JSES International 9 (2025) 1929–1937

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Scapular (glenoid and acromion) osteotomies for the treatment of posterior shoulder instability: technique and preliminary results

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A R T I C L E I N F O

Keywords:
Shoulder
Posterior instability
Glenoid
Scapula
Acromion
SCOPE
Osteotomy

Level of evidence: Level IV; Case Series; Treatment Study

Background: Static and dynamic posterior shoulder instability (PSI) are associated with a higher, more horizontal acromion providing poor posterior humeral head (HH) coverage. The current surgical treatment yields unsatisfactory long-term outcomes with high recurrence rates in dynamic and failure to restore joint concentricity in static PSI. We hypothesized that restoring physiological acromio–glenoid relations would prevent recurrence of dynamic and positively influence static PSI.
Methods: This study reports the outcome after a "scapular (acromion and glenoid) corrective osteotomy for posterior escape procedure in 9 consecutive patients at a minimum 2-year follow-up. One patient had static, 2 had dynamic and 6 had combined PSI. Osteotomies to restore normal scapular bony anatomy were three-dimensionally planned and executed with three-dimensional printed cutting and reduction guides. Preoperatively and postoperatively the absolute Constant Scores (CS), relative CS, subjective shoulder value and glenohumeral subluxation indices (GHSIs) and scapulohumeral subluxation indices (SHSIs) were measured.
Results: The mean age at surgery was 37 years (±9.3; 23-47) and mean follow-up was 29 months (±8). In 6 patients, the operation was a revision. In 1 case, we operatively failed to achieve the planned correction resulting in clinical failure, persistent subluxation, and osteoarthritis progression. For the other 8 patients, the median subjective shoulder value increased by 42.5%, absolute CS by 18 points, relative CS by 18%, pain score by 3.5 points. The SHSI was ≥61% in 7/7 patients, GHSI was ≥55% in 4/7 patients. In 5/7 patients with pathological SHSI, the HH was recentered; in 2/7, it was improved but remained ≥61%. In 2/4 patients with the pathological GHSI, the HH was recentered, and improved but remained ≥55% in the other 2. All patients had subjectively stable shoulders.
Conclusion: At a minimum of 2 years successful correction of scapular anatomy can improve static subluxation and restore subjective and objective shoulder stability.

Posterior shoulder instability (PSI) presents as static or recurrent dynamic instability or combinations thereof. Static PSI is defined as the permanent posterior displacement of the humeral head (HH) relative to the glenoid on computed tomography (CT).[2,3,43] This condition is prearthritic[13,43,45] and inevitably progresses to eccentric osteoarthritis (OA)[13,45] characterized by B1 and B2 glenoids.[26,43,45] Current surgical treatments for static PSI includes arthroscopic soft-tissue procedures,[36] glenoid osteotomies,[15,38,46] and posterior bone blocks.[10,12,15] Although subjective improvement is reported, glenohumeral joint (GHJ) recentering and prevention of OA progression have not been obtained.[10,12,15,30,36,38,46]

Dynamic PSI occurs mainly on anterior elevation of the internally rotated arm and has been associated with posterior capsular redundancy, capsulolabral tears, flattened and/or retroverted glenoid, glenoid bone loss, and rarely, reverse Hill–Sachs lesions.[6,37] When conservative measures fail, surgical options include capsulolabral repair, glenoid osteotomies (± J-Graft), posterior glenoid bone augmentation, or combinations thereof.

Treatment approaches for static and dynamic PSI, have focused on soft tissue alterations and glenoid orientation and shape.[9,16] It is uncontested that these findings are associated with PSI, but it is uncertain whether they are a cause or a result of PSI.[9,16] At least for

Ethics committee approval was obtained before commencement of this study.
Investigation was performed at the Department of Orthopaedics of the University of Zürich, Balgrist University Hospital and Balgrist Campus, Orthopaedic Research Center, Zürich, Switzerland.
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https://doi.org/10.1016/j.jseint.2025.06.018
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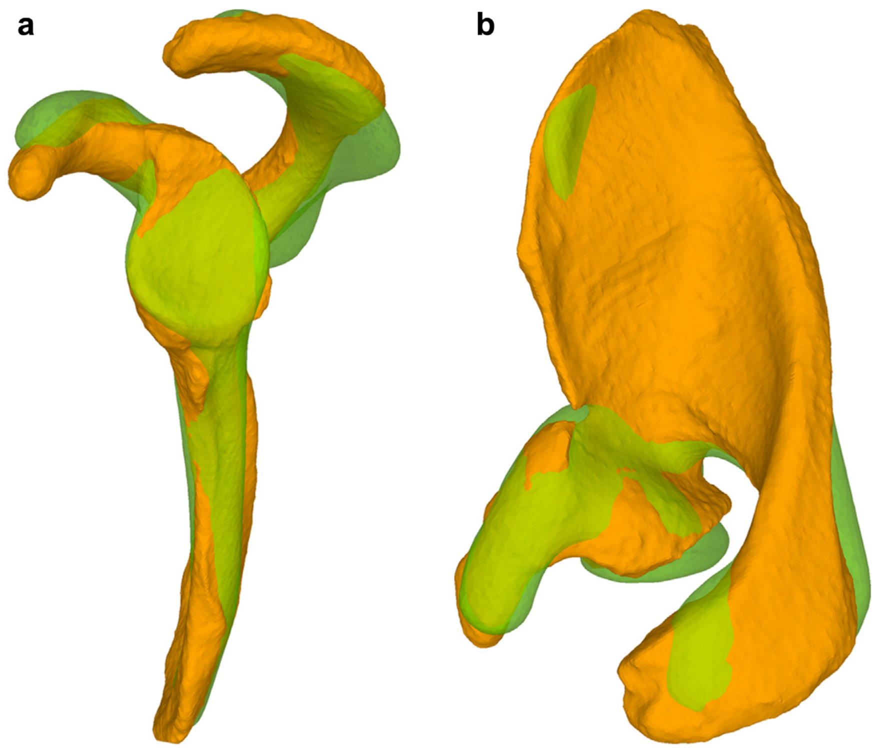

Figure 1 Comparison of the 3D shape of a scapula with PSI (*yellow*) with a normal scapula as determined by a statistical shape model. (**a**) True lateral and (**b**) axillary lateral view. *PSI*, posterior shoulder instability.

surgical failures, it remains plausible that these lesions are a consequence rather than the cause of instability.

Static and dynamic PSI are associated with characteristic changes in shape, position, and orientation of the acromion[4-6,32]: it is higher and more horizontal, providing poor posterior HH coverage. Biomechanical studies have shown that such acromial morphologies lead to increased posterior HH translation during loading, which can be restored to normal patterns through acromial correction.[23,24]

With the consistent finding of specific acromial abnormalities associated with PSI and biomechanical evidence of their importance, we hypothesized that restoring physiological acromion–glenoid relations would prevent recurrent PSI and positively influence static PSI. To achieve this goal, we designed the 3-dimensional (3D)–planned "scapular corrective osteotomy for posterior escape (SCOPE) procedure, which includes restoration of acromion and—if present—glenoid malorientations. This study reports the outcomes in the first 9 patients at a minimum of 2 years.

Materials and methods

Study design and setting

This is a retrospective, single-center study evaluating 9 consecutive patients treated by 1 surgeon (C.G.). Ethical approval was obtained (KEK; project number 2023-00854); all patients provided written consent.

Patients

Between December 2020 and January 2022, 8 male and one female consecutive patients underwent a SCOPE procedure for static and/or dynamic PSI. Indications were symptoms of PSI, unresponsive to physiotherapy, and/or pain unresponsive to conservative management including 1 intra-articular steroid injection. All patients had standardized preoperative radiographs and CT. Scapular malalignment was defined as an at least 1 standard deviation difference from the normal values of glenoid retroversion, glenoid inclination, posterior acromial coverage (PAC), posterior acromial height (PAH) and sagittal acromial tilt (SAT) on 3D-CT scans.[6]

Static PSI was defined as a glenohumeral subluxation index (GHSI) of ≥56%,[13,26] or a scapulohumeral subluxation index (SHSI) of ≥61%[13,37] as measured on reoriented 2D-CT scans and proposed by Jacxsens et al.[13,26] GHSI and SHSI quantify the posterior positioning of the HH relative to the glenoid or scapular body, respectively. GHSI represents the percentage of the HH located posterior to a line perpendicular to the glenoid face, whereas SHSI refers to the position of the HH relative to a line extending from the medial border of the scapula through the midpoint of the glenoid. The GHSI thus reflects glenoid-specific alignment, whereas the SHSI incorporates the entire scapular axis.

Dynamic PSI was defined as a positive jerk[28] and a posterior apprehension test.[47] One patient had static PSI (type C2),[37] 2 had dynamic PSI (type B2: n = 2),[37] and 6 had combined PSI (type C1: n = 2, type C2: n = 4)[37] (Supplementary Table S1).

Preoperative planning

The patients' CT data (Siemens Somatom Edge Plus; Siemens, Munich, Germany; 1-mm slices) were imported into MIMICS software (Materialise, Leuven, Belgium) for semiautomatic 3D segmentation. The 3D patient data were compared to a mean statistical shape model (mSSM) of a normal scapula, created from 40 asymptomatic shoulders collected for a previous study.[6] The mSSM and the patient scapula were imported into the planning software Computer-Assisted Surgery Planning Application (version 5.32; Balgrist CARD AG, Zurich, Switzerland), oriented in a standardized coordinate system and aligned using the entire scapular body (Fig. 1).

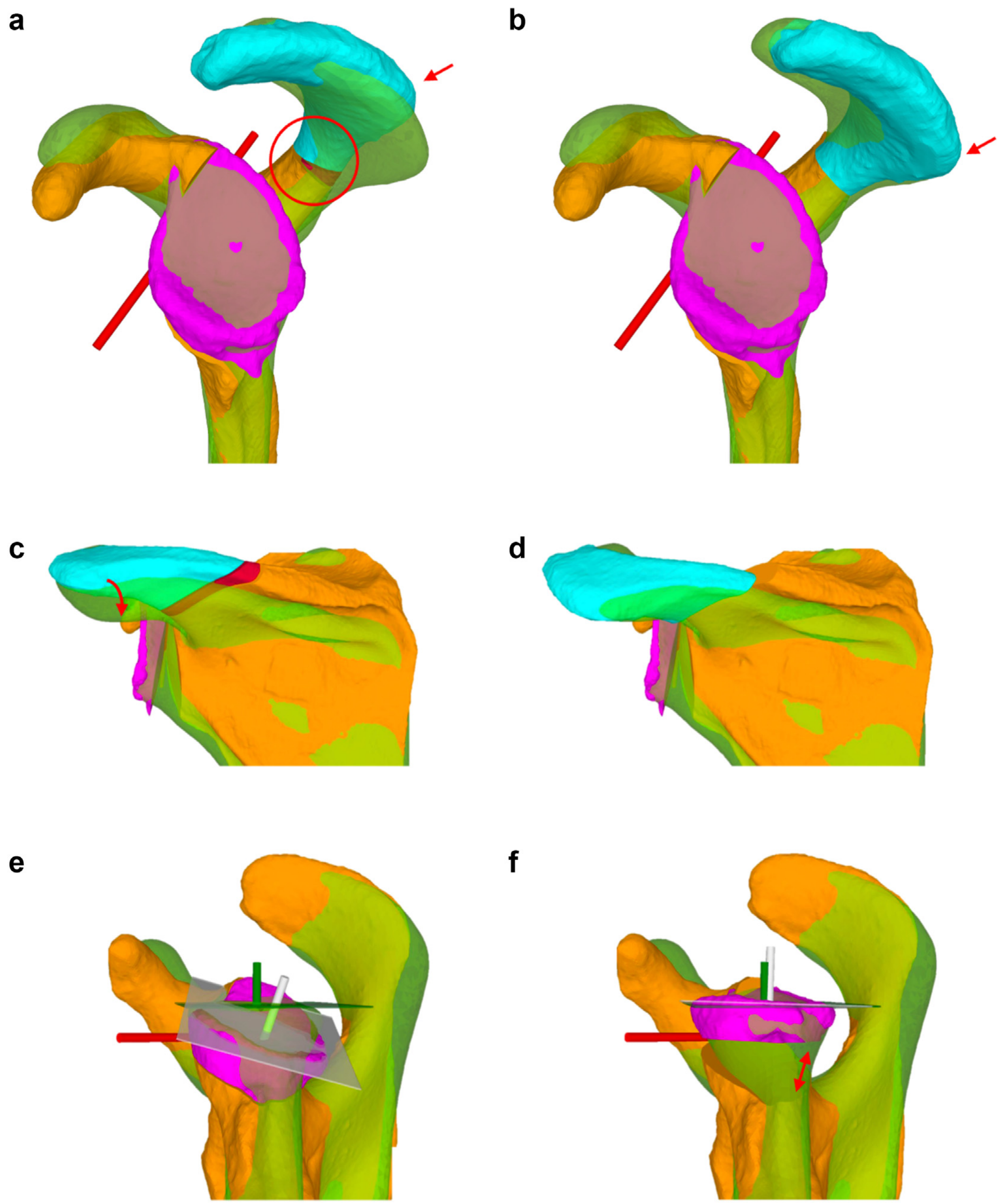

Figure 2 Visualization of the required correction of the glenoid and acromial morphology. (**a**) Illustrates a pathologically high and flat acromion (*blue*) overlaid with the statistical shape model of a normal scapula (*green*). (**b**) The planned biplanar closing-wedge acromial osteotomy is marked with a *red circle*, and the *red arrow* highlights the posterolateral acromial corner targeted for correction. (**c** and **d**) Displays the same correction from a posterior perspective. The glenoid in (**A**) through (**d**) has already been corrected by rotation around the planned axis (*red line*). (**e**) Shows the pathological glenoid (*pink*) in an inferior view. The white plane and *arrow* represent the combined retroversion and inferior tilt of the native glenoid, whereas the *green* plane and *arrow* indicate the orientation of a normal glenoid based on the statistical shape model. (**f**) Illustrates the planned glenoid correction, with alignment of the *white and green arrows*. The *red arrow* denotes the opening wedge required to restore normal version and inclination.

The glenoid surface and the lateral acromion fragment were isolated and aligned with the mSSM to imitate normal scapular anatomy (Fig. 2). Restoration of anatomy required corrective acromial osteotomies in 8 and glenoid osteotomies in 9 patients. After determining osteotomy site, orientation, and the resulting displacement of fragments, internal fixation was planned. Patient-specific, polyamide, cutting (Fig. 3) and reduction guides (Fig. 4) were 3D printed (Formiga P100; EOS GmbH, Krailling, Germany) and sterilized according to MyOsteotomy guidelines (Medacta SA, Castel San Pietro, Switzerland).

Surgical technique

With the patients in lateral decubitus, an L-shaped incision was made along the scapular spine, passing behind the acromioclavicular (AC) joint, and extending 5 cm distally (Appendix 1). The scapular spine and the glenoid were exposed. Acromial and glenoid osteotomies were performed using personalized cutting guides (Fig. 3). The suprascapular nerve was not directly visualized during the osteotomies. However, meticulous care was taken to protect it throughout the procedure. The acromion osteotomy and division of

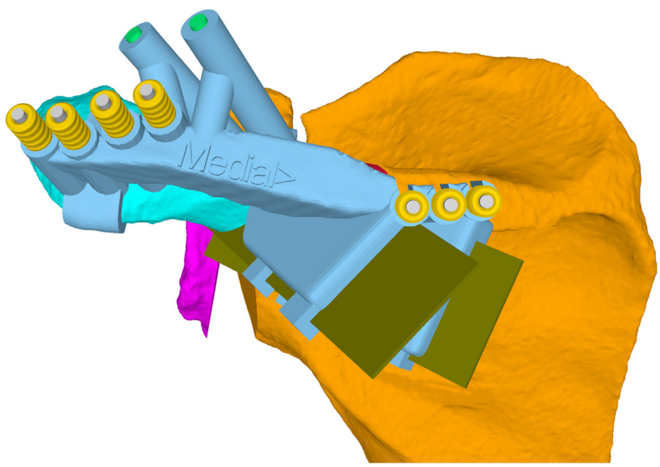

Figure 3 A personalized, 3D planned cutting guide (*light blue*) is precisely adapted to acromion and scapular spine and fixed with 2.5-mm terminally threaded K-wires (*yellow entry holes*). The preplanned cuts are executed with a .9-mm sawblade (*dark green*) through the slots identifying the planned position and orientation of the acromial osteotomy. The gliding holes are drilled with a 3.5-mm drill bit (*light green*) to the planned length form acromial surface to osteotomy.

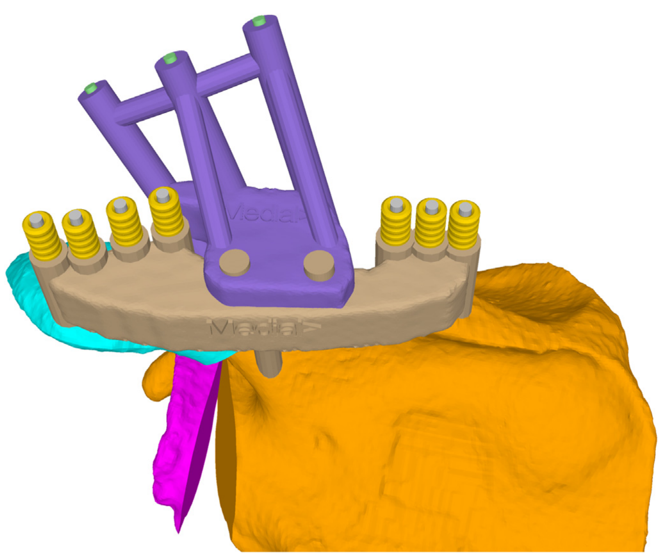

Figure 4 The cutting guide is removed, and the reduction guide (*light brown*) is mounted over the K-wires bringing the acromion into the desired position. Usually, 2 2.8-mm holes are drilled through the *purple* drill guide passing through the gliding holes into the scapular spine. The *purple* drill guide is removed, the osteotomy is fixed, and the reduction guide is removed. If the acromial fragment is thin, a 3 hole plate can be used as a washer to prevent pulling out of the fragment over the screw heads.

the coracoacromial ligament through a separate anterior incision allowed inferolateral translation, distalization, and posterior tilt of the lateral fragment. Personalized reduction guides allowed acromion fixation with 3.5-mm lag screws through the osteotomy and into the scapular spine (Fig. 4). For the first 6 cases, a 3.5-mm clavicle plate was added to increase stability. Thereafter, only 2 lag screws were used. The bony wedge created by the biplanar osteotomy served as a graft in the glenoid osteotomy. It was shaped intraoperatively to match the planned correction. Custom cutting guides were used to assist in preparing the bone graft to the appropriate dimensions. It was squeezed into the gap without further fixation. The joint capsule was closed but the labrum remained untouched whether there was a labral lesion or not.

Postoperatively, the arm was protected in neutral rotation for 6 weeks. Sports activities were permitted at 6 months.

Clinical outcome parameters

Standardized clinical examination was performed preoperatively and 6 weeks, 3 and 6 months, 1 and 2 years postoperatively. Passive and active ranges of motion were documented with a goniometer. Preoperatively and at follow-ups, the absolute Constant Scores and relative Constant Scores (rCS) and the subjective shoulder value (SSV) were measured (Table I). In addition, active range of motion was photo- and video-documented. Patient-reported shoulder scores were the SSV,[19] with 100% representing a normal shoulder and a minimum clinically important difference (MCID) of 12%,[14] and the Constant pain scale score, with 15 points representing no pain and an MCID of 1.5 points.[29] Subjective stability was assessed through direct patient questioning during follow-up. Specifically, patients were asked whether their shoulder felt stable, whether they continued to experience the sensation of subluxation or dislocation, and whether they felt confident using the shoulder in positions that had previously provoked instability—particularly flexion combined with internal rotation. Complications and reoperations were documented.

Radiological outcome parameters

All patients underwent standardized radiographs and CTs preoperatively and 2 years postoperatively (Figs. 5 and 6). Preoperative and postoperative glenoid retroversion, inclination, PAC, SAT, and PAH were measured on 3D segmented CTs[6] (Tables II and III). For the PAH ratio (relative PAH) the absolute distances were divided by the maximum glenoid length to account for size differences between individuals.

Preoperative and postoperative HH subluxation was assessed on reoriented axial CT images using the GHSI and SHSI[34] (Table I).

Preoperative glenoid morphology,[44] revealed posterior glenoid cartilage erosion (type B1 glenoid) in 4/9 patients. Anteroposterior radiographs were evaluated for grade and progression of dislocation arthropathy.[40] Preoperative OA was mild in 5, moderate in 1, and absent in 3 patients (Supplementary Table S1).

Statistical analysis

Values are presented as median (range), due to the small sample size. Differences were assessed using the Wilcoxon matched-pair signed rank test. The alpha risk was set to 5% ($\alpha = 0.05$). Statistical analysis was performed with GraphPad Prism (version 10.2.3) (GraphPad Software, Boston, MA, USA).

Results

Patient characteristics

All patients had a minimum 2-year follow-up (mean follow-up 29 months [±8]). The mean age at surgery was 37 years (±9.3; 23-47). Except for one, all patients reported a traumatic onset of shoulder problems, either due to repetitive loading of the shoulder in flexion/internal rotation (bench presses, n = 1) or a specific event with possible posterior subluxation (n = 5) or dislocation (n = 3). In 6 patients, the operation was a revision: 5 had undergone a failed arthroscopic posterior Bankart and one an arthroscopic anteroinferior stabilization and subscapularis repair. One had further undergone an arthroscopic revision capsulolabral repair and one an open posterior iliac crest bone block augmentation.

Table I
Clinical and radiological outcome preoperatively and postoperatively, excluding the patient in which implementation of acromial correction failed (n = 8; f-up: 29 mo [23-47]).

	Preoperative		Postoperative		Difference		
	Median	Range	Median	Range	Δ	Range	*P* value
Clinical outcome							
aCS (pts)	54.0	28-86	81.0	50-94	18.0	−6; 44	**.016**
rCS (%)	56.5	32-91	84.5	53-100	18.0	−6; 43	**.016**
SSV (%)	40.0	20-75	87.5	50-100	42.5	25; 75	**.008**
Pain (pts)°	9.0	4-13	15.0	8-15	3.5	2; 9	**.008**
Radiological outcome*							
SHSI (%)	70.0	62-80	59.0	50-67	−10.0	−22; −6	**.012**
GHSI (%)°	61.5	56-66	53.0	49-59	−7.0	−16; −1	.125

Δ, absolute difference; *aCS*, absolute Constant score; *rCS*, relative Constant score; *SSV*, subjective shoulder value; *SHSI*, scapulohumeral subluxation index; *GHSI*, glenohumeral subluxation index.
Statistically significant differences are indicated in bold.
*Static and combined (type C) instabilities (n = 7).

One patient had a slowly progressive neurological disease with trouble of coordination, which could not be diagnosed by repeated neurological investigations performed at our university.

Complications and reoperations

There was one failure in the patient with the neurological disorder. In this patient, although the correction was correctly planned, we were unable to achieve the desired correction intraoperatively because the lateral fragment had insufficient mobility for adequate posterior and lateral translation, as during the early stages of our experience with this procedure, we did not yet routinely release the AC and coraco-acromial ligaments to fully mobilize the lateral acromial fragment. The postoperative CT showed essentially no change compared to preoperatively. Postoperatively, static and dynamic PSI persisted. OA progressed rapidly from grade 0 to 1, and the clinical and radiological result was poor (ΔrCS −29pts, ΔSSV −15%, Δpain −1pts; ΔSHSI +9%, ΔGHSI +4%).

In another patient the clinical assessment remained initially fair due to persistent pain (ΔrCS −6pts, ΔSSV 0%), despite an objectively stable GHJ, radiologically correct realization of the planned osteotomies, and improvement of posterior subluxation (ΔSHSI −11%, ΔGHSI −4%) at the 2-year follow-up. CT revealed a partial nonunion. A revision was planned but the revising surgeon, who is not involved in the study, reported a healed osteotomy after the plate removal. Postoperatively, the clinical symptoms remained unchanged, prompting an magnetic resonance imaging which showed a pathological long biceps tendon. Subsequently, an ultrasound-guided bicipital groove injection was performed, after which he reported complete pain relief and a SSV of 85% (ΔSSV 35%), 3 years postoperatively.

In a third patient, the plate was removed 1.5 years postoperatively due to local pain.

Clinical outcome

At the final follow-up, the median SSV, absolute CS, rCS, and pain scores had significantly improved with median differences of 42.5% ($P = .008$), 18 points ($P = .016$), 18% ($P = .016$) and 3.5 points ($P = .008$). respectively. Six patients graded their result as excellent, 2 as good, and one as poor. No patient had subjective residual instability, but one patient had a positive jerk test. The MCIDs were achieved in all but one patient (see complications).

Radiological outcome

There was no OA progression in 8/9 patients. According to the SHSI cutoff values, preoperatively, the HH was posteriorly decentered in 7/9 patients; the remaining 2 dynamic instabilities had centered HHs. The SHSI was ≥61% in 7/7 patients and GHSI was ≥55% in 4/7. In 5/7 patients with the pathological SHSI, the HH was recentered (Fig. 6), whereas it improved but remained ≥61% in 2 patients. In 2/4 patients with the pathological GHSI, the HH was recentered, whereas it improved but remained ≥55% in the other 2 patients (Table I).

There were significant radiological changes comparing preoperative with postoperative measurements (Table III): median glenoid retroversion and inclination decreased significantly ($P = .016$ for both comparisons). The planned glenoid correction was achieved (planned vs. postoperative: $P = .156$ for retroversion; $P = .921$ for inclination). In terms of acromial morphology, SAT was significantly reduced ($P = .0156$). PAC increased ($P = .156$) and relative PAH significantly decreased ($P = .0156$). However, the comparison between planned and achieved acromial parameters showed relevant differences (SAT: Δ-6.3° (−10;7), $P = .219$; PAC: Δ10.1° (−9;21), $P = .08$ and relative PAH: Δ-0.2 (−0.4;0.1), $P = .047$), indicating that those parameters were undercorrected.

Discussion

The key finding of this study is that static posterior HH subluxation can be effectively reversed, the GHJ can be recentered, and recurrence of dynamic PSI can be prevented by restoring physiological glenoacromial relationships without any soft tissue or labral surgery. To our knowledge, this is the first procedure demonstrating successful reversion of static PSI without significant glenohumeral OA progression and restoration of dynamic posterior stability for at least 2-years. It confirms previous biomechanical studies which showed restoration of stability in 3D printed and cadaveric shoulders.[23,24]

The procedure is new and has presented technical challenges. In one patient we technically failed to realize the planned correction. This surgical failure resulted in a full clinical failure. In the other cases of this preliminary series, we have accurately corrected the (often little deformed) glenoid, but for PAH and PAC, the obtained correction was clinically successful but smaller than planned. Specifically, from the beginning, we were able to tilt the acromion sufficiently but unable to bring it fully posteriorly, laterally, and inferiorly. In the cases following this preliminary report, which will be reported later, we have opened the AC-joint dividing the AC-ligaments. After the acromion osteotomy, the latter is flipped forward, so that its undersurface can be followed to the coracoacromial ligament insertion, which is then divided. These 2 additional steps release the acromion completely and allow for full anatomical correction leaving the anterior and anterolateral deltoid intact. It is interesting that, so far, none of these recent patients

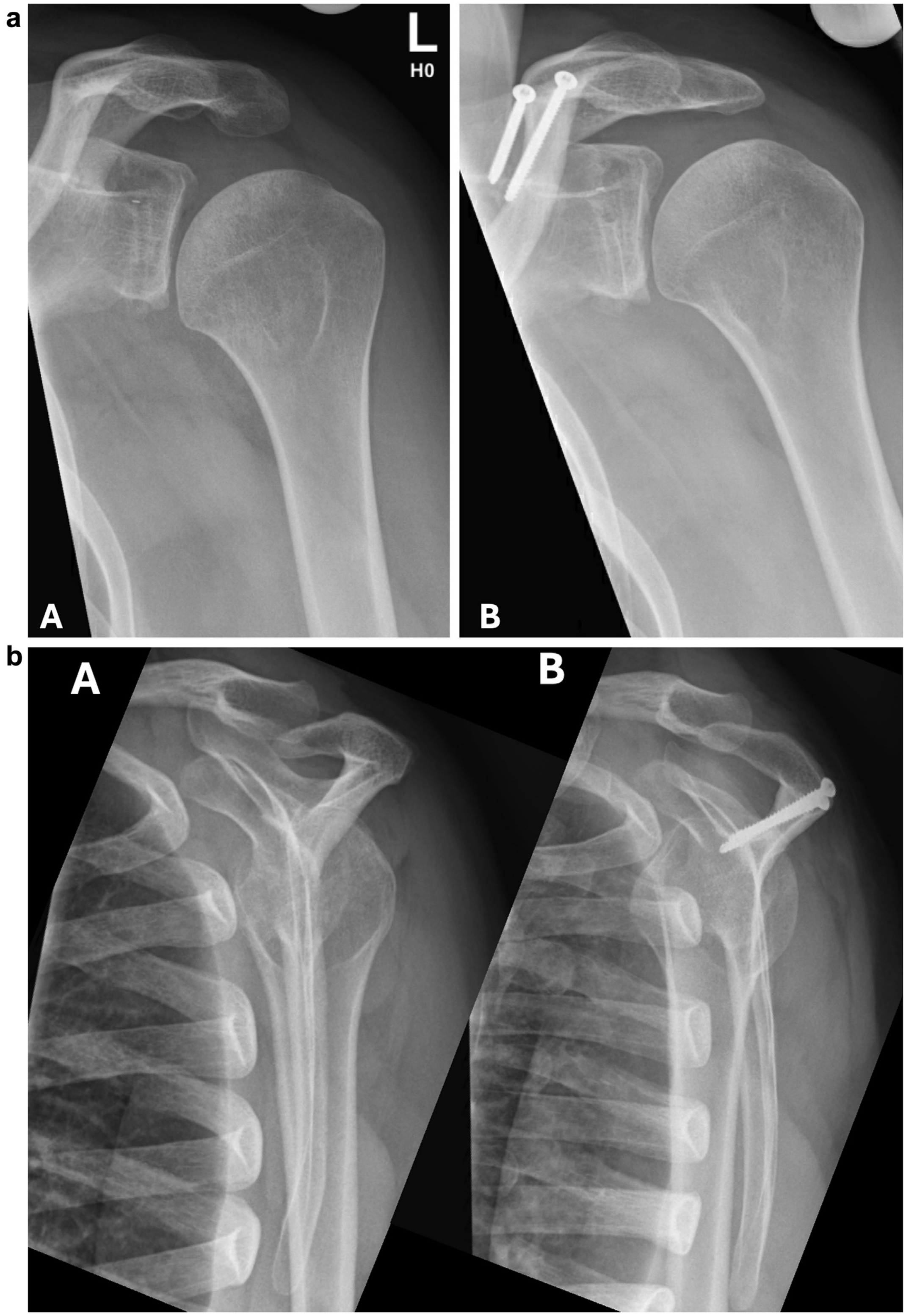

Figure 5 (**a**) Typical preoperative and final anteroposterior and (**b**) true lateral radiographs documenting change in shape and antero-posterior recentering of the humerus on the glenoid. (case #8) (**A**) Preoperative. (**B**) Final result..

complains of AC-pain or -instability. This is further observed but currently accepted with the gain of posterior stability and joint recentering.

We had one delayed union. As an acromial nonunion would potentially constitute a major problem in further arthroplasty, the authors are aware of the importance of restoring acromial integrity and stability. Historically, acromion osteotomies have been performed to treat subacromial impingement: Grammont[20] published results of 110 cases with nearly vertical osteotomies which he fixed with a screw and tension band wire. He reported 3 nonunions.

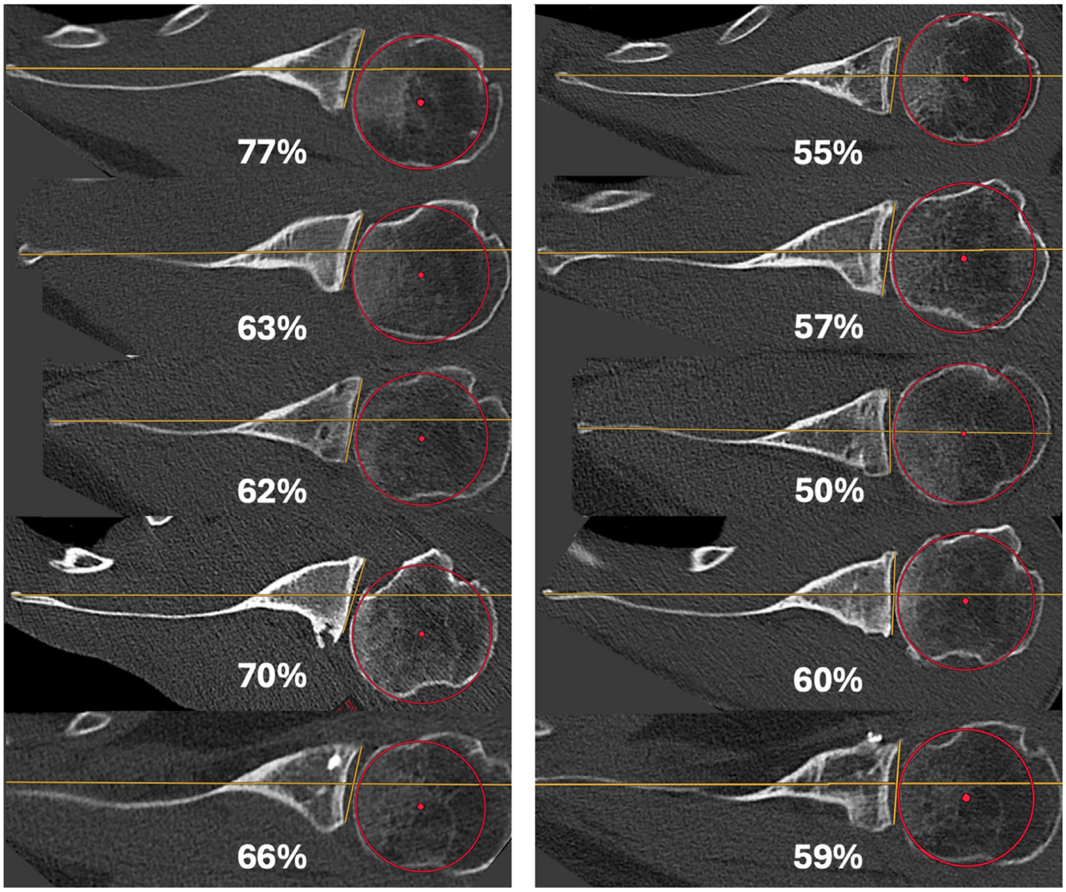

Figure 6 Preoperative and postoperative CTs of the recentered glenohumeral joints. Case 1 at 4 years and the other cases at 2 years. The scapulohumeral subluxation index is given at the bottom under each image. *CT*, computed tomography.

Table II
Preoperative and postoperative radiological analysis of glenoid parameters.

Radiological parameters	Median	Range
Glenoid retroversion		
Preoperative	12.8	2.7; 22.7
Postoperative	4.5	−1.4; 11.6
Planned	3.7	0.9; 6.8
SSM	5.2	
Glenoid inclination		
Preoperative	86.9	67.4; 89.8
Postoperative	81.7	64.2; 89.0
Planned	79.3	73.3; 91.0
SSM	83.1	

SSM, statistical shape model.

Table III
Preoperative and postoperative radiological analysis of acromial parameters.

Radiological parameters	Median	Range
Sagittal acromial tilt (°)		
Preoperative	78.0	63.7; 84.7
Postoperative	56.0	53.3; 70.3
SSM	56.5	
Planned	54.3	46.3; 68.6
Posterior acromial coverage (°)		
Preoperative	50.5	39.2; 57.7
Postoperative	54.5	42.4; 67.1
SSM	67.0	
Planned	66.3	57.7; 70.3
Posterior acromial height (mm)		
Preoperative	32.4	26.7; 41.1
Postoperative	24.5	17.5; 34.0
SSM	16.9 (0.0)	
Planned	18.1	12.8; 22.9
Relative posterior acromial height		
Preoperative	0.85	0.77; 1.2
Postoperative	0.71	0.46; 0.97
SSM	0.48 (0.0)	
Planned	0.51	0.38; 0.58

SSM, statistical shape model.

Thür[41] reported <1% nonunions in more than 300 patients in which lateral acromion osteotomies were performed for impingement. Thus, historically, there is good documentation of the healing potential of such an osteotomy and the 2 cutting guide inserted lag screws appear to give excellent fixation. Apart from that, we have not encountered any neurological problems with invariably normal suprascapular nerve function, or any other complications.

Various other surgical procedures have improved clinical symptoms, but none has consistently achieved durable reversal of *static* PSI or effectively halted OA progression over at least 2 years. Moroder[36] reported immediate postoperative improvement of static posterior subluxation after 14 posterior arthroscopic capsular shifts with invariable recurrence of the preoperative subluxation and progression of OA in 43% within 2 years. Neither Ortmaier[38] in a relatively short-term study of 10 opening wedge osteotomies nor Waltenspül[45] in a similar long-term study (15 years) could recenter the HH. Both authors observed OA progression. Ernstbrunner[15] followed 7 patients after glenoid opening wedge osteotomies with a J-graft for 2 years. Four of those 7 experienced OA progression, but 50% of the patients with prior static posterior subluxation had a better centered HH. Camenzind[11] reported on 17 patients with arthroscopic iliac crest bone grafting after a mean of 6.6 years. Forty-seven percent of the shoulders had OA progression. The HH was recentered in the new, substantially enlarged glenoid in 71% of cases. A recentering in the paleoglenoid, which would correspond to the usual definition of concentricity, however, is not documented. Thus, the current treatment options temporarily improve clinical symptoms but do not correct static PSI and may need to be considered palliative measures.[11,15,36,38,46]

In addition to the initial documentation of its systematic presence in PSI[6,32] an increased PAH and decreased PAC have recently been found to be significant risk factors for the failure of conservative treatment of dynamic PSI.[1,31] The acromial anthropometric measurements did not change over time as opposed to the posterior glenoid bone loss which increased with time of persistence, suggesting that the latter is mainly a result of recurrent instability and not a cause.[31]

Surgical correction of *dynamic* PSI is not associated with reliably satisfactory results. Long-term failure rates for the current procedures are actually prohibitive, reaching up to 35% for capsulolabral repairs[8,17,22,39,46] 73% for open posterior bone block procedures,[12,42] and up to 33% for glenoid osteotomies.[21,25,46] Revision posterior stabilization procedures yield results even inferior to the primary repairs.[7,15,27,35,42,46] Postoperatively, in this preliminary series, all patients were subjectively stable, only one had a positive jerk test; despite that, 6/8 had previously had unsuccessful stabilizations. It therefore seems justified to further study this treatment concept for dynamic PSI.

Given the similarities in scapular abnormalities in static and dynamic PSI,[6] precise correction of scapular anthropometric abnormalities may open new avenues for understanding and treating both forms of PSI. If, with the current findings, scapular correction is considered, it is particularly interesting, that static PSIs have a significantly smaller critical shoulder angle than dynamic ones.[6] As posterior opening wedge osteotomies alone lateralize the joint line, acromial lateralization relative to the joint line may be hypothesized to be a particularly important factor preventing OA acceleration.

Static posterior subluxation is also associated with acromial abnormalities and poorer outcome after total shoulder arthroplasty (TSA): As posterior subluxation is closely related to acromial abnormalities, “B glenoids” might better be called “B scapulae”. As acromial correction can improve concentricity of the joint, acromial correction may be worthwhile studying together with TSA. First casesa are under study.

In summary, based on systematic study of scapular anatomy in PSI[5,6,32,33] and biomechanical studies indicating that restoration of normal scapular morphology provides posterior GHJ stability,[23,24] we have designed and performed the SCOPE procedure to restore normal scapular anatomy.[18] Results at a minimum of 2 years are encouraging, document improvement of static subluxation and restoration of subjective and objective shoulder stability. Further studies to refine indications and the surgical technique are under way.

Conclusion

At a minimum of 2 years, successful correction of scapular anatomy can improve static subluxation and restore subjective and objective shoulder stability.

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.

Supplementary Material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jseint.2025.06.018.

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