Restoration of the Posterior Glenoid in Recurrent Posterior Shoulder Instability Using an Arthroscopically Placed Iliac Crest Bone Graft

A Computed Tomography–Based Analysis

Roland S. Camenzind,[*†‡] MD, Louis Gossing,[†§] MD, Javier Martin Becerra,[†||] MD, Lukas Ernstbrunner,[‡] MD, PhD, Julien Serane-Fresnel,[†¶] MD, and Laurent Lafosse,[†] MD

Investigation performed at the Alps Surgery Institute, Clinique Générale d'Annecy, Annecy, France

Background: Posterior shoulder instability is uncommon, and its treatment is a challenging problem. An arthroscopically assisted technique for posterior iliac crest bone grafting (ICBG) has shown promising short- and long-term clinical results. Changes as shown on imaging scans after posterior ICBG for posterior shoulder instability have not been investigated in the recent literature.

Purpose: To evaluate changes on computed tomography (CT) after arthroscopically assisted posterior ICBG and to assess clinical outcomes.

Study Design: Case series; Level of evidence, 4.

Methods: Patients with preoperative CT scans and at least 2 postoperative CT scans with a minimum follow-up of 2 years were included in the evaluation. Of 49 initial patients, 17 (follow-up rate, 35%) met the inclusion criteria and were available for follow-up. We measured the glenoid version angle and the glenohumeral and scapulohumeral indices on the preoperative CT scans and compared them with measurements on the postoperative CT scans. Postoperatively, graft surface, resorption, and defect coverage were measured and compared with those at early follow-up (within 16 months) and final follow-up (mean ± SD, 6.6 ± 2.8 years).

Results: The mean preoperative glenoid version was –17° ± 13.5°, which was corrected to –9.9° ± 11.9° at final follow-up ($P < .001$). The humeral head was able to be recentered and reached normal values as indicated by the glenohumeral index (51.8% ± 6%; $P = .042$) and scapulohumeral index (59.6% ± 10.2%; $P < .001$) at final follow-up. Graft surface area decreased over the follow-up period, from 24% ± 9% of the glenoid surface at early follow-up to 17% ± 10% at final follow-up ($P < .001$). All clinical outcome scores had improved significantly. Progression of osteoarthritis was observed in 47% of the shoulders.

Conclusion: Arthroscopically assisted posterior ICBG restored reliable parameters as shown on CT scans, especially glenoid version and the posterior subluxation indices. Graft resorption was common and could be observed in all shoulders. Patient-reported clinical outcome scores were improved. Osteoarthritis progression in almost 50% of patients is concerning for the long-term success of this procedure.

Keywords: shoulder; instability; arthroscopic; iliac crest bone graft; recurrent posterior shoulder instability; glenoid version; posterior subluxation

Posterior shoulder instability is not as rare as early literature has suggested, accounting for up to 10% of patients with shoulder instability events.[17,27] In a young athletic population, 18% of the patients with shoulder instability events have been reported to have posterior injuries, with 77% requiring surgical stabilization.[22] Approximately 50% of injuries are assumed to be posttraumatic[29] and involve detachment of the posteroinferior labrum, and capsular stretching, with a concomitant insufficiency of the posterior band of the inferior glenohumeral ligament, is also found. Patients may have undefined and vague symptoms, such as posterior shoulder discomfort, pain, inability to participate in their respective sport, and repeated subluxation events.[5,30,37]

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The treatment of posterior glenohumeral stability is a challenging problem, given the frequently compromised posterior capsulolabral structures and glenoid or humeral bone stock. Furthermore, these patients often participate in high-impact activities or have pathologies that place recurrent stress on the posterior glenoid. Given the high-energy impact and associated increased likelihood for recurrence, many of these patients have glenoid bone loss alone or in combination with a reverse Hill-Sachs lesion on the humerus. It is particularly challenging to stabilize the shoulder in these patients with high-demand activities and compromised bony and soft tissue stabilizers.

The treatment options range from conservative treatment including physical therapy and strengthening programs to surgery with either open or arthroscopic soft tissue and/or bony stabilization procedures. Many of the common surgical stabilization options include a soft tissue capsular plication or tightening, posterior labral repair, glenoid osteotomy, or posterior iliac crest bone grafting (ICBG).

In 2012, Lafosse et al[21] described an arthroscopically assisted technique for posterior bone grafting using iliac crest autograft. A group of patients with high-demand shoulder activities achieved promising outcomes at short-term follow-up (mean, 20 months).[33] To our knowledge, no study has used imaging to analyze a posterior ICBG or another posterior glenoid bone augmentation procedure regarding graft resorption and its influence on the glenoid shape and the subluxation of the humeral head. All that is known about resorption and remodeling of a bone graft is from bone augmentation procedures in anterior shoulder instability treatment, such as Latarjet or ICBG. The purpose of this study was to investigate the effect of a posterior ICBG on glenoid shape, humeral subluxation indices, and degenerative changes over time. We hypothesized that the arthroscopically placed ICBG would restore posterior glenoid bone defect and correct the posterior humeral subluxation.

METHODS

This institutional review board–approved study involved patients undergoing an arthroscopically assisted posterior ICBG procedure performed by the senior author (L.L.) at our institution. Indication for arthroscopically assisted posterior ICBG was irreparable soft tissue defect of the capsule or posterior labrum, along with posterior glenoid bone loss for revision in patients with a failed arthroscopic posterior Bankart repair. Between January 2008 and December 2016, a total of 49 consecutive patients underwent arthroscopically assisted posterior ICBG for recurrent posterior shoulder instability. Patients with 1 preoperative and at least 2 postoperative computed tomography (CT) scans with a minimum follow-up of 2 years were included in the evaluation. A total of 26 patients met the inclusion criteria, and 17 (follow-up rate, 35%) were available for follow-up (Figure 1).

All patients received pre- and postoperative CT scans of the affected shoulder with 3-dimensional reconstruction of the glenoid and were invited for a follow-up CT scan alongside clinical examination. The descriptive data of the study patients are summarized in Table 1.

Surgical Technique

The technique was performed similarly to the way it has been previously described[21] with slight modifications. The patient was seated in the beach-chair position with an inclination of approximately 45° to allow the harvesting of the ICBG. A monocortical ICBG (approximately 2.5 × 1.5 × 1.5 cm) was harvested after drilling two 3.2-mm holes using both, a cannulated drill and guide. The holes were then tapped, and 2 "top hat" washers were placed in the outer cortex (Figure 2A). The medial side of the iliac crest was preserved. The graft was attached to the cannula using obturators (Figure 2, B and C). After harvesting, the beach-chair inclination was increased to 70°. After diagnostic arthroscopy, the posterior working portal was enlarged to allow passage of the graft and cannula. The graft position should be flush with the subchondral bone to avoid prominence. To hold the ICBG, 2 K-wires were placed through cannulated drill holes, and the position was controlled. Two 3.5-mm partially threaded screws were placed. Anterior perforation was avoided so as not to damage neurovascular structures. The position of the ICBG was controlled arthroscopically (Figure 2D). The posterior labrum or capsule was not reattached to the graft.

The arm was then immobilized in 20° of abduction and neutral rotation for 6 weeks. Passive range of motion (ROM) exercises were started immediately, active ROM exercises were started at 3 weeks, and strengthening exercises were started at 6 weeks. Internal rotation exercises were avoided until 6 weeks postoperatively. Bench press–type exercises and return to sport were allowed at 3 months postoperatively.

*Address correspondence to Roland S. Camenzind, MD, Alps Surgery Institute, Clinique Générale d'Annecy; 4 Chemin de la Tour la Reine, 74000 Annecy, France (email: roland.camenzind@bluewin.ch).
†Alps Surgery Institute, Clinique Générale d'Annecy, Annecy, France.
‡Department of Orthopaedic Surgery, University of Zurich, Balgrist University Hospital, Zurich, Switzerland.
§Department of Orthopaedic Surgery, Braine-l'Alleud-Waterloo Hospital, Centre Hospitalier Interrégional Edith Cavell (CHIREC), Braine-l'Alleud, Belgium.
‖Ortomove, Centro Medico ABC, Mexico City, Mexico.
¶IECEM - Research Unit, Polyclinique Saint Côme, Compiègne, France.
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Ethical approval for this study was obtained from the Comité de Protection des Personnes Lyon SUD-EST IV (ID L19-004).

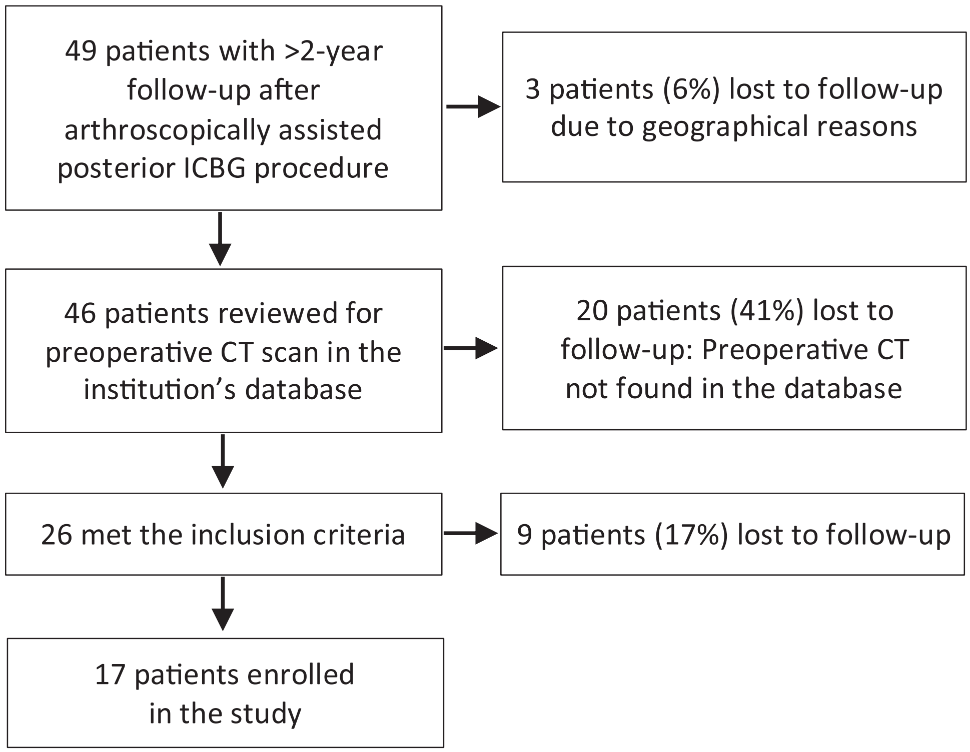

Figure 1. Flowchart of the study patients. CT, computed tomography; ICBG, iliac crest bond grafting.

TABLE 1
Patient Descriptive Data (N = 17)[a]

Age, y	36 ± 13
Side (R/L), n	10/7
Sex (F/M), n	2/15
Follow-up, y	6.6 ± 2.8
Previous surgery	8 (47)
Traumatic injury	12 (71)
Dislocation	12 (71)
Subluxation	14 (82)

[a]Data are presented as n (%) or mean ± SD unless otherwise indicated. F, female; L, left; M, male; R, right.

Clinical Outcomes

The following patient-reported outcome measures were used: Walch-Duplay score; Constant score, American Shoulder and Elbow Surgeons shoulder score, Subjective Shoulder Value (range, 0-100), and visual analog scale for pain (range, 0-10 [10 = worst pain]). These scores were assessed preoperatively and compared with the clinical examination and clinical outcome scores at the final follow-up. In addition, patients were asked at final follow-up to rate their satisfaction with the procedure on a scale of 0 (not satisfied) to 10 (very satisfied). Finally, shoulder ROM was monitored, and patients were examined for apprehension and recurrent instability. Complications and reoperation rates were noted.

CT Assessment

To enable measurements in the standardized axial imaging plane (SAIP) (Figure 3, A-C) and the en face view[8,23,25] (Figure 3, D and E), all preoperative and postoperative CT scans were analyzed in multiplanar reconstruction mode as described by Ernstbrunner et al[8] using OSIRIX software (Pixmeo SARL).

Two independent fellowship-trained shoulder surgeons (R.S.C. and L.G.) analyzed all CT scans. Before the study, both observers were instructed about the measurement techniques. The interobserver reliability was decided by the intraclass correlation coefficients. Two months after the initial measurement by the 2 surgeons, 1 surgeon (R.S.C.) remeasured all the above-mentioned parameters to evaluate the intraobserver reliability. The presented parameters are calculated means from both readers. The data are presented in Table 2.

Preoperative Measurement

On the preoperative CT scans, the glenoid version angle according to the method of Friedman et al[10] (Figure 3A) as well as the glenohumeral[40] (Figure 3C) and scapulohumeral indices[7] (Figure 3B) were measured; these were compared with measurements on the postoperatively obtained CT scans. Measurement of the glenoid bone surface (Figure 3D) and the bone defect size was based on the Pico method in the en face view[2,23]: with the best-fit circle

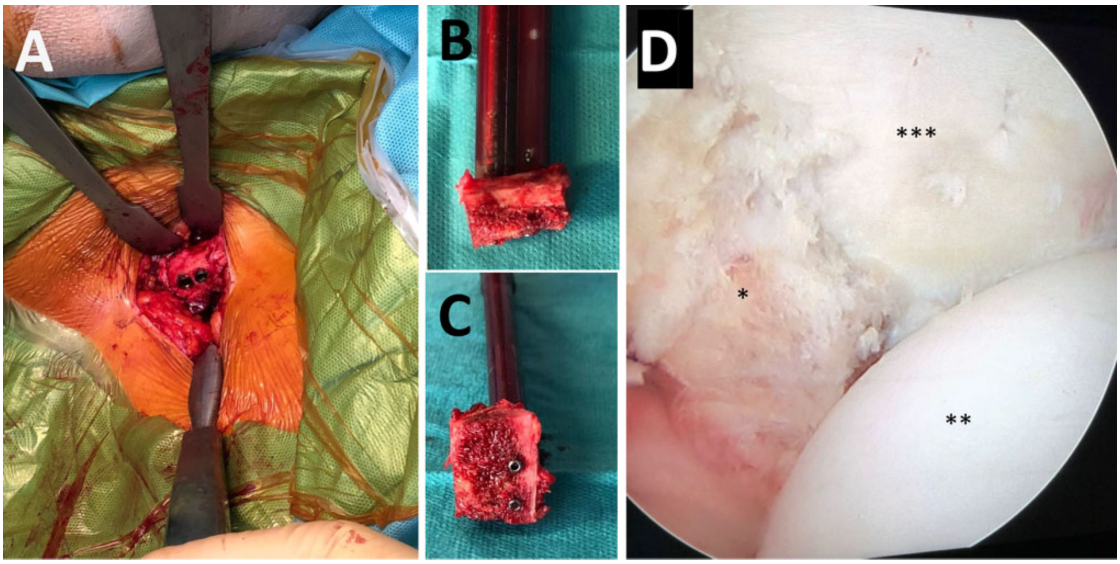

Figure 2. Intraoperative view. (A) Graft harvesting from iliac crest with the 2 “top hats” washers placed in the outer cortex, (B, C) iliac crest bone graft attached to the double-barrel cannula, and (D) arthroscopic view with posteriorly placed iliac crest bone grafting (*), humeral head (**), and posterior part of the glenoid (***).

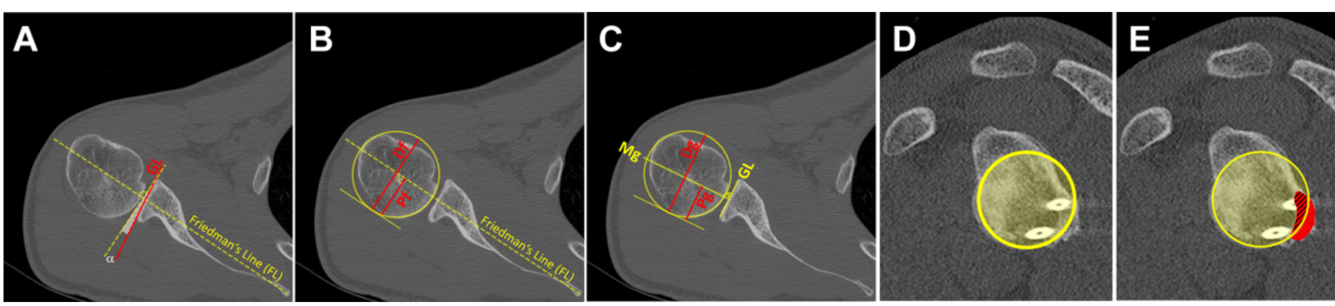

Figure 3. Method used to calculate (A) glenoid version angle α (white-shaded area), (B) humeral head subluxation according to scapulohumeral index (Pf/Df) and (C) glenohumeral index (Pg/Dg), (D) best-fit circle (yellow-shaded area), and (E) ICBG surface area (red-shaded area). The ICBG surface area (red-shaded area) and glenoid defect coverage (black-striped red shading area within the best-fit circle [yellow-shaded area]) are illustrated; the graft overhang is the dotted red-shaded area outside the yellow circle. Df, diameter of the humeral head perpendicular to Friedman's line; Dg, diameter of the humeral head; GL, line tangent to the anterior and posterior edges of the glenoid fossa; ICBG, iliac crest bond grafting; Mg, line bisecting the glenoid; Pf, relative part of the humeral head position posterior to Friedman's line; Pg, relative part of the humeral head position posterior to Mg.

of the circular inferior two-thirds of the glenoid concavity, the glenoid bone defect size was defined as the missing portion of the best-fit circle and calculated as a value relative to the total circle size (assumed native glenoid surface size). The glenoid version and the glenohumeral and scapulohumeral indices were assessed in the axial plane at the level of the SAIP.

Postoperative Measurement

The augmented glenoid surface and bone graft surface were measured. The surface size of the ICBG (Figure 3E) and defect coverage were depicted as values relative to the corresponding glenoid surface size.[2,23] Glenoid version as well as the glenohumeral and

TABLE 2
Inter- and Intraobserver Reliability[a]

	Interobserver ICC (95% CI)	Intraobserver ICC (95% CI)
Glenoid version		
Preoperative	0.906 (0.757-0.966)	0.912 (0.772-0.968)
Postoperative	0.902 (0.751-0.963)	0.946 (0.857-0.980)
Glenohumeral index		
Preoperative	0.902 (0.747-0.964)	0.868 (0.671-0.951)
Postoperative	0.799 (0.529-0.922)	0.905 (0.756-0.964)
Scapulohumeral index		
Preoperative	0.907 (0.755-0.967)	0.838 (0.599-0.940)
Postoperative	0.884 (0.707-0.956)	0.953 (0.875-0.983)

[a]ICC, intraclass correlation coefficient.

TABLE 3
Clinical Outcomes and Patient Satisfaction[a]

	Preoperative	Final Follow-up	*P* Value[b]
Constant score	60 ± 17	84 ± 11	<.001
ASES	52 ± 18	82 ± 15	<.001
Walch-Duplay	26 ± 31	84 ± 16	<.001
VAS pain	5.9 ± 2.4	2.3 ± 2.5	<.001
SSV	57 ± 20	79 ± 21	<.001
Satisfaction[c]		8.9 ± 1.6	

[a]Data are presented as mean ± SD. ASES, American Shoulder and Elbow Surgeons; SSV, Subjective Shoulder Value; VAS, visual analog scale.

[b]Paired *t* test.

[c]Satisfaction was measured on a scale from 0 (not satisfied) to 10 (very satisfied).

scapulohumeral indices were again measured and calculated in the axial plane at the level of the SAIP. The stage of osteoarthritis (OA) was stated according to the Samilson-Prieto classification.[32] Furthermore, nonunion, osteolysis,[15] and remodeling were assessed on the postoperative CT scans.

Statistical Analysis

Based on previously published data concerning the correction of glenoid retroversion,[20] an a priori power analysis was calculated to detect a significant change between pre- and postoperative time points using the freely available software G*Power 3 (Erdfelder, Faul, Buchner, Lang, HHU Düsseldorf, Düsseldorf, Germany). A sample size of at least 8 shoulders with an $\alpha = .05$ for a power of 95% was established to detect a change between 2 time points (2-sided *t* test for dependent samples). Normal distribution of the data was tested using a Kolmogorov-Smirnov test. Parametric (paired *t* test) or nonparametric tests (Wilcoxon signed rank test) were applied to compare pre- and postoperative data. Reliability was evaluated using intraclass correlation coefficients and a 2-way mixed-effects model assuming a single measurement and absolute agreement. The significance level was set at .05, and the results are reported as mean ± SD if not stated otherwise. The statistical analyses were computed using GraphPad Prism 8 for Mac (Graph- Pad Software) and SPSS Version 23 (IBM Corp).

RESULTS

The 17 study patients were examined at a mean final follow-up of 6.6 ± 2.8 years postoperatively. Early follow-up occurred within 16 months postoperatively. At the final follow-up, all clinical outcome scores were found to have improved significantly ($P < .001$ for all). Clinical outcomes and patient satisfaction are summarized in Table 3.

Overall, 47% of the patients underwent reoperation to remove hardware because of screw irritation at a mean of 8.4 ± 8 months after the posterior ICBG procedure. In these instances, the screw heads were prominent after graft remodeling, leading to irritation of the infraspinatus. In 1 patient, the posterior ICBG was arthroscopically reshaped 3 years after index surgery. No intraoperative complication occurred in the studied cohort. No patient sustained recurrent shoulder dislocation; however, in the studied group, 2 of 17 patients reported persistent posterior apprehension. One patient had a nerve transfer before the posterior ICBG procedure because of an axillary nerve palsy after a traumatic shoulder dislocation. In this case, the persistent instability was due to the muscular deficit because the patient had not fully recovered from the nerve palsy. The other patient was insecure with his operated shoulder 8 years after surgery but no longer had a feeling of instability. After a work accident initially, he fully returned to his work (territorial agent) without any symptoms.

Preoperative glenoid version was –17° ± 13.5° and was corrected using posterior ICBG to –9.9° ± 11.9° ($P < .001$) at the final follow-up. The glenohumeral index slightly improved from 57.1% ± 10.4% to 51.8% ± 6% ($P = .042$). Preoperatively, the humeral head was posteriorly subluxated, with a scapulohumeral index of 72.6% ± 12.2%; this was corrected to 59.6% ± 10.2% ($P < .001$). In all patients, the scapulohumeral index was corrected (mean ± SD, 13% ± 11%); however, 5 patients (29%) still had a scapulohumeral index greater than 61%, and 1 patient (6%) had glenohumeral index greater than 61% at the final follow-up.

The mean preoperative posterior glenoid bone defect was 5% ± 4% (range, 3%-12%) of the native glenoid surface as measured. Four shoulders showed no preoperative posterior bone defect. All grafts showed union (100%) but also remodeling (100%). The graft surface area significantly decreased in size from a mean of 2.2 cm^2 at early follow-up to 1.5 cm^2 at final follow-up ($P = .001$). The graft surface area decreased over the follow-up period from 24% ± 9% to 17% ± 10% ($P < .001$) of the glenoid size. Defect coverage was constantly high during early and final follow-ups (93% ± 5% and 98% ± 5%, respectively). The characteristics of the CT scan measurements are listed in Table 4.

The preoperative mean Samilson-Prieto stage was 0.9 ± 1, with 8 shoulders (47%) showing no signs of OA, 5 shoulders (29%) showing stage 1, and 2 shoulders (12%) each showing stage 2 or 3, respectively. The postoperative mean Samilson-Prieto stage was 1.4 ± 1.1. In 8 shoulders (47%), the OA stage had progressed or the size of the inferior humeral osteophyte had increased. In all shoulders with preexisting OA, the size of the inferior osteophyte had increased (Figure 4). In 5 shoulders (29%), no progression of OA between pre- and postoperative state was observed.

DISCUSSION

The primary finding of this study is that, in patients with symptomatic posterior shoulder instability, an arthroscopically assisted posterior ICBG can restore glenoid version and improve glenohumeral containment. The clinical results are reasonable at a long-term follow-up and comparable with those of other arthroscopic[4,41] or open[1,6,24,34,35]

TABLE 4
CT Scan Measurements[a]

	Preoperative	Early Follow-up	Final Follow-up	P Value[b]
Glenoid version, deg	–17 ± 13.5	–10.2 ± 11.3	–9.9 ± 11.9	<.001
Glenohumeral index (%)	57.1 ± 10.4	52.4 ± 4.3	51.8 ± 6	.042
Scapulohumeral index (%)	72.6 ± 12.2	59.3 ± 12	59.6 ± 10.2	<.001
ICBG surface area (%)		24 ± 9	17 ± 10	<.001
ICBG overhang (%)		8.4 ± 6.5	7.3 ± 8	.8438
Defect coverage (%)		93 ± 5	98 ± 5	.045

[a]Data are presented as mean ± SD. Early follow-up occurred within 16 months postoperatively, final follow-up occurred 6.6 ± 2.8 years postoperatively. CT, computed tomography; ICBG, iliac crest bone grafting.
[b]Paired t test.

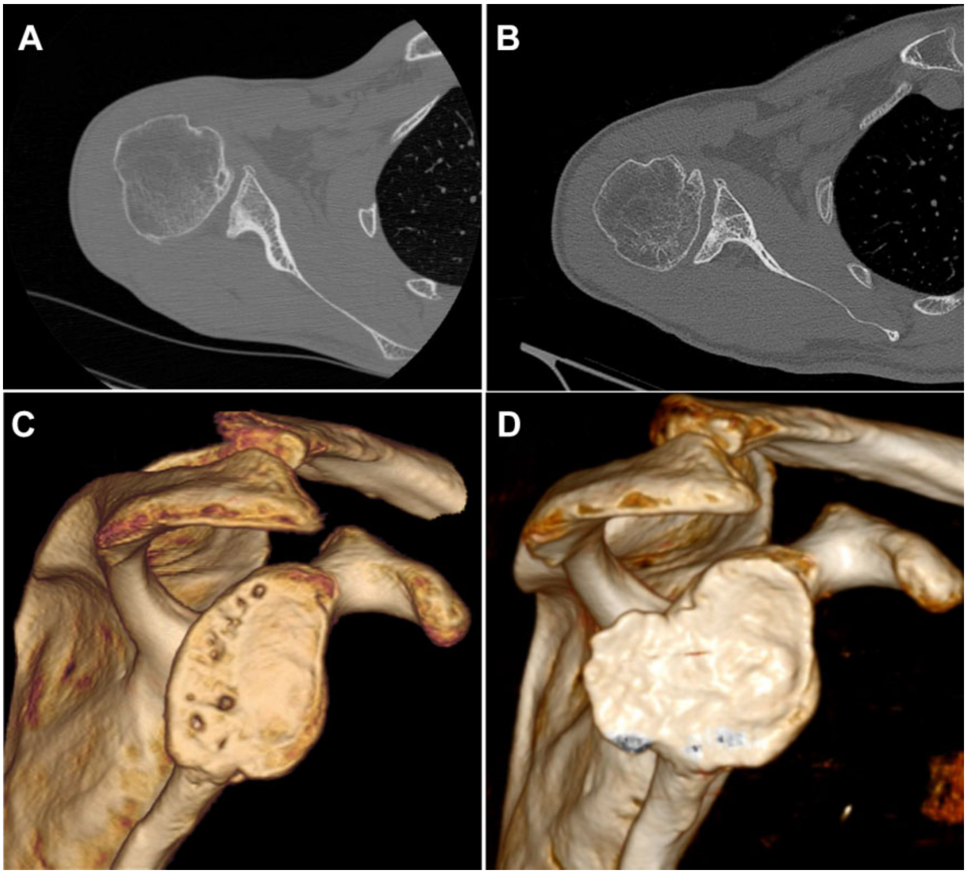

Figure 4. (A) Preoperative axial computed tomography scan and (C) 3-dimensional en face view of a 46-year-old male patient with a painful right shoulder (visual analog scale for pain, 6) and failed posterior Bankart procedure 4 years before arthroscopically assisted iliac crest bone grafting. This patient showed preoperative glenoid retroversion of 30° and humeral posterior subluxation with a scapulohumeral index of 80%. (B, D) Postoperatively, at 9-year follow-up, the patient showed decreased glenoid retroversion of 17° and a scapulohumeral index of 67%. This patient showed high-grade osteoarthritis preoperatively. Nevertheless, he had a good clinical outcome, with a Constant score of 95.

posterior ICBG procedures. It is known that patients with posterior shoulder instability do not have similar clinical outcomes compared with patients with anterior instability and surgical treatment.[3] Additionally, in 47% of our patients, the ICBG was being performed as a revision procedure. This procedure successfully restored radiographic parameters associated with posterior instability, and outcome scores were improved. However, resorption was seen in all grafts, and progression of OA was common.

Glenoid retroversion appears to be associated with an increased risk of recurrent instability.[27] Glenoid version was measured according to the Friedman method.[10,31]

With increased glenoid retroversion, the humeral head centration shifts posteriorly in a linear relationship.[18] Fuchs et al[11] showed an average glenoid retroversion of 12.5° in patients with recurrent posterior instability. Gottschalk et al[14] mentioned that patients with retroversion of more than 16° have a higher incidence of contralateral posterior shoulder injury and described a cutoff value of 15.4° of retroversion for a patient group with posterior instability. In the present cohort of 17 patients with posterior instability, mean glenoid retroversion was 17° preoperatively. With the posterior glenoid augmentation and after the remodeling of the ICBG, the "new" glenoid showed an average retroversion of 9.9°.

For the young patient, a posterior subluxation of the humeral head in the absence of posterior glenoid erosion combined with an increased glenoid retroversion is seen as an early stage of primary shoulder OA[39] and was recently named the Walch B0 glenoid.[7] A calculation of 2 different subluxation indices was performed to quantify the eccentricity of the humeral head: glenohumeral and scapulohumeral indices. Papilion and Shall[28] introduced the glenohumeral index to measure the subluxation of the humeral head in reference to the glenoid. A glenohumeral index of more than 55% has been originally defined as humeral posterior subluxation.[40] In the present study, the glenohumeral index was 57% preoperatively and could be corrected to 52%. The scapulohumeral index[31,40] uses the Friedman (scapular) line[10] as reference, which shows a strong correlation with the glenoid version for subluxation,[36] was initially 73%, and was corrected to 60%. A recent study[19] defined the cutoff values for posterior subluxation measured using a 2-dimensional CT scan in the axial view for both the glenohumeral and scapulohumeral indices as greater than 61%. Both mean subluxation indices were postoperatively less than this cutoff value. At final follow-up 5 patients (29%) still had a scapulohumeral index greater than 61%, and 1 patient (6%) had glenohumeral index greater than 61%. This was due to excessive preexisting glenoid retroversion (mean ± SD, –22° ± 14°) in these patients.

All of the grafts united, but remodeling of the graft was observed in all cases. The remodeling of the graft had already been observed in the early stages postoperatively. Eight patients (47%) required hardware removal due to predominant screw heads irritating the posterior soft tissue after the remodeling of the bone graft. The mean time to hardware removal was 8.4 ± 8 months. The graft surface showed a significant decrease in size from early to final follow-up. There are no studies about osteolysis of posterior ICBG. More is known about osteolysis of the coracoid in the Latarjet procedure. Di Giacomo et al[12] reported a mean bone loss of 59% in 26 patients after a mean follow-up period of 17.5 months. This is comparable with the results presented here, showing a graft surface area of 68% (1.5 cm^2) of the initial measured graft area (2.2 cm^2) after a mean follow-up of 6.6 years. We suspect adaption of the bone to the external forces according to the Wolff law[13,38,42] is the main reason for the bone resorption. A preoperative posterior bone loss of 5% (range, 3%-12%) in 76% of the analyzed shoulders is in accordance with a recent study by Hines et al,[16] with measurable bone loss in 69% of their patients and a mean bone loss of 7.3%. To augment the posterior glenoid bone and with the idea of improving the posterior glenoid track, the size of the ICBG was approximately 2.5 × 1.5 × 1.5 cm. To avoid screw predominance and as a consequence of reducing the rate of hardware removal, a graft with a smaller anteroposterior size should be considered for this procedure. The fixation of a smaller graft using 2 screws can be technically more demanding because the risk of fracturing it is probably higher.

In all shoulders with preexisting OA, the grade of Samilson-Prieto or size of the inferior osteophyte increased during the follow-up period. Nine shoulders with preoperative signs of OA showed slightly higher glenoid retroversion (mean ± SD, –22.1° ± 17.3° vs −11.3° ± 5.3°; P = .005) and a higher grade of humeral head subluxation measured using the scapulohumeral index (median, 75.6% vs 69.2%; n.s.) compared with 8 shoulders without signs of OA. Together with the results of a biomechanical study that showed that an increase of glenoid retroversion leads to a higher degree of humeral head decentralization,[18] current findings support the thesis that a higher degree of humeral head subluxation leads to altered glenohumeral biomechanics with increased posterior glenoid bone wear. A posterior ICBG cannot alter the development of shoulder OA but improves posterior shoulder stability; therefore, the posterior ICBG is a considerable procedure in young patients with severe glenoid retroversion and glenohumeral OA when shoulder arthroplasty is not yet an option. Nourissat et al[26] showed that the only factor compromising the functional outcome of surgical treatment for posterior shoulder instability is the presence of glenoid cartilage lesions. This corresponds with the findings of the present study. Nevertheless, most patients showed mild symptomatic dislocation arthropathy. Similar findings were reported in a recent study with patients aged more than 40 years who underwent an open Latarjet procedure for anterior shoulder instability and developed radiologically severe but clinically mild symptomatic dislocation arthropathy.[9] The high mean age of 36 years in our study can be explained by almost 50% of the patients having undergone previous surgery and the remaining elevated incidence rates throughout the third and fourth decades of life.[43] A longer-term follow-up is needed to determine the effect of OA progression on the long-term outcome of this procedure.

Limitations

This study has several limitations. First, the study design is a retrospective case study, and because of its design, a control group is missing. This limit led to a comparison of the radiological results of this arthroscopic procedure with those of other studies using procedures for anterior shoulder instability. Second, the sample size of the study cohort is relatively small, and the follow-up rate is low. This was due to the low number of patients with recurrent posterior instability and the very strict inclusion criteria. This can lead to a selection bias and misinterpretation of the data regarding this surgical technique.

Third, the inclusion of patients with severe OA and partial glenoid erosion made the study cohort heterogeneous. Fourth, using CT scans only and selected cuts can lead to an underestimation of the posterior subluxation and is strongly dependent on the arm's position during imaging acquisition and selected slices for measuring. Therefore, inter- and intraobserver reliability for all measurements were evaluated and showed high correlation.

CONCLUSION

The arthroscopically assisted posterior ICBG procedure restored reliable parameters as seen on CT scans, especially the posterior subluxation indices and glenoid version. Graft resorption was common and could be observed in all shoulders. Patient-reported clinical outcome scores were improved. The progression of OA in almost 50% of participants is concerning for the long-term success of this procedure. Despite the development of severe dislocation arthropathy, as seen on imaging, the clinical symptoms were mild in most patients.

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