig. 6, A–D). He reported no restrictions of his activities of daily living. The American Shoulder and Elbow Surgeons shoulder score had improved to 85 points, the University of California, Los Angeles score had improved to 33 points, and the constant score had improved to 84 points. Radiographs revealed no lucent line of the humerus and glenoid components and humeral head position was centric (Fig. 7, A and B). Postoperative CT images showed that the glenoid component was placed as planned (Fig. 8, A and B). He was satisfied with his treatment.

Discussion

Glenohumeral osteoarthritis frequently leads to glenoid bone loss, which occurs mainly in the posterior glenoid. In 1999, Walch et al[22] classified the glenoid morphology associated with primary glenohumeral osteoarthritis as five types assessed using two-dimensional CT. The Walch classification has been recently modified to add subtypes B3 and D as assessed using 3-dimensional CT.[1,2,12] The type D glenoid exhibits any level of glenoid anteversion with humeral head subluxation of less than 40-50%, which represents anterior subluxation. The occurrence of type D glenoid is rare and estimated 3% of glenohumeral osteoarthritis.[12] The pathology associated with anterior bone loss is unclear. Neyton et al[12] reported that type D is probably not related to muscle imbalance and subscapularis insufficiency. Similarly, his glenoid morphology was evaluated as Walch type D with 11 degrees of anteversion and an intact subscapularis tendon.

The managements of glenoid bone loss associated with glenohumeral osteoarthritis is often problematic with TSA. The correction of glenoid version and appropriate component positioning are important for restoring glenohumeral joint function and optimizing the outcomes of TSA. Asymmetric reaming, bone grafting, and use of an augmented glenoid component are available options for the management of glenoid bone loss. However, asymmetric reaming in patients with severe bone loss requires excessive bone removal, which can lead to a perforated glenoid wall, shift of the joint line medially, reducing stability, and muscle shortening.[9,16] Glenoid bone grafts have been reported to produce variable clinical results and complications. Bone grafting can preserve the joint line without the need for excessive bone removal, but poor graft incorporation and failure of fixation can cause glenoid loosening and poor clinical outcomes.[7,20,21]

An augmented glenoid component can be placed without excessive bone removal and can help to restore the native joint line and maintain joint stability without shifting the component medially.[5,6,14,15] Two commercially available design types are the wedge-shaped and stepped components. Biomechanical studies have shown that the wedge-shaped glenoid component has a better performance and fixation profile with lower overall micromotion and stress levels on the implant compared with the stepped-type component.[17,18] One retrospective case series described the efficacy of the stepped glenoid component for treating the anterior glenoid bone loss.[10] However, the wedge-shaped glenoid component would be more suitable than the stepped component from a biomechanical perspective.

Soft-tissue imbalance causes instability after shoulder arthroplasty.[19] Anterior glenoid wear patterns often have excessive posterior capsular tightness as well as a potential tendency to anterior subluxation, leading to anterior instability after TSA. Posterior capsular release may be required to correct anterior subluxation of the humeral head. In this patient, we carefully checked the soft-tissue balance intraoperatively. Because the posterior capsular tightness was not severe and the subsucapulatris tendon is intact, we were able to bring a balance of anterior and posterior soft tissue after TSA.

The hybrid cage glenoid, which is designed using peripheral metal peg cementation and interference fit of the central cage, was used in our patient. All-polyethylene keel or pegged glenoid components are the gold standard for TSA. However, aseptic loosening remains a common complication. Friedman et al[5] demonstrated that the cage glenoid provided good clinical outcomes, the same as

Figure 6 Active shoulder range of motion at the most recent follow-up. (**A**) Forward elevation, (**B**) abduction, (**C**) adducted external rotation, (**D**) and adducted internal rotation.

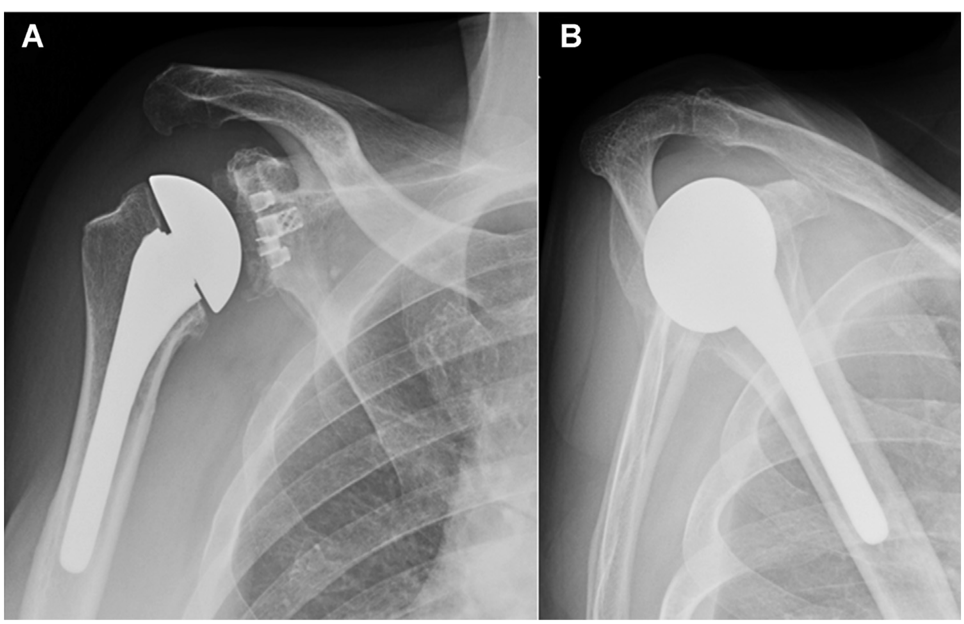

Figure 7 Radiographs of the right shoulder at the most recent follow-up. (**A**) Grashey view, (**B**) trans-scapular Y view.

those produced by an all-polyethylene glenoid. However, the cage glenoid showed a reduction in the incidence of aseptic loosening compared with the cemented all-polyethylene peg glenoid. In our patient, the anteriorly augmented hybrid cage glenoid showed no lucent line around pegs in the short term, however, longer-term radiographic assessment based on the bone ingrowth around or through the central cage peg is needed to clarify the efficacy of the hybrid cage glenoid.

Poor implant placement poses a risk for dislocation and component wear and loosening.[3,4] However, the optimal placement of the glenoid component is difficult to identify when glenoid deformity is severe.[9] Recent computer-assisted surgical techniques such as 3-dimensional planning software, patient-specific guides, and navigation systems have been developed for shoulder arthroplasty.[8,11,13,23] Previous studies have shown that the use of a navigation system reduces the average deviation of postoperative

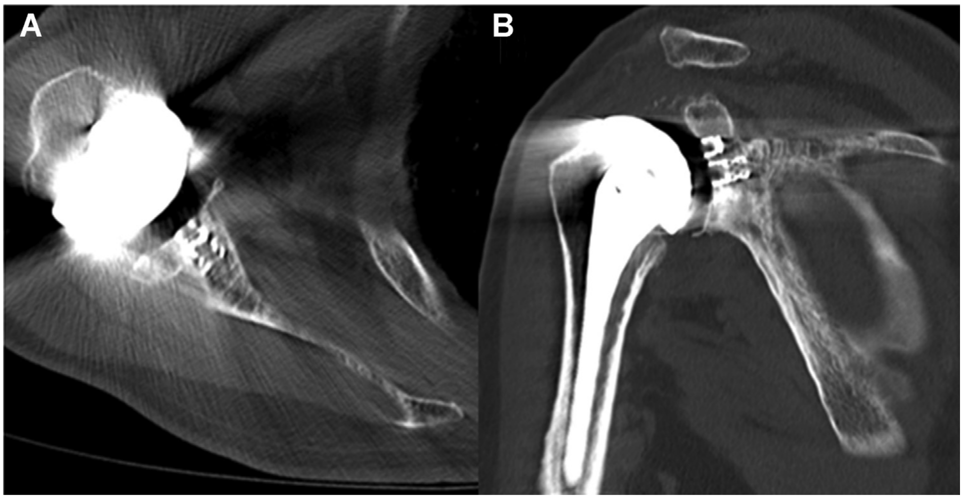

Figure 8 Postoperative computed tomography images of the right shoulder demonstrate the position of the glenoid component as planned. (**A**) Axial view and (**B**) coronal view.

glenoid component positioning.[11,13] Similarly, our treatment of this patient involved accurate component placement using the navigation system as planned preoperatively.

Conclusion

In summary, the patient presented with a case of shoulder osteoarthritis with the anterior glenoid bone loss. He was treated with TSA with an anteriorly wedge-shaped glenoid component and showed improved active range of motion of his shoulder and upper limb function. This technique may be a useful treatment for the Walch type D glenoid; however, further studies are needed because the longer-term clinical and radiographic outcomes after insertion of an anteriorly augmented glenoid component remain unknown.

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