Acceptable Long-Term Outcomes of Arthroscopic Bone Grafting for Recurrent Posterior Shoulder Instability: Minimum Follow-up of 5 Years

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Purpose: To examine the long-term clinical outcome associated with arthroscopically placed autologous iliac crest bone graft (ICBG) for recurrent posterior shoulder instability. **Methods:** From January 2008 to December 2013, patients treated with posterior ICBG and a minimum follow-up of 5 years were included. Clinical outcome of patients operated with a posterior ICBG was analyzed with multiple patient-reported outcome measures included Constant (CS), American Shoulder and Elbow Surgeons (ASES), Walch—Duplay, and Rowe scores, shoulder subjective value, and pain visual analog score. Patient satisfaction was assessed by asking the patients their overall level of satisfaction at last follow-up on a 1 to 10 scale. **Results:** In total, 18 patients (19 shoulders) were included. At a mean follow-up of 7.3 years (range, 5-10 years), patients had significant improvements in their mean CS from 63 (standard deviation [SD] 18) to 80 (SD 18; $P = .005$), ASES from 57 (SD 18) to 81 (SD 18; $P = .003$), Walch—Duplay from 34 (SD 31) to 79 (SD 22; $P < .001$), and Rowe score from 37 (SD 23) to 79 (SD 24; $P < .001$). Pain level decreased from 5.6 (SD 2.5) preoperative to 2.3 (SD 2.3; $P < .001$) and shoulder subjective value improved 58 (SD 20) to 76 (SD 24; $P = .002$). Global satisfaction with the procedure was 8.4 (SD 2.1). Clinical significance was met or exceeded by 84% for CS and 89% of the patients for ASES and 95% met or exceeded satisfaction threshold for CS. There were 7 shoulders (37%) reoperated for symptomatic screw irritation. **Conclusions:** This series reporting on the long-term follow-up after arthroscopic posterior ICBG for recurrent posterior shoulder instability demonstrates, despite a high number of reoperations for symptomatic screw irritation, its effectiveness with acceptable clinical outcomes and satisfied patients. **Level of Evidence:** IV, therapeutic case series.

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Posterior instability remains a poorly understood pathology, with a broad range of presenting symptoms from subtle subluxations to recurrent dislocations.[1,2] Patients may have undefined and vague symptoms, such as posterior shoulder discomfort, pain, inability to participate in their respective sport, and repeated subluxation events.[3-5] Although posterior instability represents less than 10% of all shoulder instabilities, there is a relatively high percentage of these presenting with glenoid bone loss or retroversion.[2,3,6-8] Given this high incidence of bone loss, combined with the posterior capsule being thinner than the anterior capsule, the treatment of posterior glenohumeral instability is a challenging problem. In addition to the low incidence of posterior instability, the vast majority of the instability literature focuses on anterior instability, leading surgeons to extrapolate concepts in anterior to posterior instability. However, the anatomy and destabilizing forces associated with posterior instability are quite different than anterior instability. Furthermore, the treatment of recurrent posterior

instability is particularly challenging, as many patients are high demand with compromised bony and soft-tissue stabilizers.

After failure of nonoperative measures, patients who present with recurrent posterior shoulder instability are left with 2 primary surgical options, either soft-tissue or bony stabilization. Soft-tissue procedures may include arthroscopic capsulorrhaphy and/or labral repair, whereas bony procedures include glenoid osteotomy or posterior bone block procedures. However, there remains a paucity of studies examining large cohorts or long-term outcomes associated with these procedures. Particularly in high-demand patients or those who present with glenoid bone loss, where soft-tissue procedures are unlikely to achieve optimal stability, there remains a lack of investigations into the long-term outcomes of posterior bone grafting.

An arthroscopic technique for the placement of an iliac crest bone graft (ICBG) was introduced by Lafosse et al.[9] In this study, a group of high-demand patients achieved good short-term clinical outcomes at a mean follow-up of 20 months.[10] Despite this promising early success, there remains a lack of investigations into the long-term outcomes of this procedure. The purpose of this study was to examine the long-term clinical outcome associated with arthroscopically placed autologous ICBG for recurrent posterior shoulder instability. We hypothesized that patients treated with an arthroscopically placed ICBG for recurrent posterior shoulder instability would achieve acceptable clinical outcomes at long-term follow-up.

Methods

After institutional review board approval (Comité de Protection des Personnes Lyon SUD-EST IV, L19-003), a retrospective review was performed on all patients who were treated for recurrent posterior shoulder instability with an arthroscopic posterior ICBG procedure from January 1, 2008, to December 31, 2013, with a minimum of 5 years of follow-up. Patients were excluded if they had concurrent procedures or clinical follow-up of less than 5 years. Specific indication for surgery is recurrent posterior shoulder instability due to glenoid dysplasia, posterior glenoid bone loss or irreparable soft-tissue defect, and in case of revision for persistent instability in patients after failed posterior Bankart repair.

Surgical Technique

A modified technique from that previously described was used,[9] one that was designed to improve bone healing and avoid prominent screw heads in the posterior soft tissue. For the iliac crest graft harvesting, the patient is positioned in a lazy beach chair (approximately 45° of inclination). After harvest the inclination is then increased to 70° for the posterior bone graft procedure. The mono-cortical graft is harvested from the anterior iliac crest just lateral to the anterior superior iliac spine. After exposure, two 3.2-mm holes are drilled into the iliac crest using a cannulated drill and guide (DePuy Synthes, Oberdorf, Switzerland). The holes are then tapped and 2 "top hat" washers (DePuy Synthes) are placed in the outer cortex. We prefer 2 holes along the long axis of the graft, just medial to midline, to avoid any possible prominent screws. Of note, only the outer portion of the iliac crest is harvested as the internal side is left intact. After harvesting, the graft with an approximate size of $2.5 \times 1.5 \times 1.5$ cm is attached to the cannula.

Diagnostic arthroscopy from the anterior portal focuses on examining the extent of posterior glenoid bone loss (Fig 1A) and assessing for the presence of a reverse Hill−Sachs lesion. Throughout the majority of the procedure, the anterosuperior portal is the main viewing portal and the working portals are posterior and posterolateral. After the diagnostic arthroscopy, any remnant labral lesions from the posterior glenoid neck are mobilized, enabling visualization of the muscle fibers of the infraspinatus. The posterior glenoid surface is then abraded with an arthroscopic burr or rasp until you can see bleeding cancellous bone (Fig 1B).

To enable future graft passage through the cannula, the posterior portal is then enlarged. It is important also to use a scalpel to enlarge the muscle split and capsulotomy as well, visualizing arthroscopically. The graft is then positioned on the posterior glenoid neck flush with the articular surface (Fig 1C). Ideally, the graft should be flush with the subchondral bone, just under the level of the cartilage surface. Two K-wires are then placed through cannulated drill holes into the glenoid. During this step, it is critical to hold the cannula and graft parallel to the glenoid surface. It is also important not to advance the K-wires too far anteriorly (<40 mm) to avoid damage of anterior neurovascular structures. Next, a 3.5 mm partially threaded screw is drilled inferiorly, measured, and placed. The superior one is then drilled and placed after the inferior one has been secured. The screws are usually about 32 to 36 mm in length. The k-wires are then removed, and the graft prominence is ultimately analyzed arthroscopically (Fig 1D). Graft position can be assessed with a switching stick inserted from the anterior portal. We do not routinely reattach the posterior labrum and instead let it heal spontaneously on top of the graft.

Postoperatively, all patients are immobilized on an abduction pillow with 20° abduction and neutral rotation for the first 6 weeks. Passive range of motion exercises are allowed to start immediately after surgery, whereas active range of motion can be started after 3 weeks postoperatively. Strengthening of the shoulder girdle muscles, as well as active internal rotation, are allowed after clinical and radiographic follow-up examination 6 weeks after surgery.

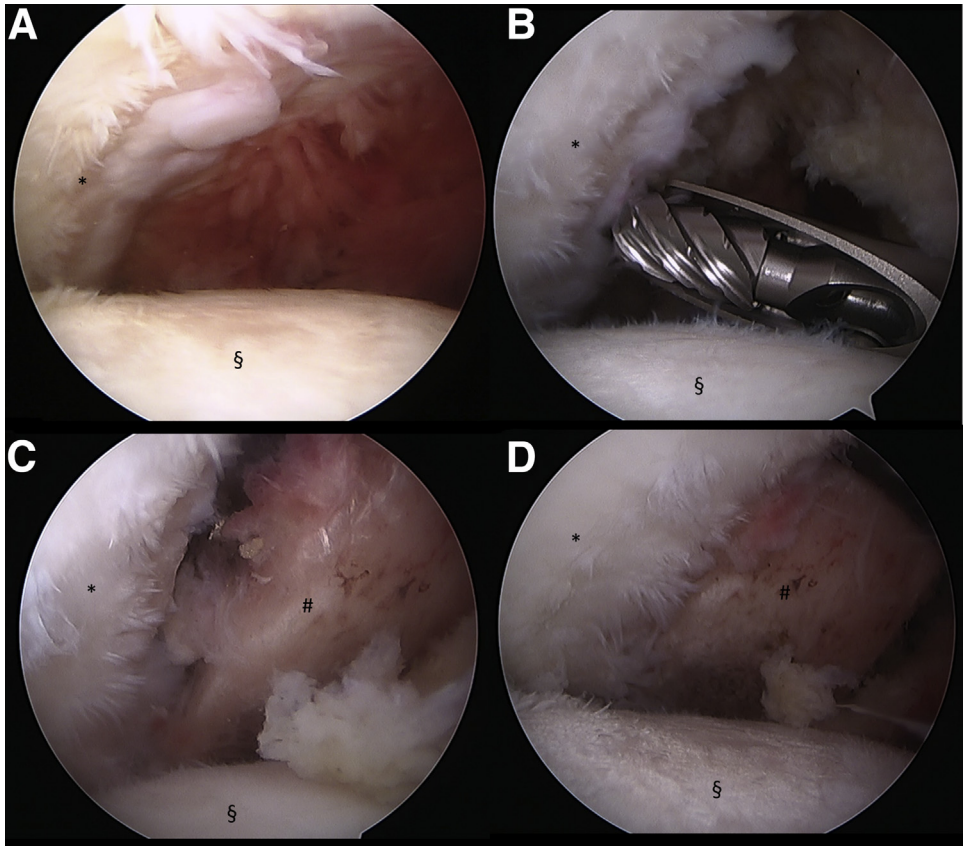

Fig 1. Intraoperative arthroscopic view from the anterolateral portal showing (A) posterior glenoid bone loss (*) and humeral head (§) of a left shoulder. (B) The posterior glenoid surface is prepared with an arthroscopic burr. (C) The bone graft (#) is passed through the posterior portal and positioned flush to the articular surface. (D) Graft position is controlled after fixating it with 2 screws to avoid prominence.

Clinical Outcomes

We analyzed multiple parameters, including demographics, comorbidities, number of previous dislocations and etiology of dislocations, occupation and sports participation, and history of smoking. The patient's clinical and radiographic outcomes were analyzed, as well as any complications or reoperations. Osteoarthritis was graded primary radiographically. If there was no inferior osteophyte on the radiograph, the arthroscopic finding (cartilage damage) was added to the analysis. The clinical outcome measures included shoulder motion, Walch–Duplay Score,[11] Rowe Score,[12] Constant Score,[13] American Shoulder and Elbow Surgeons Score (ASES) score,[14] shoulder subjective value (SSV),[15,16] pain visual analog score, and patient satisfaction. Patient satisfaction was assessed by asking the patients their overall level of satisfaction at last follow-up on a 1 to 10 scale. Furthermore, postoperative physical examination findings included posterior apprehension and relocation. All patients underwent a postoperative computed tomography scan to confirm healing.

Statistical Analysis

Statistical analysis included descriptive statistics were performed for all outcome measures. Comparisons between categorical variables were performed using a Fisher exact test, whereas categorical and continuous variables with normal distribution were compared using an unpaired Student *t* test with unequal variances. Statistical significance was considered if the *P* value was $<.05$. Clinical significance was analyzed using minimal clinically important difference for Constant and ASES score and patient acceptable symptom state for Constant score.[17] The statistical analyses were computed using SPSS, version 23 (SPSS Inc., Chicago, IL).

Results

During the study period, 31 patients were treated with an arthroscopic ICBG with a follow-up greater than 5 years. Ultimately, the study included 19 shoulders in 18 patients (follow-up rate 61%), including 13 on the right and 6 on the left side. There were 2 female patients and 16 male patients, with 1 male patient undergoing bilateral procedures with 11 months between them. The mean age was 33.9 years (range, 22-68). There were 9 (47%) shoulders that had previous surgeries, including posterior Bankart procedure (n = 5), Latarjet (n = 2), 1 arthroscopic SLAP repair, and suprascapular nerve release and radial motor branch to

axillary nerve transfer for axillary nerve palsy after a previous shoulder dislocation. The etiologies of the initial and recurrent dislocations included traumatic 11 (58%), dysplastic with retroversion >15° in 2 shoulders (11%), hyperlaxity in 2 shoulders (11%), Ehler–Danlos syndrome in 1 shoulder, and unknown in 4 (21%) (Table 1). Surgery duration was about 90 minutes, and duration of the hospital stay was 2 days.

At a mean follow-up of 7.3 years (range, 5 to 10), patients had significant improvements in their Constant, ASES, Walch–Duplay, Rowe, pain level, SSV, and satisfaction scores (Table 2). Clinical significance measured with minimal clinically important difference for Constant (10.4) and ASES score (6.4) was met or exceeded by 84% and 89% of the patients and 95% met or exceeded satisfaction threshold for Constant score (44).

Patients with previously existing glenohumeral cartilage lesions (n = 7) had significantly inferior clinical scores compared with patients with no signs of glenohumeral cartilage lesions preoperatively (Table 3). In every patient with moderate osteoarthritis (grade 2) preoperatively, the arthritis evolved to severe (grade 3) at last follow-up. However, none of them had to be converted into a shoulder arthroplasty.

Of note, there was no statistically significant difference between patients with traumatic posterior bone loss and dysplastic glenoids (>15° retroversion) regarding the final clinical outcomes

Overall, there were no patients who experienced an acute complication that needed immediate revision surgery. No problems with donor-site morbidity were reported in this cohort. At final follow-up, 4 patients continued to have posterior apprehension findings, including the patient with the previous axillary nerve palsy and nerve transfer. None of them had a posterior dislocation of the shoulder. There were 7 shoulders (37%) reoperated for symptomatic screw irritation. In all cases, the screws had to be removed because they became predominant and provoked a painful activation of the infraspinatus muscle. The mean time to removal of hardware was 13 months (range, 3-33 months) postoperatively. Of note, the patient with Ehlers–Danlos syndrome did well, with a visual analog score of 4, SSV of 75, ASES of 70, Constant score of 86, and return to sport without apprehension with a Rowe score of 100 and Walch–Duplay score of 100.

Radiographic analysis demonstrated complete bony healing by computed tomography control done at a mean 7 months postoperatively. There were all grafts with partial resorption, whereas no grafts showed signs of complete osteolysis or resorption at final follow-up (Fig 2).

Table 1. Patient Demographic Data

n	19
Age, y	34 (13)
Side, right/left	13/6
Sex, female/male	2/17
Follow-up, y	7.3 (1.3)
Previous surgery	9 (47%)
Traumatic	11 (58%)
Dislocation	10 (53%)
Subluxation	14 (74%)
Dysplastic glenoid	2 (11%)

NOTE. Data are presented as N or mean (standard deviation).

Table 2. Clinical Long-Term Outcome (n = 19)

	Preoperative	Postoperative	*P* Value
Constant score	63 (18)	80 (18)	.005
ASES score	57 (18)	81 (18)	.003
Walch–Duplay	34 (31)	79 (22)	<.001
Rowe	37 (23)	79 (24)	<.001
VAS pain	5.6 (2.5)	2.3 (2.3)	<.001
SSV	58 (20)	76 (24)	.002
Satisfaction		8.4 (2.1)	

NOTE. Data are presented as mean (standard deviation).

ASES, American Shoulder and Elbow Surgeons; SSV, subjective shoulder value; VAS, visual analog scale.

Discussion

In this series of 19 shoulders treated with arthroscopic posterior bone blocks, patients experienced improvements in their clinical outcomes by a mean follow-up of over 7 years. The treatment of recurrent posterior instability in a high-demand patient or those with glenoid bone loss remains controversial. Although nonoperative management should be the initial treatment, it has a greater risk of recurrent instability than operative management.[18] In the setting of minimal or no bone loss, particularly in lower-demand individuals, arthroscopic capsulorrhaphy and labral repair is a reasonable and efficacious treatment.[4,8,19-22] However, in greater-demand patients or those with posterior bone loss, soft-tissue stabilization is at increased risk of failure and often bony stabilization is potentially preferred.[19,23-25] Although there are series with short-term follow-up of arthroscopic bone blocks to treat recurrent posterior instability,[9] there are no long-term studies of this treatment. Therefore, the purpose of this study was to examine the long-term (minimum 5-year follow-up) outcomes of arthroscopic posterior bone block procedures to treat recurrent shoulder instability

Most patients in this series obtained reliable stability of their shoulders, with only 1 patient requiring a revision procedure for recurrent instability. It should be noted that 37% of patients required arthroscopic screw removal at a mean 13 months' follow-up. There were no cases of nonunion. Given this challenging patient

Table 3. Comparison of Clinical Outcome Between Patients With and Without Preoperative OA

	With OA (n = 7)	Without OA OA (n = 12)	*P* Value
Constant score	71 (17)	86 (17)	.0424
ASES	69 (19)	88 (13)	.0258
Walch–Duplay	68 (14)	85 (23)	.0179
Rowe	69 (17)	85 (25)	.0335
VAS pain	3.6 (2.3)	1.5 (1.9)	.0533
SSV	61 (23)	85 (19)	.031
Satisfaction	6.9 (2.2)	9.3 (1.5)	.0118

NOTE. Data are presented as mean (standard deviation).

ASES, American Shoulder and Elbow Surgeons; OA, osteoarthritis; SSV, subjective shoulder value; VAS, visual analog scale.

cohort, these results demonstrate that arthroscopic posterior bone block procedure is a reasonable but technically demanding option. To increase the surface of the contact area with the glenoid, we changed the technique of iliac crest harvesting. We anticipate having the large medial side of the iliac crest toward the glenoid instead of the narrower side between the medial and lateral cortex. This means that we changed 90° by drilling now the holes from lateral to medial cortex. We suppose that this will decrease the amount of bone resorption and the need for screw removal.

For patients with unilateral posterior shoulder instability, arthroscopic capsulolabral reconstruction is an effective treatment, with more than 90% returning to sports and a 5% to 8% recurrent instability rate in most series with short-term follow-up.[4,8,19-22,26] However, a multicenter study in 2017 by Andrieu et al.[25] demonstrated a 35% recurrence rate after posterior capsulolabral reconstruction in the retrospective cohort at a mean 4.8 years follow-up. Furthermore, there was a 22% recurrence rate in the same study's prospective cohort at a mean 1.1 years follow-up. Nonetheless, 92% of patients returned to work and 80% of athletes returned to their preinjury level of sports. This and other studies have helped our field to understand the importance of separating patients with bone loss in the setting of recurrent instability and its associated high rate of failure after soft tissue procedures.

Posterior glenoid bone loss and glenoid retroversion appear to be associated with an increased risk of recurrent instability. In a biomechanical study, the humeral head posterior subluxation was directly associated with increasing glenoid retroversion.[27] One study demonstrated that the risk of recurrent posterior instability increases by 17% for every 1° increase of glenoid retroversion.[28] Unlike anterior shoulder instability,[29-32] the exact amount of bone loss or retroversion associated with increased rates of failure after soft-tissue procedures has yet to be studied in posterior shoulder instability. Nonetheless, when extensive bone loss is present, most surgeons prefer to reconstruct the glenoid with a posterior glenoid bone graft.

There are many techniques and graft choices when performing a posterior glenoid bone graft, including humeral head allograft,[33,34] femoral head allograft,[35] distal tibial allograft,[36] acromial pediculated bone block,[37] and iliac crest autograft.[9,24,38-43] Although a recent systematic review pointed out the paucity of high-quality studies examining the outcomes of these procedures, they concluded that bone grafting regardless of source is a reliable option that leads to predictable improvements in clinical outcomes. In one of the largest studies to date, Clavert et al.[24] examined using an open bone grafting technique in 66 patients with a mean follow-up of 3.7 years. The Constant score improved to 76 points, whereas the postoperative Walch–Duplay and Rowe scores were 81.5 and 86.5, respectively. In one of the longest studies to date, Sirveau et al.[43] reported on 9 patients at a mean 13.5 years follow-up after open posterior bone grafting for recurrent posterior instability in the setting of bone loss. Although 4 patients required screw removal, the postoperative Walch–Duplay and Constant scores were 78 and 88, respectively. In another series of 21 open posterior bone block procedures, at a mean follow-up of 6 years, patients had improved clinical outcomes in all but 3, including 1 with a recurrent posterior dislocation and 2 with substantial posterior apprehension.[38] These clinical outcomes in the open procedure are comparable with the outcomes seen in our arthroscopic posterior bone block at a mean 7 years follow-up.

The arthroscopic posterior bone graft procedure has been a recent innovation in shoulder surgery. The first study to report on it included a study by Schwartz et al.[10] of 19 arthroscopic posterior bone graft procedures in 2013. At a mean follow-up of 10 months, the Rowe score improved from 18.4 to 82.1 points, and the Walch–Duplay score improved from 37.4 points to 82.9 points. Subsequently, Wellman et al.[44] reported on 24 shoulders treated with an arthroscopic posterior bone block and capsular reconstruction. At a mean 26 months follow-up, the recurrence rate was 12.5%, with an improvement in the Rowe score from 50 points to 75 points. Our series confirms these early short-term promising findings, demonstrating that arthroscopic posterior bone grafting is a reliable procedure with low rates of recurrent instability and high rates of clinical improvement at long-term follow-up.

There are certain circumstances in which the surgeon should pay special consideration when evaluating and potentially surgically managing the patient's recurrent posterior shoulder instability. Patients who have previous brachial plexus or axillary nerve injuries are very challenging to treat, given their deficient dynamic shoulder stabilizers. Similar to the patient in our series, a posterior bone block is potentially not enough to overcome the lack of dynamic stabilizing musculature. Furthermore, patients with Ehlers–Danlos syndrome or severe

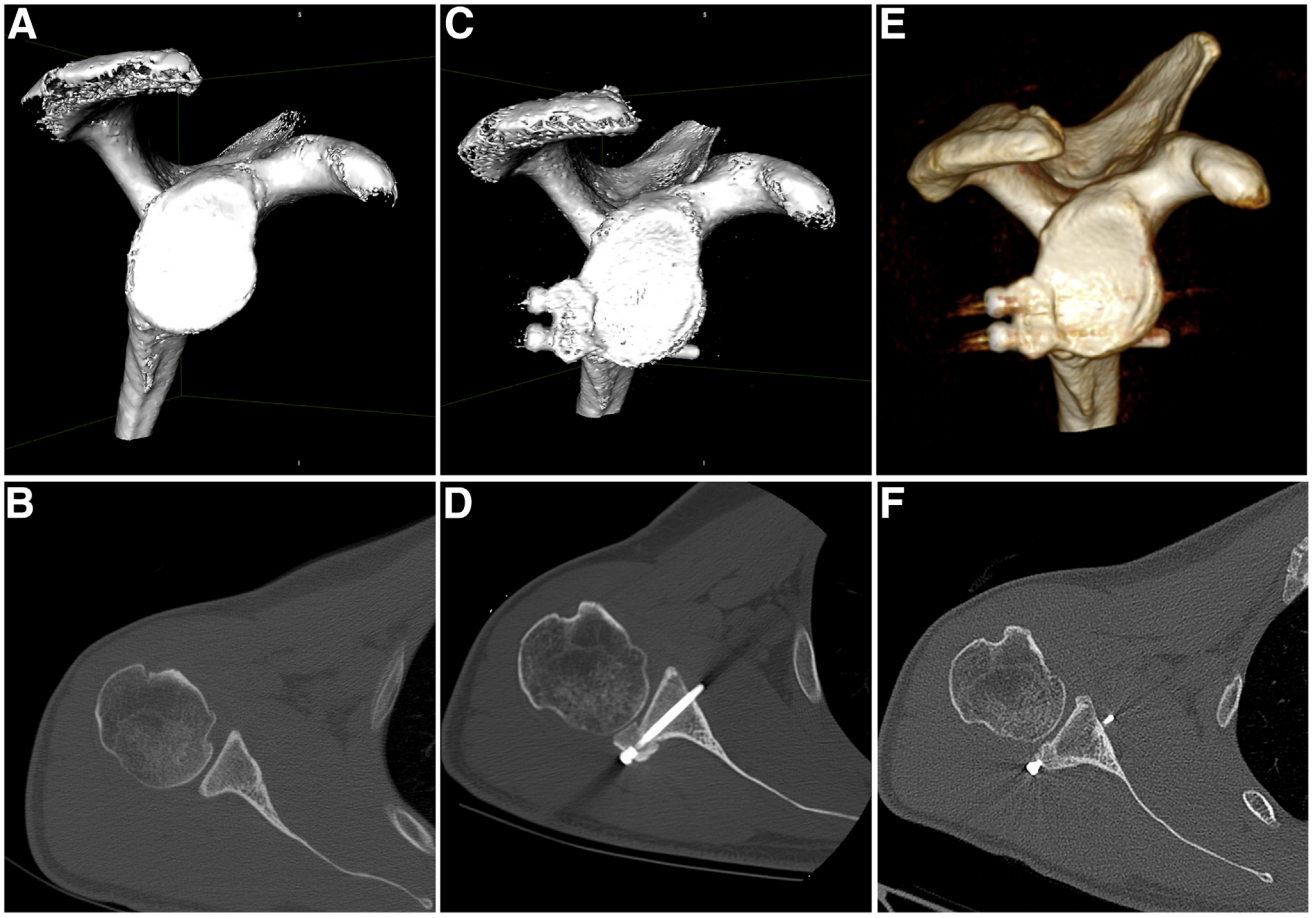

Fig 2. CT scan of a right shoulder with 3D-CT reconstruction of the scapula (A, C, E) and axial images (B, D, F) of the (A, B) preoperative state, (C, D) 3 months postoperative, and (E, F) at the final follow-up 94 months postoperatively showing complete integration of the iliac crest bone graft and slight remodeling. (3D, 3-dimenstional; CT, computed tomography.)

hyperlaxity represent a very challenging patient cohort. Given their significant lack of soft-tissue stabilizers, there is a high rate of failure when attempting soft-tissue stabilization procedures. In addition, although they are at risk of failing any bony procedures, as demonstrated by the patient in our series, arthroscopic posterior bone block is a reasonable option for these patients. In our study, neither retroversion nor glenoid dysplasia influenced clinical outcome. This finding is in accordance with a recent study of patients treated with an arthroscopic posterior labral repair for posterior shoulder instability.[45] In contrary, in our series the presence of glenoid cartilage lesions leads to inferior clinical results compared with patients without signs of cartilage damage. Two studies from the French Arthroscopy Society[46,47] confirmed that the only factor jeopardizing functional outcomes of posterior instability surgery was the presence of glenoid cartilage lesions.

Limitations

This study's conclusions should be taken in light of certain limitations. As a retrospective case series, it lacks the prospective data collection and any ability to compare to control groups. This limits our ability to compare this arthroscopic bony procedure to open bony techniques or arthroscopic soft-tissue techniques. In addition, the study was performed on a relatively small sample size but with long-term follow-up. This is in part due to the relatively low number of patients with posterior shoulder instability in high-demand patients or the setting of glenoid bone loss. This negates our ability to perform a power analysis and ultimately makes our study underpowered to examine different factors that might influence outcomes. Furthermore, the surgical indications for this cohort were very heterogeneous, limiting our ability to compare high numbers of specific pathologies. Given this is our senior author's (L.L.) preferred treatment method for these complex patients, this potentially is subject to confirmation bias. In addition, given the surgeries take place at a tertiary referral center, this study is subject to referral bias.

Conclusions

This series reporting on the long-term follow-up after arthroscopic posterior ICBG for recurrent posterior

shoulder instability demonstrates despite a high number of reoperations for symptomatic screw irritation its effectiveness with acceptable clinical outcomes and satisfied patients.

References

1. Hill NA, McLaughlin HL. Locked posterior dislocation simulating a "frozen shoulder." *J Trauma* 1963;3:225-234.
2. McLaughlin HL. Posterior dislocation of the shoulder. *J Bone Joint Surg Am* 1952;24:584-590.
3. Provencher MT, LeClere LE, King S, et al. Posterior instability of the shoulder: Diagnosis and management. *Am J Sports Med* 2011;39:874-886.
4. Bradley JP, McClincy MP, Arner JW, Tejwani SG. Arthroscopic capsulolabral reconstruction for posterior instability of the shoulder: A prospective study of 200 shoulders. *Am J Sports Med* 2013;41:2005-2014.
5. Van Tongel A, Karelse A, Berghs B, Verdonk R, De Wilde L. Posterior shoulder instability: Current concepts review. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1547-1553.
6. Kowalsky MS, Levine WN. Traumatic posterior glenohumeral dislocation: Classification, pathoanatomy, diagnosis, and treatment. *Orthop Clin North Am* 2008;39:519-533, viii.
7. Antoniou J, Duckworth DT, Harryman DT. Capsulolabral augmentation for the the management of posteroinferior instability of the shoulder. *J Bone Joint Surg Am* 2000;82:1220-1230.
8. DeLong JM, Jiang K, Bradley JP. Posterior Instability of the Shoulder. *Am J Sports Med* 2015;43:1805-1817.
9. Lafosse L, Franceschi G, Kordasiewicz B, Andrews WJ, Schwartz D. Arthroscopic posterior bone block: Surgical technique. *Musculoskelet Surg* 2012;96:205-212.
10. Schwartz DG, Goebel S, Piper K, Kordasiewicz B, Boyle S, Lafosse L. Arthroscopic posterior bone block augmentation in posterior shoulder instability. *J Shoulder Elbow Surg* 2013;22:1092-1101.
11. Walch G. The Walch-Duplay Score for instability of the shoulder. Directions for the use of the quotation of anterior instabilities of the shoulder. Presented at the Abstracts of the First Open Congress of the European Society of Surgery of the Shoulder and Elbow, Paris, 1987; 51-55.
12. Rowe CR, Patel D, Southmayd WW. The Bankart procedure: A long-term end-result study. *J Bone Joint Surg Am* 1978;60:1-16.
13. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. *Clin Orthop Relat Res* 1987;214:160-164.
14. Richards RR, An KN, Bigliani LU, et al. A standardized method for the assessment of shoulder function. *J shoulder Elbow Surg* 1994;3:347-352.
15. Fuchs B, Jost B, Gerber C. Posterior-inferior capsular shift for the treatment of recurrent, voluntary posterior subluxation of the shoulder. *J Bone Joint Surg Am* 2000;82:16-25.
16. Gilbart MK, Gerber C. Comparison of the subjective shoulder value and the Constant score. *J Shoulder Elbow Surg* 2007;16:717-721.
17. Harris JD, Brand JC, Cote MP, Faucett SC, Dhawan A. Research Pearls: The significance of statistics and perils of pooling. Part 1: Clinical versus statistical significance. *Arthroscopy* 2017;33:1102-1112.
18. Cruz-Ferreira E, Abadie P, Godenèche A, Mansat P, Clavert P, Flurin P. Posterior shoulder instability: Prospective non-randomised comparison of operative and non-operative treatment in 51 patients. *Orthop Traumatol Surg Res* 2017;103:S185-S188.
19. Leivadiotou D, Ahrens P. Arthroscopic treatment of posterior shoulder instability: A systematic review. *Arthroscopy* 2015;31:555-560.
20. Fronek J, Warren RF, Bowen M. Posterior subluxation of the glenohumeral joint. *J Bone Joint Surg Am* 1989;71:205-216.
21. Pennington WT, Sytsma MA, Gibbons DJ, et al. Arthroscopic posterior labral repair in athletes: Outcome analysis at 2-year follow-up. *Arthroscopy* 2010;26:1162-1171.
22. Wooten CJ, Krych AJ, Schleck CD, Hudgens JL, May JH, Dahm DL. Arthroscopic capsulolabral reconstruction for posterior shoulder instability in patients 18 years old or younger. *J Pediatr Orthop* 2015;35:462-466.
23. Cerciello S, Visonà E, Morris BJ, Corona K. Bone block procedures in posterior shoulder instability. *Knee Surg Sport Traumatol Arthrosc* 2016;24:604-611.
24. Clavert P, Furioli E, Andieu K, et al. Clinical outcomes of posterior bone block procedures for posterior shoulder instability: Multicenter retrospective study of 66 cases. *Orthop Traumatol Surg Res* 2017;103:S193-S197.
25. Andrieu K, Barth J, Saffarini M, Clavert P, Godenèche A, Mansat P. Outcomes of capsulolabral reconstruction for posterior shoulder instability. *Orthop Traumatol Surg Res* 2017;103:S189-S192.
26. Lenart BA, Sherman SL, Mall NA, Gochanour E, Twigg SL, Nicholson GP. Arthroscopic repair for posterior shoulder instability. *Arthroscopy* 2012;28:1337-1343.
27. Imhoff FB, Camenzind RS, Obopilwe E, et al. Glenoid retroversion is an important factor for humeral head centration and the biomechanics of posterior shoulder stability. *Knee Surg Sport Traumatol Arthrosc* 2019;27:3952-3961.
28. Owens BD, Campbell SE, Cameron KL. Risk factors for posterior shoulder instability in young athletes. *Am J Sports Med* 2013;41:2645-2649.
29. Burkhart SS, De Beer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: Significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. *Arthroscopy* 2000;16:677-694.
30. Tauber M, Resch H, Forstner R, Raffl M, Schauer J. Reasons for failure after surgical repair of anterior shoulder instability. *J Shoulder Elbow Surg* 13:279-285.
31. Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on anteroinferior stability of the shoulder after Bankart repair: A cadaveric study. *J Bone Joint Surg Am* 2000;82:35-46.

32. Gerber C, Nyffeler RW. Classification of glenohumeral joint instability. *Clin Orthop Relat Res* 2002;400:65-76.
33. Gerber C, Catanzaro S, Jundt-Ecker M, Farshad M. Long-term outcome of segmental reconstruction of the humeral head for the treatment of locked posterior dislocation of the shoulder. *J Shoulder Elbow Surg* 2014;23:1682-1690.
34. Martinez AA, Navarro E, Iglesias D, Domingo J, Calvo A, Carbonel I. Long-term follow-up of allograft reconstruction of segmental defects of the humeral head associated with posterior dislocation of the shoulder. *Injury* 2013;44:488-491.
35. Diklic ID, Ganic ZD, Blagojevic ZD, Nho SJ, Romeo AA. Treatment of locked chronic posterior dislocation of the shoulder by reconstruction of the defect in the humeral head with an allograft. *J Bone Joint Surg Br* 2010;92:71-76.
36. Gupta AK, Chalmers PN, Klosterman E, Harris JD, Provencher MT, Romeo AA. Arthroscopic distal tibial allograft augmentation for posterior shoulder instability with glenoid bone loss. *Arthrosc Tech* 2013;2:e405-e411.
37. Métais P, Grimberg J, Clavert P, et al. Posterior shoulder instability managed by arthroscopic acromial pediculated bone-block. Technique. *Orthop Traumatol Surg Res* 2017;103:S203-S206.
38. Servien E, Walch G, Cortes ZE, Edwards TB, O'Connor DP. Posterior bone block procedure for posterior shoulder instability. *Knee Surg Sport Traumatol Arthrosc* 2007;15:1130-1136.
39. Boileau P, Hardy MB, McClelland WB, Thélu CE, Schwartz DG. Arthroscopic posterior bone block procedure: A new technique using suture anchor fixation. *Arthrosc Tech* 2013;2:e473-e477.
40. Meuffels DE, Schuit H, van Biezen FC, Reijman M, Verhaar JAN. The posterior bone block procedure in posterior shoulder instability: A long-term follow-up study. *J Bone Joint Surg Br* 2010;92:651-655.
41. Gosens T, van Biezen FC, Verhaar JA. The bone block procedure in recurrent posterior shoulder instability. *Acta Orthop Belg* 2001;67:116-120.
42. Lévigne C, Garret J, Grosclaude S, Borel F, Walch G. Surgical technique arthroscopic posterior glenoidplasty for posterosuperior glenoid impingement in throwing athletes. *Clin Orthop Relat Res* 2012;470:1571-1578.
43. Sirveaux F, Leroux J, Roche O, Gosselin O, Gasperi M De. Traitement de l'instabilité postérieure de l'épaule par butée iliaque ou acromiale. *Rev Chir Orthop Reparatrice Appar Mot* 2004;90:411-419.
44. Wellmann M, Pastor MF, Ettinger M, Koester K, Smith T. Arthroscopic posterior bone block stabilization-early results of an effective procedure for the recurrent posterior instability. *Knee Surg Sport Traumatol Arthrosc* 2018;26:292-298.
45. Galvin JW, Morte DR, Grassbaugh JA, Parada SA, Burns SH, Eichinger JK. Arthroscopic treatment of posterior shoulder instability in patients with and without glenoid dysplasia: a comparative outcomes analysis. *J Shoulder Elbow Surg* 2017;26:2103-2109.
46. Nourissat G, Hardy MB, Garret J, Mansat P, Godenèche A. Glenoid cartilage lesions compromise outcomes of surgical treatment for posterior shoulder instability. *Orthop J Sport Med* 2020;8:1-7.
47. Garret J, Nourissat G, Hardy MB, et al. Painful posterior shoulder instability: Anticipating and preventing failure. A study in 25 patients. *Orthop Traumatol Surg Res* 2017;103:S199-S202.