JSES Reviews, Reports, and Techniques 5 (2025) 276–282

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Survival of humeral head autograft for glenoid bone loss in reverse total shoulder arthroplasty: a case report of long-term follow-up post ground level fall

Tyler B. Seckel, MD*, Daniel J. Lynch, MD, Nicholas D. Pekmezian, BS, Zakariah S. Mahmood, MD

HCA Ocala Orthopedic Surgery Department, Ocala, FL, USA

ARTICLE INFO

Keywords:
RTSA
Reverse total shoulder arthroplasty
Glenoid bone loss
Autograft
Humeral head
Augment
Glenoid wear
Graft incorporation

There has been a steady rise in the number of shoulder arthroplasty procedures performed every year in the United States. It is estimated that the number of total shoulder arthroplasties performed annually will double every 7 years.[12] As a subset of shoulder arthroplasty, there has been a dramatic rise in the incidence specifically of reverse total shoulder arthroplasties (rTSAs) performed, increasing from 7.3 per 100,000 cases performed in 2012 to 19.3 cases per 100,000 in 2017.[1] Osteoarthritis is the primary reason for performing shoulder arthroplasty.[12]

An important factor that needs to be addressed when considering shoulder arthroplasty is glenoid wear. The Walch classification is frequently used to describe the type of glenoid wear that is present[15]; however, the gold standard for accurate assessment of glenoid bone loss is through 3-dimensional computed tomography (CT) scanning.[8,11] The pattern and degree of glenoid wear can have a large impact on stability of the shoulder along with the longevity of the implant.[3,12] Data from biomechanical studies have suggested that the rate of micromotion is significantly increased if glenoid baseplate coverage is only 25%, which in turn increases the rate of component loosening.[3] The most common technique for correcting glenoid malversion is eccentric reaming, which can correct smaller defects.[12] For larger defects, bone grafting may be necessary. Common indications for bone grafting include uneven wear unable to be corrected by implant positional changes, >15° of glenoid retroversion and penetration of the glenoid vault after version correction.[1]

Autologous bone graft using humeral head remnants has been described as a technique used for glenoid bone grafting.[5,9,10] There is debate in the literature as to how well the humeral head autograft incorporates with the native glenoid, with some reports suggesting lucencies are present in a large portion of the population contributing to up to 25% of glenoid baseplate failure in rTSA[5,6,13] while others suggest near total incorporation.[7,14] There are also limited data relating to long-term follow-up after humeral head autograft beyond 2 years.[9,14] One series followed patients for 5 years; however, only plain radiographs were used for surveillance.[13] The current case describes complete humeral head autograft incorporation into the native glenoid 4 years after the index surgery as discovered on a CT scan when the patient presented to the emergency department after a fall. Interestingly, the patient suffered a periprosthetic humerus fracture while their glenosphere remained well-fixed.

Case report

History and examination

The patient was an 83-year-old male with a past medical history of hypertension, hyperlipidemia, skin and prostate cancer, tobacco

*Corresponding author: Tyler B. Seckel, MD, Department of Orthopedic Surgery, University of Central Florida/HCA Florida-Ocala, 3755 SW 2nd Place, Gainesville, FL 32607, USA.

E-mail address: Tyler.Seckel@gmail.com (T.B. Seckel).

https://doi.org/10.1016/j.xrrt.2024.12.009
2666-6391/© 2025 The Authors. Published by Elsevier Inc. on behalf of American Shoulder and Elbow Surgeons. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

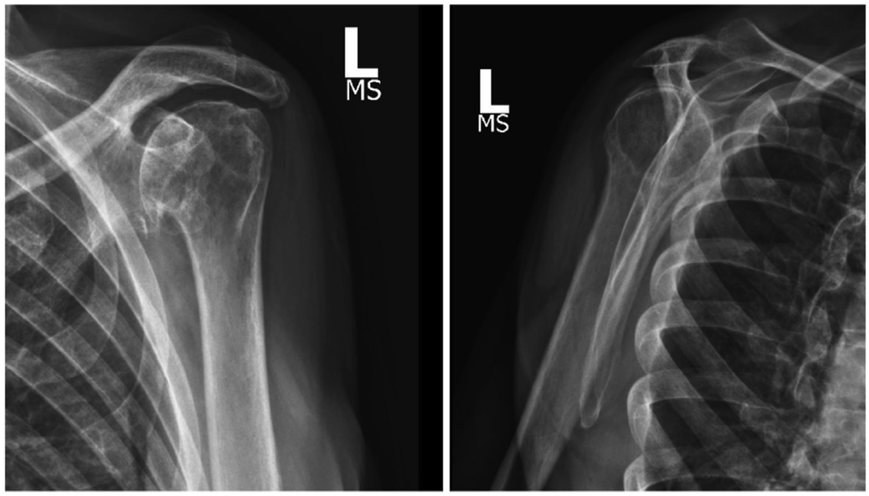

Figure 1 Preoperative X-rays showing end-stage glenohumeral arthritis with posterior subluxation of the humeral head. The amount of subluxation is suspicious for glenoid hypoplasia.

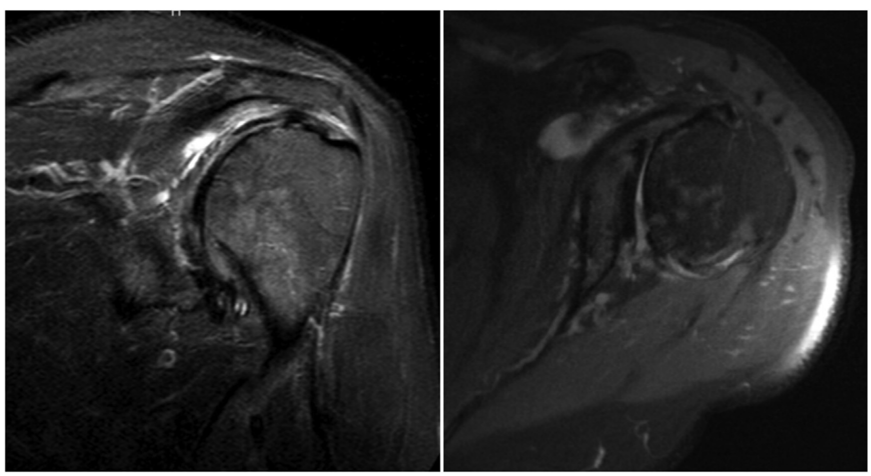

Figure 2 MRI of the left shoulder showing severe tendinosis of the supraspinatus. *MRI*, magnetic resonance imaging.

use, sleep apnea and previous right rTSA who presented to the clinic for chronic pain in his left shoulder negatively impacting his activities of daily living and quality of life.

His exam showed limited range of motion (ROM) with crepitus. He demonstrated 90° forward flexion, 35° external rotation (ER), 10° internal rotation (IR), and 115° abduction (ABD). Initial x-rays of the right shoulder showed end-stage osteoarthritic changes with posterior subluxation of the humeral head (Fig. 1). The degree of posterior subluxation of the humeral head raised concern for glenoid hypoplasia versus primary osteoarthritic changes. Magnetic resonance imaging obtained of the left shoulder showed diffuse high-grade tendinosis of the supraspinatus and infraspinatus, with an intact subscapularis tendon (Fig. 2). Of note, the magnetic resonance imaging also shows a hypertrophied posterior labrum, which is a finding consistent with glenoid hypoplasia[9] (Fig. 3). The patient was thought to be a good candidate for a rTSA. Studies have shown that rTSA is a viable treatment option for patients with recurrent glenohumeral instability especially in the setting of glenoid bone loss, and that no differences in outcomes exist when treating patients with recurrent glenohumeral instability with rTSA when compared to those undergoing rTSA for rotator cuff insufficiency.[4]

Preoperative planning

Due to the patient's significant glenoid wear noted on plain radiographs, he underwent a CT scan for preoperative templating. The preoperative CT scan is shown in Figures 4 and 5. Figure 4 demonstrates significant narrowing of the glenohumeral joint along with a severe glenoid deformity and subluxation of the humeral head. The CT scan has several findings that correspond with glenoid hypoplasia. There is a characteristic notch and dentated appearance of the glenoid (Fig. 5) along with scapular neck deficiency, representing the incomplete ossification of the inferior glenoid.[9] The CT scan was then incorporated into a templating system (Equinoxe; Exactech, Gainesville, FL, USA) for preoperative planning (Fig. 6). Glenoid retroversion was calculated at 50° with 5° of inferior inclination. The baseplate was placed in a neutral version to optimize shoulder kinematics. This allowed only 40% of the baseplate to be in contact with the

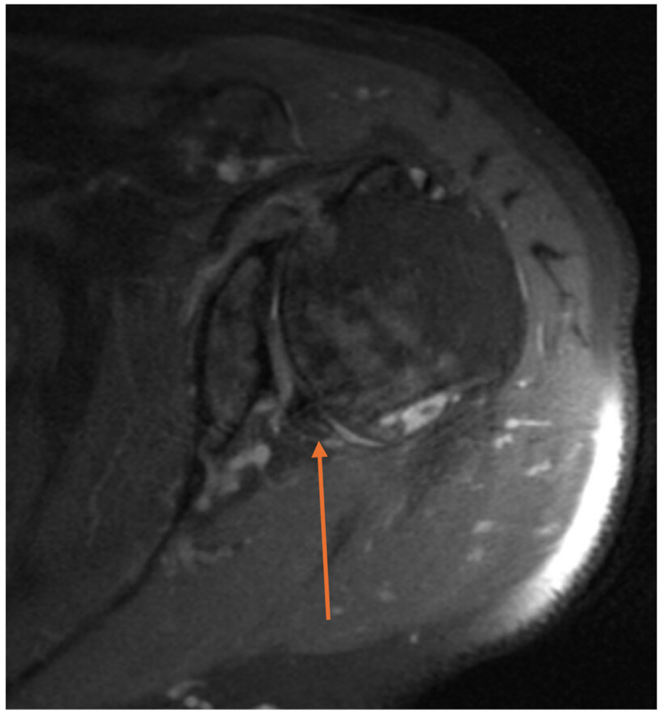

Figure 3 MRI of the left shoulder showing posterior labral hypertrophy (*arrow*) characteristic in glenoid hypoplasia. *MRI*, magnetic resonance imaging.

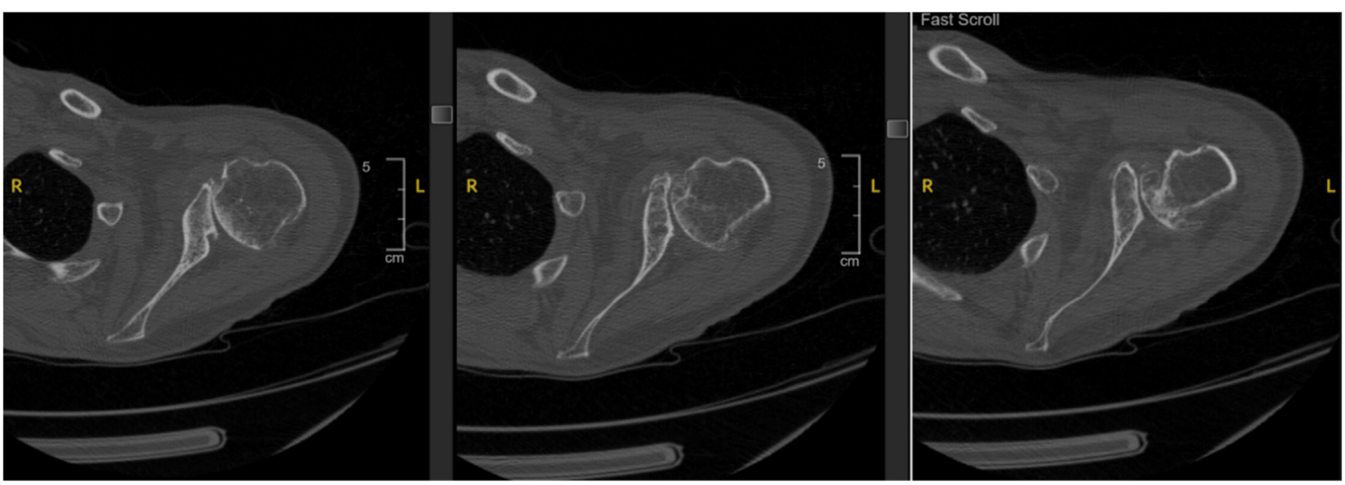

Figure 4 Preoperative axial CT images demonstrating the severity of posterior glenoid bone loss and glenoid retroversion. *CT*, computed tomography.

glenoid bone. Following these measurements, the surgical plan was to use humeral head autograft to augment the posterior glenoid.

Intraoperative findings

The patient was positioned in the beach chair position. A standard deltopectoral approach was used. The cephalic vein was protected and retracted medially. The subscapularis was then detached at its insertion on the lesser tuberosity and reflected. Once exposed, a cut guide was used to make the humeral head cut. A cut protector was then placed on the humerus. The humeral head was then placed on the back table for later use as graft.

The navigation guide was then placed on the coracoid and anchored with 2 screws. Minimal reaming of the glenoid occurred once targets were appropriately captured. The hole for the center cage of the baseplate was then drilled, and the autograft from the humeral head was placed into the center cage. At this time, there was noted to be significant posterior glenoid wear. As templated, only the anterior 40% of the implant had good contact with glenoid bone.

On the back table, attention was turned to the excised humeral head. The flat surface was placed on the table, so the dome of the head was face-up. The center of the diameter of the humeral head was found. Using a goniometer, a line was drawn from this point on the humeral head measuring 50° from the axis of the table to correlate with the measured glenoid retroversion. A saw was then

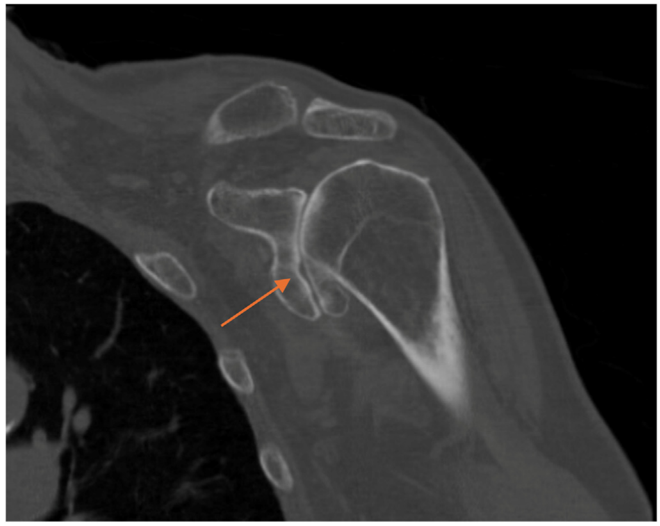

Figure 5 CT scan demonstrating a characteristic dentate lesion of the glenoid in glenoid hypoplasia. *CT*, computed tomography.

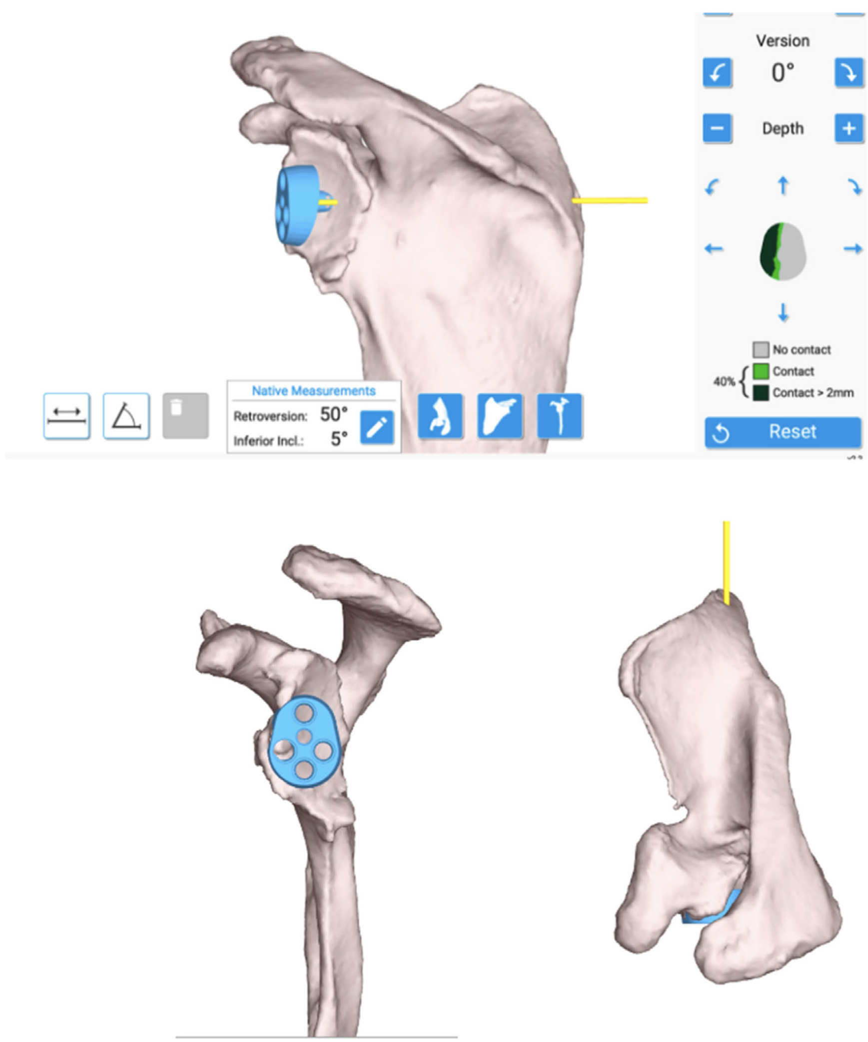

Figure 6 Preoperative templating demonstrating the remaining void after baseplate positioning. Only 40% of baseplate is in contact with bone. Glenoid retroversion was measured at 50°.

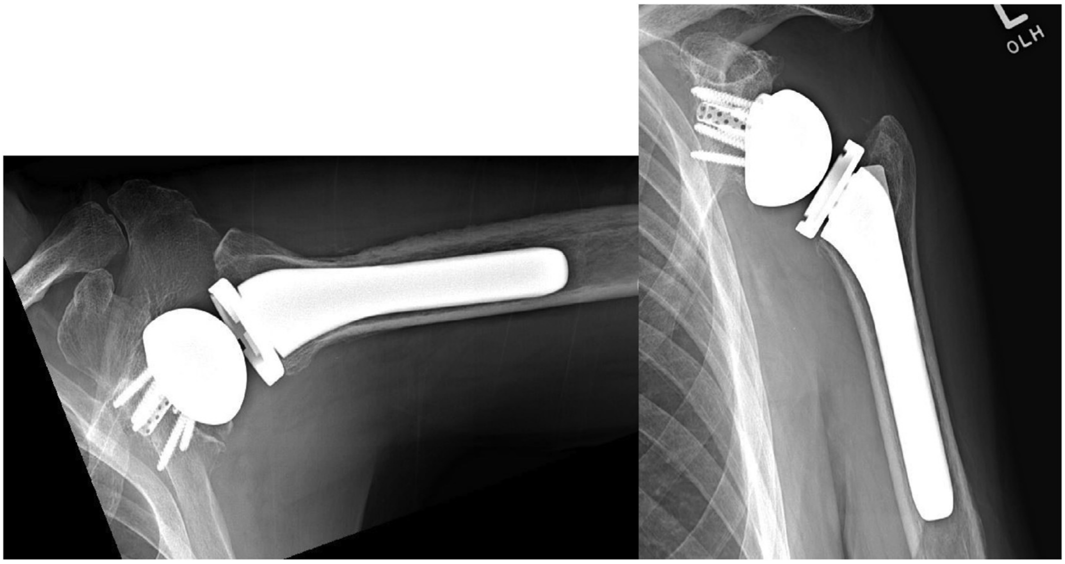

Figure 7 Two-week postoperative anterior-posterior and axillary views of the left shoulder showing humeral head autograft (*left*) and appropriate glenohumeral alignment (*right*).

Figure 8 Preoperative CT of patient's periprosthetic humerus fracture 4 years after index surgery before ORIF. *CT*, computed tomography; *ORIF*, open reduction and internal fixation.

used to cut the humeral head along this line. The autograft was then taken over to the glenoid and appropriately positioned so that it filled the defect. The graft was held in place using 2 k-wires that were placed percutaneously through the posterior deltoid so that the wires would not impede the remainder of the operation. With the graft secured, the glenoid baseplate was placed using GPS. The baseplate was secured with screws, and the posterior screws were able to incorporate the autograft. This process took around 20-30 minutes. The K-wires were removed, and the autograft was noted to be secured. A size 42 glenosphere (Exactach, Gainesville, FL, USA) was placed onto the baseplate and secured with a center screw.

Attention was turned back to the humerus where manual reaming and broaching were done. A size 15 stem was used for the humerus (Equinoxe; Exactech, Gainesville, FL, USA). The shoulder was reduced and taken through the ROM. Full ROM was noted along with excellent stability. The wound was copiously irrigated and closed in a layered fashion. The subscapularis was not repaired. The patient was given a sling before being transferred to the recovery room.

Postoperative course

The patient was made non–weight-bearing with no shoulder ROM in a standard sling for 2 weeks after his operation. A radiograph obtained at his first postoperative visit is shown in Figure 7. The patient continued with physical therapy for 10 weeks, after which he was able to achieve the following measurements with active ROM: 145° ABD, 145° flexion, and 65° ER. His strength was noted to be 4/5 in shoulder ABD, forward flexion and ER.

He returned to the clinic 2 years after his index surgery for yearly surveillance. At that time, the patient was very content with his outcome. He did request to have additional physical therapy for bilateral shoulders for general strengthening due to moderate weakness with overhead activities. His last documented physical therapy measurements were 145° of active ABD, 145° of active flexion, 65° of active ER, and 48° or active IR. Passively, he was able to achieve 150° ABD and 155° flexion, respectively. Strength testing was 4−/5 with ABD, 4/5 with flexion, 4−/5 with ER, and 3+/5 with IR. At this time, the patient was instructed to follow-up as needed.

Unfortunately, 4 years after the index rTSA the patient sustained a left periprosthetic humeral shaft fracture after a ground level fall. A CT scan of the left upper extremity was obtained in the emergency department (Fig. 8). Axial images obtained from the CT scan demonstrated an intact glenoid component with complete humeral head autograft incorporation with no evidence of lucencies or fracture (Fig. 9). Using the Friedman method, we measured 4° glenoid anteversion on this post-rTSA shoulder CT scan. This Wright and Cofield type A fracture, with the fracture centered near the distal stem and extending proximally, was deemed to have stable implants due to the lack of observed stem subsidence and lack of peri-implant lucency around the humeral stem or glenoid baseplate. The patient then underwent open reduction and internal fixation of his periprosthetic humeral shaft fracture without complication. He was discharged home on postoperative day 1. At

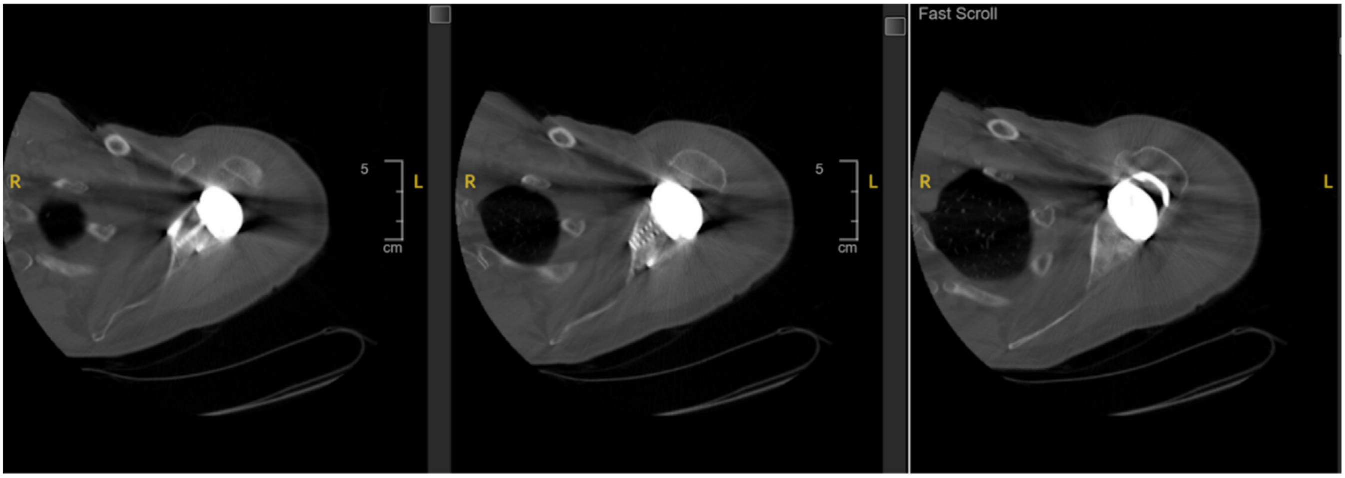

Figure 9 Axial CT images showing complete incorporation of humeral head autograft 4 years after index operation. No fractures, lucencies or migration present despite traumatic event. *CT*, computed tomography.

his last physical therapy visit 15 weeks after surgery, the patient was noted to have 90° of active flexion and 94° of active ABD. He was able to carry objects weighing about 4.5 kg (10 lbs) without pain, but he was having difficulty with activities of daily living such as dressing himself and reaching overhead. Overall, the patient felt that he was at about 75% of his preoperative level of functioning. It was at this time the patient was lost to follow-up as he moved out of state.

Discussion

The prevalence of shoulder arthroplasty in the United States continues to increase, and it is estimated that the number of total shoulder arthroplasties performed annually will double every 7 years.[12] The number of performed rTSAs has also been on the rise, increasing from 7.3 to 19.3 per 100,000 from 2012 to 2017.[1]

rTSA in the setting of significant glenoid bone loss poses a challenge to surgeons. There are many techniques available to address this problem, which is important for preserving shoulder kinematics, preventing early loosening, and increasing stability. Using humeral head autograft to correct a significant glenoid deformity is a technique that has been commonly described.[3,5-7,9,12-14] The results of this described technique have been inconsistent, with some reports suggesting lucencies are present in a large portion of the population[2,9] while others suggest near total incorporation.[7,14] Data analyzed at long-term follow-up at 5 years used only plain radiographs for surveillance rather than advanced imaging.[13]

The advantages to using humeral head autograft for large glenoid defects is that it is structurally sound and can be contoured to match the glenoid defect.[12] Correctly using humeral head autograft can be technically demanding, and even if done appropriately can still undergo resorption leading to loosening and failure.[12] Rates of graft resorption and baseplate failure can be as high as 25% after only 8 months following an rTSA using structural autografts.[6] Despite these high rates of resorption and baseplate failure, it has been suggested that there is no difference in outcomes when using autograft versus allograft for glenoid defects.[7]

The current case is unique in a couple aspects. First, this patient has imaging findings consistent with glenoid hypoplasia, which is a relatively rare condition.[16] However, most lesions consistent with glenoid hypoplasia are found incidentally in asymptomatic patients, leading to the assumption that the condition might be more common than what is reported.[16] The condition in this patient resulted in severe symptomatic glenohumeral arthritis. This case is also unique in that advanced imaging was able to detect the degree of graft incorporation 4 years after the index surgery, long after routine follow-up and longer than most published reports. It is also unique in that it demonstrates the force that humeral head autograft can sustain once it is fully incorporated. This patient sustained a great enough trauma to cause a fracture in the ipsilateral humerus; however, no fracture, lucency, subsidence, or migration were noted around the glenoid. This indicates that humeral head autograft is an excellent option for durable, structural support.

Conclusion

Severe glenoid deficiency augmented with humeral head autograft can lead to stable deformity correction, excellent graft incorporation, and improved functional outcomes. In the present case, the graft incorporation was even strong enough to withstand a traumatic event that led to a periprosthetic humerus fracture instead. This case report is meant to add to the evolving literature regarding outcomes and techniques using humeral head autograft for correction of severe glenoid deformity at the time of rTSA.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.
Patient consent: Obtained.

References

1. Best M, Aziz K, Wilckens J, McFarland E, Srikumaran U. Increasing incidence of primary reverse and anatomic total shoulder arthroplasty in the United States. J Shoulder Elbow Surg 2021;30:1159-66. https://doi.org/10.1016/j.jse.2020.08.010.
2. Colasanti C, Lin C, Ross K, Luthringer T, Elwell J, Roche C, et al. Augmented baseplates yield optimum outcomes when compared with bone graft augmentation for managing glenoid deformity during reverse total shoulder arthroplasty: a retrospective comparative study. J Shoulder Elbow Surg 2023;32:958-71. https://doi.org/10.1016/j.jse.2022.10.015.
3. Formaini N, Everding N, Levy J, Santoni B, Nayak A, Wilson C, et al. The effect of glenoid bone loss on reverse shoulder arthroplasty baseplate fixation. J Shoulder Elbow Surg 2015;24:E312-9. https://doi.org/10.1016/j.jse.2015.05.045.

4. Hasler A, Fornaciari P, Jungwirth-Weinberger A, Jentzsch T, Wieser K, Gerber C. Reverse shoulder arthroplasty in the treatment of glenohumeral instability. J Shoulder Elbow Surg 2019;28:1587-94. https://doi.org/10.1016/j.jse.2019.02.001.
5. Hill J, Norris T. Long-term results of total shoulder arthroplasty following bone-grafting of the glenoid. J Bone Joint Surg Am 2001;83A:877-83.
6. Ho J, Thakar O, Chan W, Nicholson T, Williams G, Namdari S. Early radiographic failure of reverse total shoulder arthroplasty with structural bone graft for glenoid bone loss. J Shoulder Elbow Surg 2020;29:550-60. https://doi.org/10.1016/j.jse.2019.07.035.
7. Jones R, Wright T, Zuckerman J. Reverse total shoulder arthroplasty with structural bone grafting of large glenoid defects. J Shoulder Elbow Surg 2016;25:1425-32. https://doi.org/10.1016/j.jse.2016.01.016.
8. Kwon Y, Powell K, Yum J, Brems J, Iannotti J. Use of three-dimensional computed tomography for the analysis of the glenoid anatomy. J Shoulder Elbow Surg 2005;14:85-90. https://doi.org/10.1016/j.jse.2004.04.011.
9. Nace J, Abboud JA. Hypoplastic glenoid with hyperplastic labrum: a case report. J Shoulder Elbow Surg 2009;18:e17-20. https://doi.org/10.1016/j.jse.2008.07.016.
10. Neer C, Morrison D. Glenoid bone grafting in total shoulder arthroplasty. J Bone Joint Surg Am 1988;70A:1154-262.
11. Rosenthal Y, Samim M, Gyftopoulos S, Kolade O, Kwon Y, Zuckerman J, et al. 3D-MRI versus 3D-CT in the evaluation of glenoid deformity in glenohumeral arthritis using Dixon 3D FLASH sequence. Skeletal Radiol 2022;51:2281-9. https://doi.org/10.1007/s00256-022-04086-6.
12. Sears B, Johnston P, Ramsey M, Williams G. Glenoid bone loss in primary total shoulder arthroplasty: evaluation and management. review. J Am Acad Orthop Surg 2012;20:604-13. https://doi.org/10.5435/JAAOS-20-09-604.
13. Steinmann S, Cofield R. Bone grafting for glenoid deficiency in total shoulder replacement. J Shoulder Elbow Surg 2000;9:361-7.
14. Tashjian R, Granger E, Chalmers P. Structural glenoid grafting during primary reverse total shoulder arthroplasty using humeral head autograft. J Shoulder Elbow Surg 2018;27:E1-8. https://doi.org/10.1016/j.jse.2017.07.010.
15. Walch G, Boulahia A, Boileau P, Kempf J. Primary glenohumeral osteoarthritis: clinical and radiographic classification. The Aequalis Group. Acta Orthop Belg 1998;64:46-52.
16. Wirth M, Lyons F, Rockwood C. Hypoplasia of the glenoid. A review of sixteen patients. J Bone Joint Surg 1993;75:1175-84.