JSES International 9 (2025) 194–200

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Reverse shoulder arthroplasty in ankylosing spondylitis with partial scapular ankylosis

Stefan Bauer, MD[a,b], Abdelkader Shekhbihi, MD[c,*], George Athwal, MD[d,e], Gilles Walch, MD[f]

[a]*Ensemble Hospitalier de la Côte, Morges, Switzerland*
[b]*School of Surgery, University of Western Australia, Perth, Australia*
[c]*Department of Trauma Surgery, Lörrach District Hospital, Baden-Württemberg, Lörrach, Germany*
[d]*Roth | McFarlane Hand and Upper Limb Centre, St Joseph's Health Care, London, Canada*
[e]*Department of Surgery, Western University, London, Canada*
[f]*Ramsay Générale de Santé, Hôpital privé Jean Mermoz, Centre Orthopédique Santy, Lyon, 69008, France*

A R T I C L E I N F O

Keywords:
Ankylosing spondylitis
Scapular ankylosis
Reverse shoulder arthroplasty
Scapulohumeral rhythm
Releasing osteotomies
Ostectomies

Ankylosing spondylitis (AS) is a chronic, typically advancing systemic inflammatory condition with a genetic component (human leukocyte antigen HLA-B27) reported in over 95% of the cases.[4] Symptoms, including stiffness and pain, at rest may be partially relieved through the administration of anti-inflammatory drugs and physical exercises. However, over time, chronic inflammation may lead to ossification of tendons, ligaments, fascia, or joint capsules, resulting in severe joint stiffness, warranting surgical intervention when functionally debilitating.[3]

Reports on reverse shoulder arthroplasty (RSA) addressing end-stage arthritis associated with advanced AS do not exist. The study by Figgie et al[5] reported on anatomic total shoulder arthroplasty in inflammatory arthritis, including one case of AS without specific details (preoperative scapula orientation, scapulohumeral rhythm, and their effect on the postoperative outcome) that would provide a comprehensive understanding of the subject matter.

The lack of data on shoulder joint replacement in AS-related shoulder arthritis prompted the authors to present this case to highlight this unique clinical scenario. The patient was informed that data concerning the case would be submitted for publication and he provided consent. To our knowledge, this article represents the first account of an RSA in progressive glenohumeral arthritis associated with a partially ankylosed scapula in AS, with a subsequent revision requiring scapula releasing osteotomies.

Case presentation

A 58-year-old right-handed male busy manager with HLA-B27-positive AS had been experiencing severe pain and functional limitations in his left shoulder for 3 years. The case-relevant patient characteristics and comorbidities are listed in Table I. The key factors that prompted surgical consultation were severe pain and the inability to reach overhead.

Clinically, loss of scapular motion was evident in the context of a fixed type C thoracic kyphosis and scapular protraction (Fig. 1). The preoperative range of motion (ROM) and functional scores are listed in (Fig. 2).

Radiographic assessments were consistent with advanced AS, characterized by a pronounced thoracic kyphosis, severe glenohumeral arthritis, and extensive ossification of the acromioclavicular (AC) and coracoclavicular (CC) ligaments (Fig. 3).

Subsequent computed tomography (CT) scans of the thorax and left shoulder joint highlighted the ankylosed thoracic kyphosis correlating with an altered scapular orientation and static fixation in protraction and internal rotation (Fig. 4).

Three-dimensional (3D) CT analysis (Blueprint; Stryker, Kalamazoo, MI, USA) showed 70% static posterior subluxation of the humeral head, 16° of retroversion, and 10° of superior inclination of the glenoid.[1] Furthermore, advanced degeneration and ankylosis of the AC and sternoclavicular (SC) joints were noted (Fig. 5).

Institutional review board approval was not required for this study; the patient consented for data concerning his case to be published.

*Corresponding author: Abdelkader Shekhbihi, MD, Department of Trauma Surgery, Lörrach District Hospital, Spitalstraße 25, 79539, Lörrach, Germany.
E-mail address: abdelkadershekhbihi@outlook.com (A. Shekhbihi).

https://doi.org/10.1016/j.jseint.2024.09.009

Table I
Patient data and case-relevant features.

Clinical variables	Patient data
Date of birth	24.02.1961
Sex	Male
Height (cm)	170
Weight (kg)	76
Body mass index	26.3
Comorbidities	Ankylosing spondylitis, psoriasis, and Crohn's disease
American Society of Anesthesiologists score	II
Scapula posture	Type C
Descriptive diagnosis	Ankylosing arthritis of the glenohumeral joint with degenerative cuff wear and ankylosis of the scapula and spine

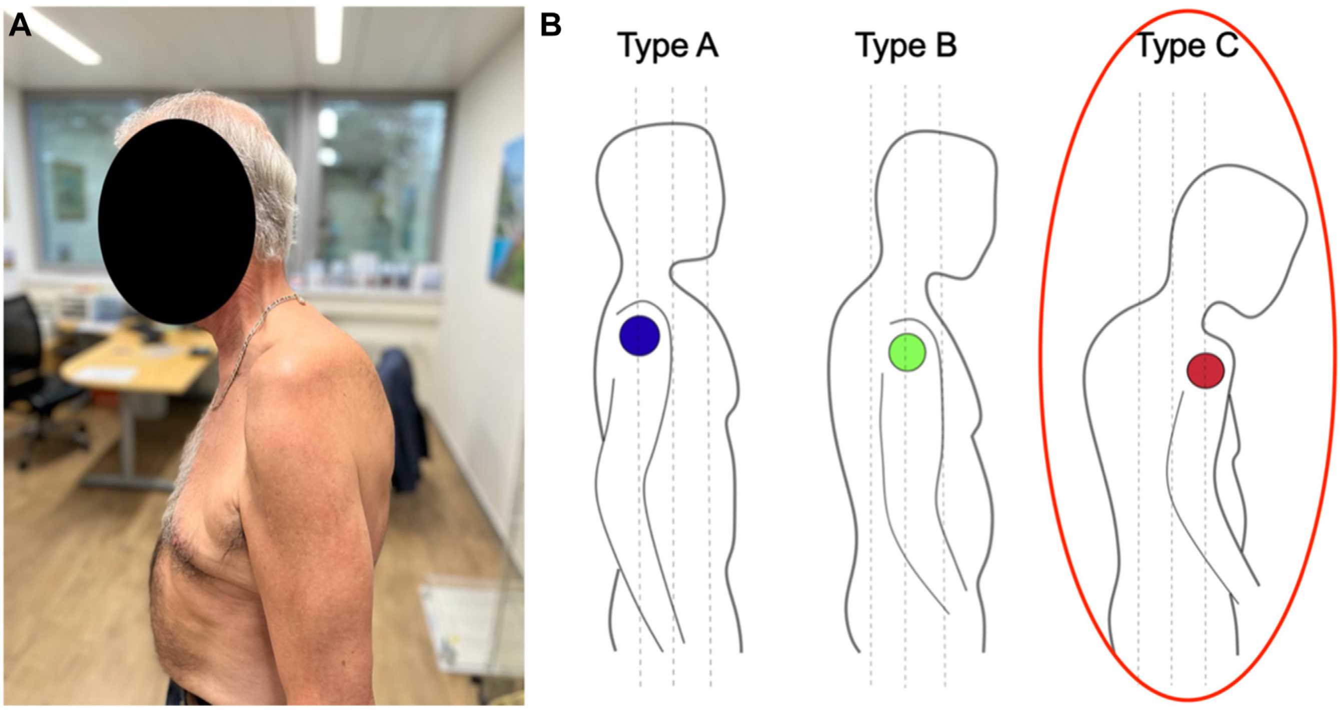

Figure 1 Preoperative clinical image highlighting the thoracic kyphosis and protracted Left scapula (**A**) Classification of the progressive scapular protraction and alteration of the glenoid Center of rotation related to thoracic kyphosis [courtesy of Moroder et al[12]] (**B**).

Magnetic resonance imaging findings demonstrated a degenerative rupture of the supraspinatus and infraspinatus and fatty infiltration (goutallier grade 2), subscapularis with some fatty streaks (goutallier grade 2), and teres minor without atrophy but minor grade 1 fatty infiltration (Fig. 6).

Given the severe restriction of ROM caused by the arthritis, the partial scapular ankylosis from AS, and the degenerative changes to the rotator cuff, the decision was made to proceed with RSA. A plan was formulated for RSA, utilizing a CT-scan 3D analysis software, with bony-increased-offset (BIO-RSA) as a backup option.

At surgery, a deltopectoral approach was used, with the patient in the beach chair position. The poor quality with liquified spongiosa of the humeral head ruled out a bony-increased-offset procedure. Instead, a wedged 15° metal-augmented base plate in postero-superior position (Aequalis Perform + Reversed; Wright Medical, Memphis, TN, USA) was used. A comprehensive arthrolysis was performed, involving the removal of bridging osteophytes and the complete release of the subscapularis tendon, resulting in a significant gain of tendon length, approximately 1 cm.

The inferior osteophyte of the glenoid was excised, with careful attention to protecting the axillary nerve. The glenoid surface was conservatively reamed, removing 2-3mm of bone to preserve cortical integrity. The full wedge-augmented base plate (25mm/15°) was secured using three peripheral 5.0mm screws (2 × 38mm and 1 × 34mm) and one central 6.5mm screw. Retroversion was partially corrected to 5°. A standard 36mm glenosphere, a short pressfit stem (size 5B), and a tray with a 3.5mm offset (+0mm height) were implanted, with 20° of retroversion and good stability. A +6mm insert (36B) was utilized (Aequalis Ascend Flex, Wright Medical, Memphis, TN, USA). Intraoperative passive ROM was limited, with approximately 90° of flexion, 80° of abduction, and 30° of external rotation in a prepped and draped shoulder. Immediate postoperative radiographs confirmed the satisfactory positioning of the RSA.

Follow-up assessments were scheduled at two weeks, six weeks, six months, 1 year, and two years postsurgery. At the 6-month mark, the patient expressed considerable satisfaction, noting a reduction in pain intensity and significant enhancements in both active and passive ROM (Fig. 2). At the 1-year follow-up, the patient continued to exhibit high satisfaction (Fig. 2). The strength, measured in 90° of elevation in the scapula plane, demonstrated a peak force of 21 pounds (MicroFT 2TM). Radiographic assessments revealed bony alterations around the stem and scapular notching grade 1-2.

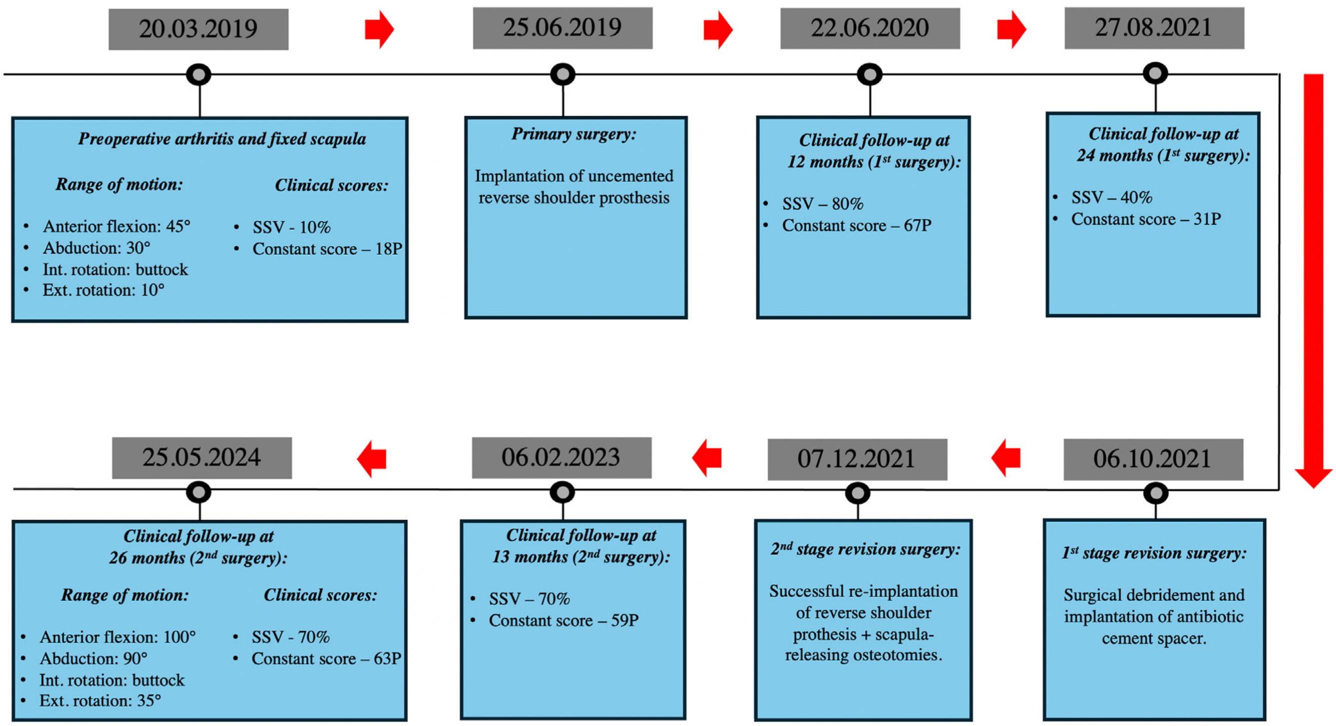

Figure 2 Timeline illustrating the patient's case progression over a five-year period following surgery. *SSV*, subjective shoulder value.

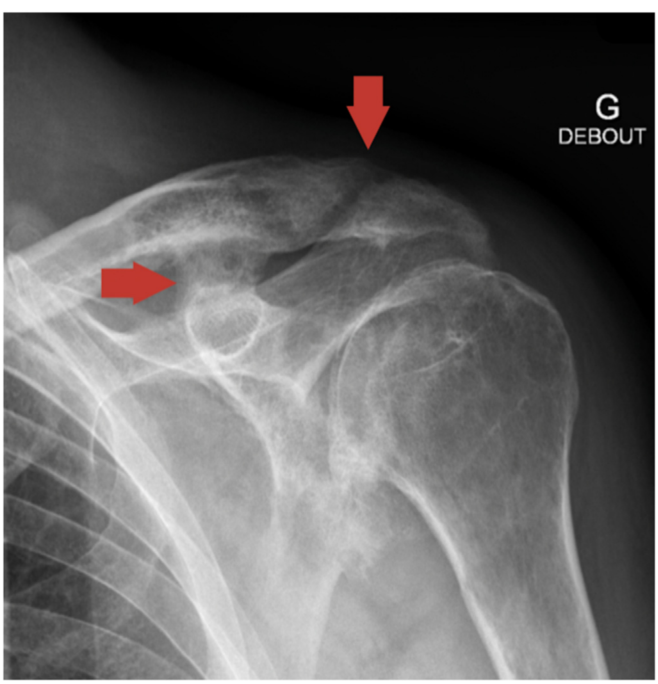

Figure 3 Preoperative anteroposterior shoulder radiograph demonstrating severe ankylosing glenohumeral arthritis and extensive ossification of the acromioclavicular and coracoclavicular ligaments (➡).

Figure 4 Static fixation of the scapula in 65.3° of internal rotation.

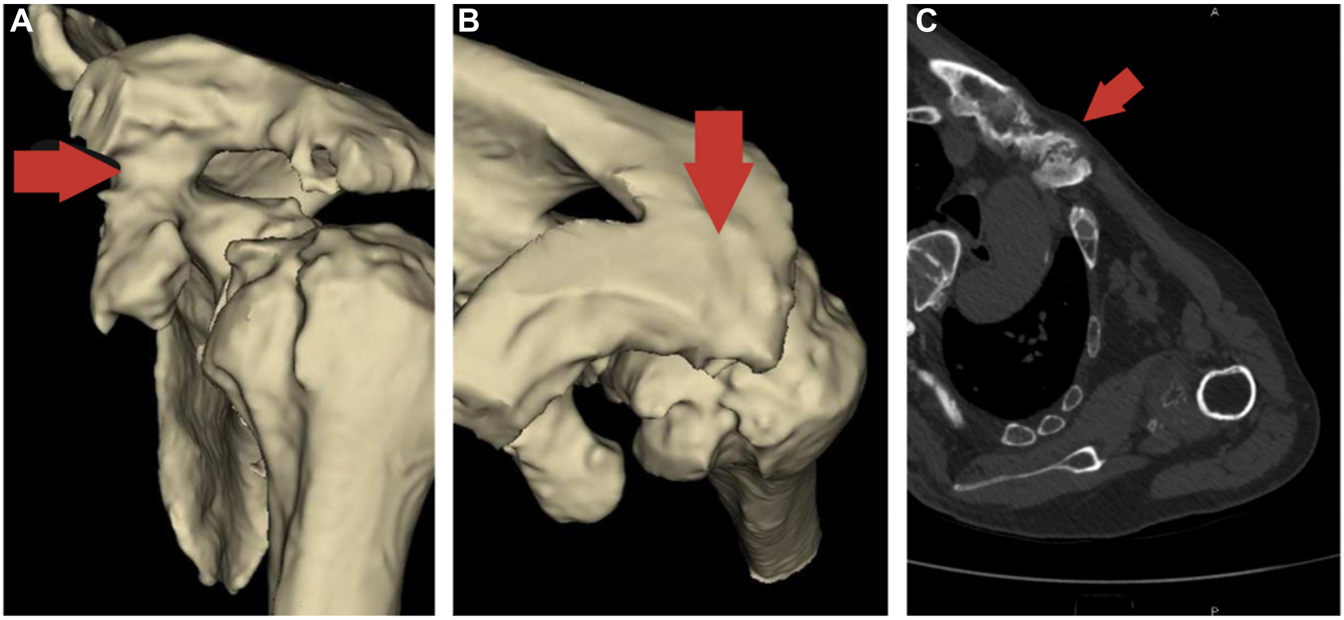

Figure 5 Three-dimensional analysis of the Left shoulder joint showing the extensive ossification of the acromioclavicular and coracoclavicular ligaments (**A, B**) and ankylosis of the sternoclavicular joint (**C**).

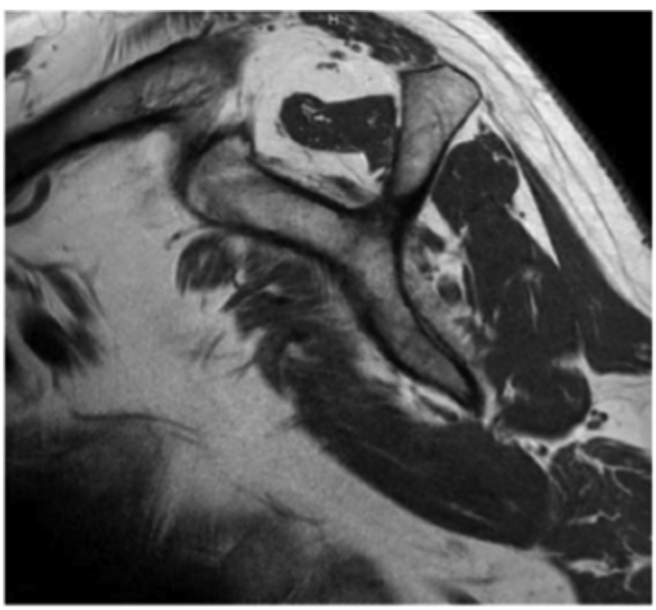

Figure 6 Sagittal T1 weighted magnetic resonance imaging demonstrating rotator cuff muscle atrophy.

At the two-year follow-up, the patient reported sporadic shoulder pain, particularly linked to strenuous manual activities, such as gardening and tree cutting. The subjective shoulder value decreased to 60%. The CS declined from 67 points to 42 points (Fig. 2). Subsequent radiographs revealed findings of stem loosening (Fig. 7). Consequently, a planned revision procedure was initiated. The initial stage revealed a suspicion of infection, involved prosthesis removal, culture sampling, placement of an antibiotic spacer, and administration of broad-spectrum intravenous antibiotics. Meanwhile, the results of culture samples from the first revision surgery tested positive for *Cutibacterium acnes*. In the second stage, 8 weeks after the spacer implantation, a cemented stem with a full-wedge implant and a 9.5 mm central screw were implanted (aequalis perform + reversed). To perform the scapula-releasing osteotomies, the deltopectoral incision was extended proximally over the coracoid process near the anterior border of the clavicle. A superolateral full-thickness skin flap was raised to provide access to the ossification of the AC joint, as well as the CA ligament, CC ligament, and coracoid process. The ossification of the CA ligament was first dissected and divided using a 1 cm oscillating saw and osteotome at the base of the coracoid and under the acromion. Next, the AC joint ossification was osteotomized just lateral to the triangular space between the clavicle and scapular spine. Following this, 3 cm of the ossification and distal clavicle, along with the ossified AC ligaments, were osteotomized and excised. Finally, the scapular release was assessed, demonstrating partial passive ROM and reducibility.

The patient was painfree in the subsequent postrevision follow-ups, the joint remained stable, and the clinical scores showed improved function and satisfaction (Fig. 2).

At the 5-year follow-up, more than 2 years after the last revision surgery, the subjective shoulder value and CS improved, reaching 70% and 63/100, respectively. Additionally, the abduction strength slightly increased to 15 pounds (Fig. 2). This ROM was satisfactory to the patient (Fig. 8) and the most recent radiographs showed good alignment of the prosthetic elements and increased scapula motion after scapula-releasing osteotomies (Fig. 9).

Discussion

RSA has been deemed a durable solution for managing end-stage primary osteoarthritis in patients older than 60 years.[7,9,14,15] However, there is no available literature on the outcomes of RSA in AS with a partially ankylosed scapula. In this distinctive case scenario, we believe that the evident loss of scapulothoracic motion observed during the physical examination, as well as in pre- and postoperative radiographs and CT scans, negatively influenced the postoperative outcome. Previous studies have established that RSA shoulders demonstrate high reliance on scapular motion compared to normal shoulders.[11,16,19]

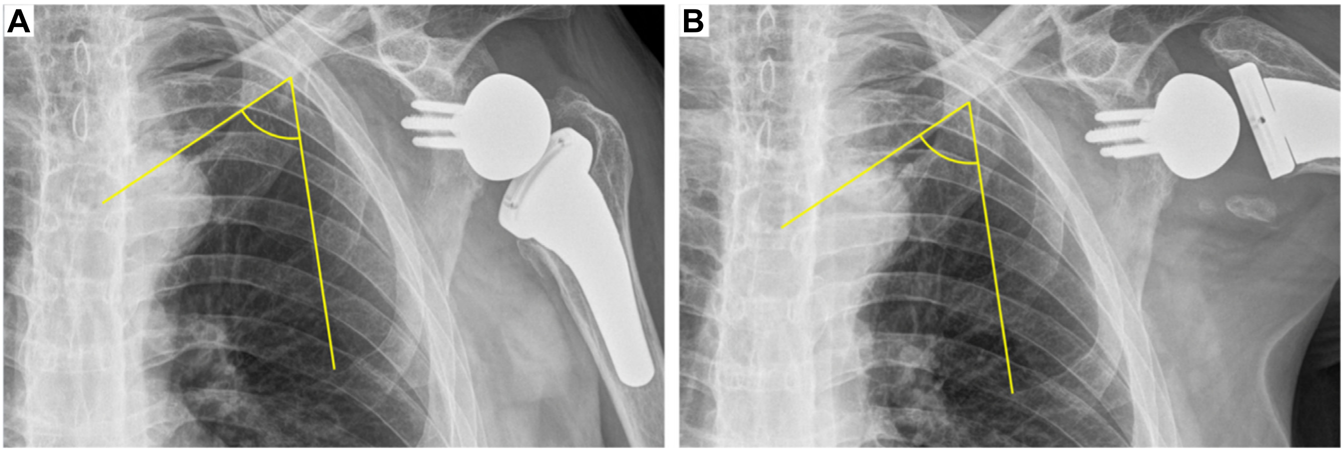

Figure 7 Anteroposterior resting (**A**) and dynamic (**B**) abduction radiographs of the Left shoulder joint following the first arthroplasty, highlighting the lack of scapular motion.

Figure 8 Range of motion of both shoulders showing improved motion of the affected (Left) shoulder at the 5-year follow-up (more than 2 years after the revision).

In the present case, the scapulohumeral rhythm dysfunction was attributed to two structural etiologies: 1) A fixed thoracic kyphosis with excessive scapular protraction, which alters the role of the scapula in shoulder function and has been suggested as a cause of scapular dyskinesis[8] and 2) the ossified SC joint, AC joint, and CC ligaments that contributed to restricting scapula motion. The significance of the AC and CC ligaments as a connecting element in the screw axis mechanism that regulates the normal scapulohumeral rhythm has been substantiated in previous research.[13,17,18]

Considering the patient's age and the potential for future revisions, a noncemented stem was deemed more advantageous at the first operation than cemented fixation. However, in a patient with inflammatory arthropathy and reduced bone quality, it could be argued that initial cementation of the stem would have been more appropriate.

In contrast to the favorable outcomes reported in the studies by Figgie et al[5] and Hattrup et al,[6] reporting results of anatomic total shoulder arthroplasty and RSA in inflammatory arthritis, respectively, the patient in this report exhibited subpar results on the 2-year follow-up that were mainly attributed to the strict loss of scapula motion, stem loosening, and periprosthetic joint infection. Remarkably, the outcomes improved at the 5-year follow-up, more than 2 years after the two-staged revision surgery with the scapula-releasing osteotomies (resection of complete bridging ossifications of the AC joint and CC ligaments). However, given the continuously impaired scapulothoracic posture and motion,[1] the authors maintain a guarded prognosis for the long-term outcome of this RSA.

Postreleasing osteotomies, the condition resembled a Rockwood V injury of the AC joint, which is amenable to successful conservative treatment.[10] Boström et al[2] demonstrated no significant difference in outcomes between patients managed conservatively and those undergoing surgical intervention.

Even though scapulothoracic motion is initiated at the SC joint and theoretically more motion could have been gained by releasing it, the authors believed that sufficient scapular mobility could be achieved by releasing the bridging ossifications of the AC joint, CA ligament, and CC ligaments, effectively disconnecting the scapula and off-loading the clavicle. Releasing the SC joint would have

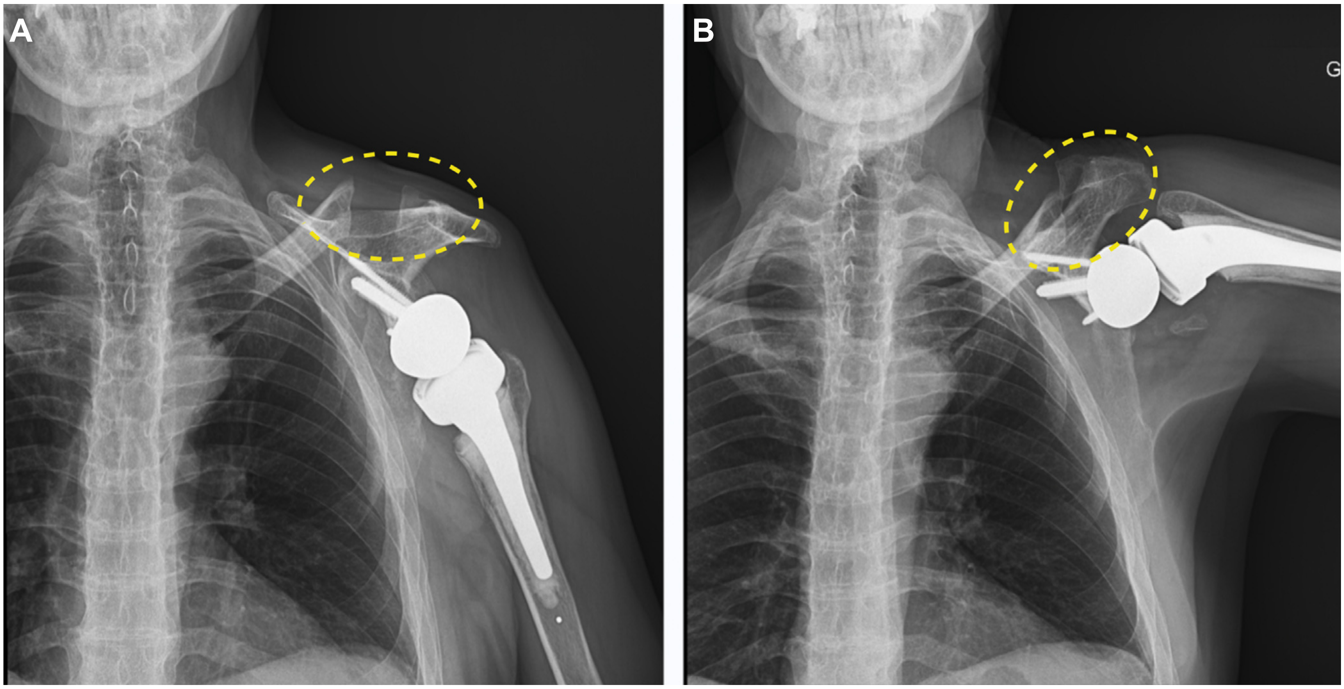

Figure 9 Anteroposterior resting (**A**) and dynamic (**B**) abduction radiographs after revision reverse shoulder arthroplastyand releasing osteotomies of the scapula show improved scapular motion, which is indicated by the screws fixing the baseplate in the scapula and the closure of the acromioclavicular gap after resection ( ). The scapula is moving around a disconnected clavicle, which remains in a static position.

resulted in a floating clavicle situation, increasing the risk of additional morbidity, such as neurovascular complications, hematoma, infection, and altered cosmesis, hence, the decision to preserve it.

Conclusion

Restoration of scapular motion through scapula-releasing osteotomies, along with optimizing implant configuration, may enhance outcomes and partially restore shoulder function following RSA in AS with a fixed scapula. In the context of continuously impaired scapulothoracic posture and motion in a younger patient, the long-term outcome and prognosis of RSA in this setting may well be limited, and patients willing to undergo RSA with concomitant AS should be informed about these limitations.

Acknowledgments

The authors would like to give many thanks to the Australian Government for the support of this work as part of a Research Training Programm PhD scholarship kindly granted for the main author (S.B.).

Disclaimers:

Funding: The Australian Government supported this work as part of a Research Training Programm PhD scholarship kindly granted for the main author (S.B.). The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.
Conflicts of interest: Stefan Bauer is a consultant for Stryker Osteonics SA without any personal payments. Gilles Walch and George Athwal are paid consultants and receive royalties for shoulder arthroplasty design from Stryker. The other authors, their immediate families, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article. The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

References

1. Bauer S, Blakeney WG, Wang AW, Ernstbrunner L, Corbaz J, Werthel J-D. Challenges for optimization of reverse shoulder arthroplasty part II: subacromial space, scapular posture, moment arms and muscle tensioning. J Clin Med 2023;12:1616. https://doi.org/10.3390/jcm12041616.
2. Boström Windhamre H, von Heideken J, Une-Larsson V, Ekström W, Ekelund A. No difference in clinical outcome at 2-year follow-up in patients with type III and V acromioclavicular joint dislocation treated with hook plate or physiotherapy: a randomized controlled trial. J Shoulder Elbow Surg 2022;31:1122-36. https://doi.org/10.1016/j.jse.2021.12.003.
3. Braun J, Sieper J. Ankylosing spondylitis. Lancet 2007;369:1379-90. https://doi.org/10.1016/S0140-6736(07)60635-7.
4. Brewerton DA, Hart FD, Nicholls A, Caffrey M, James DCO, Sturrock RD. Ankylosing spondylitis and HL-a 27. Lancet 1973;301:904-7.
5. Figgie MP, Inglis AE, Figgie HE, Sobel M, Burstein AH, Kraay MJ. Custom total shoulder arthroplasty in inflammatory arthritis. J Arthroplasty 1992;7:1-6.
6. Hattrup SJ, Sanchez-Sotelo J, Sperling JW, Cofield RH. Reverse shoulder replacement for patients with inflammatory arthritis. J Hand Surg Am 2012;37:1888-94. https://doi.org/10.1016/j.jhsa.2012.05.015.
7. Karimi A, Reddy RP, Njoku-Austin C, Nazzal E, James MG, Lin A. Reverse total shoulder arthroplasty for primary osteoarthritis with restricted preoperative forward elevation demonstrates similar outcomes but faster range of motion recovery compared to anatomic total shoulder arthroplasty. J Shoulder Elbow Surg 2024;33:S104-10. https://doi.org/10.1016/j.jse.2024.03.003.
8. Ben Kibler W. The role of the scapula in athletic shoulder function. Am J Sports Med 1998;26:325-37.
9. Kozak T, Bauer S, Walch G, Al-karawi S, Blakeney W. An update on reverse total shoulder arthroplasty: current indications, new designs, same old problems. EFORT Open Rev 2021;6:189-201. https://doi.org/10.1302/2058-5241.6.200085.
10. Krul KP, Cook JB, Ku J, Cage JM, Bottoni CR, Tokish JM. Successful conservative therapy in rockwood type V acromioclavicular dislocations. Orthop J Sports Med 2015;3. https://doi.org/10.1177/2325967115S00017.
11. Linderman SE, Hall JRL, Johnson JE, Caceres AP, Hettrich CM, Anderson DD. Return of scapulohumeral rhythm in patients after reverse shoulder arthroplasty: a midterm Stereoradiographic imaging analysis. Iowa Orthop J 2022;42:227-37.

12. Moroder P, Akgün D, Plachel F, Baur ADJ, Siegert P. The influence of posture and scapulothoracic orientation on the choice of humeral component retrotorsion in reverse total shoulder arthroplasty. J Shoulder Elbow Surg 2020;29:1992-2001. https://doi.org/10.1016/j.jse.2020.01.089.
13. Oki S, Matsumura N, Iwamoto W, Ikegami H, Kiriyama Y, Nakamura T, et al. Acromioclavicular joint ligamentous system contributing to clavicular strut function: a cadaveric study. J Shoulder Elbow Surg 2013;22:1433-9. https://doi.org/10.1016/j.jse.2013.01.004.
14. Puzzitiello RN, Moverman MA, Menendez ME, Hart P-A, Kirsch J, Jawa A. Rotator cuff fatty infiltration and muscle atrophy do not impact clinical outcomes after reverse total shoulder arthroplasty for glenohumeral osteoarthritis with intact rotator cuff. J Shoulder Elbow Surg 2021;30:2506-13. https://doi.org/10.1016/j.jse.2021.03.135.
15. Raiss P, Zeifang F, Pons-Villanueva J, Smithers CJ, Loew M, Walch G. Reverse arthroplasty for osteoarthritis and rotator cuff deficiency after previous surgery for recurrent anterior shoulder instability. Int Orthop 2014;38:1407-13. https://doi.org/10.1007/s00264-014-2325-y.
16. Reina M, Fiumana G, Mantovani M, D'Antonio L, Porcellini G. Scapulohumeral rhythm in shoulders with reverse shoulder arthroplasty measured with a new portable three-dimensional scapular kinematics assessment system. J Shoulder Elbow Surg 2023;32:729-37. https://doi.org/10.1016/j.jse.2022.12.007.
17. Sahara W, Sugamoto K, Murai M, Yoshikawa H. Three-dimensional clavicular and acromioclavicular rotations during arm abduction using vertically open MRI. J Orthop Res 2007;25:1243-9. https://doi.org/10.1002/jor.20407.
18. Teece RM, Lunden JB, Lloyd AS, Kaiser AP, Cieminski CJ, Ludewig PM. Three-dimensional acromioclavicular joint motions during elevation of the arm. J Orthop Sports Phys Ther 2008;38:181-90. https://doi.org/10.2519/jospt.2008.2386.
19. Walker D, Matsuki K, Struk AM, Wright TW, Banks SA. Scapulohumeral rhythm in shoulders with reverse shoulder arthroplasty. J Shoulder Elbow Surg 2015;24:1129-34. https://doi.org/10.1016/j.jse.2014.11.043.