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Arthroscopic Suture Anchor Fixation of Bony Bankart Lesions: Clinical Outcome, Magnetic Resonance Imaging Results, and Return to Sports

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Purpose: The purpose of this study was to evaluate the outcome, return to sporting activity, and postoperative articular cartilage and bony morphology of shoulders that underwent arthroscopic suture anchor repair of bony Bankart lesions. **Methods:** The inclusion criteria for this retrospective study were anterior glenoid rim fractures after traumatic shoulder instability that were treated with arthroscopic suture anchor repair. Patients were surveyed by a questionnaire including sport-specific outcome, Rowe score, Western Ontario Shoulder Instability Index, and Oxford Instability Score. Three-tesla magnetic resonance imaging could be performed in 30 patients to assess osseous integration, glenoid reconstruction, and signs of osteoarthritis. **Results:** From November 1999 to April 2010, 81 patients underwent an anterior bony Bankart repair in our department (50 arthroscopic suture anchor repairs, 5 arthroscopic screw fixations, and 26 open repairs). The 55 arthroscopic repairs comprised a consecutive cohort of patients treated by a single surgeon. Of the 50 patients in the suture anchor group, 45 (90%) were available for evaluation. At 82 ± 31 months postoperatively, the mean Rowe score was 85.9 ± 20.5 points, the mean Western Ontario Shoulder Instability Index score was 89.4% ± 14.7%, and the mean Oxford Instability Score was 13.6 ± 5.4 points. Compared with the contralateral shoulder, all scores showed a significantly reduced outcome ($P < .001$, $P < .001$, and $P < .001$, respectively). A redislocation occurred in 3 patients (6.6%). Regarding satisfaction, 35 patients (78%) were very satisfied, 9 (20%) were satisfied, and 1 was partly satisfied. Overall, 95% of patients returned to any sporting activity after surgery. The number of sports disciplines ($P < .001$), duration ($P = .005$), level ($P = .02$), and risk category ($P = .013$) showed a significant reduction compared with the pretrauma condition. However, only 19% of patients reported that shoulder complaints were the reason for the reduction in activity. Nonunion occurred in 16.6%, with a higher frequency in patients with chronic lesions ($P = .031$). Anatomic reduction was achieved in 72%, the medial step-off in patients with nonanatomic reduction averaged 1.8 ± 0.9 mm, and the remaining glenoid defect size averaged 6.8% ± 7.3%. Full-thickness cartilage defects of the anterior glenoid were detected in 70% of patients. **Conclusions:** Arthroscopic suture anchor repair may enable an anatomic reduction of bony Bankart lesions with no or only minimal articular steps and provides successful midterm outcomes concerning clinical scores, recurrence, and patient satisfaction. The return to activity is limited for various, mostly non−shoulder-related causes. Chronic lesions may have an inferior healing potential; therefore early surgical stabilization of acute Bankart fragments is suggested to avoid possible nonunion. **Level of Evidence:** Level IV, therapeutic case series.

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Bony Bankart lesions are avulsion fractures of the glenoid rim that occur during traumatic dislocation of the glenohumeral joint.[1,2] Historically, these bony lesions have been approached by open repair.[3,4] However, in 2002 Porcellini et al.[4] published a case series of bony Bankart lesions treated with all-arthroscopic fragment reduction and suture anchor fixation. Since then, numerous arthroscopic techniques to address Bankart fractures have been published.[5-14]

Despite the high incidence (4% to 70%) of bony Bankart lesions after shoulder dislocation, few clinical outcome studies of arthroscopic bony Bankart repair have been published to date.[1-3,11,15-17] Most of the published clinical trials focus on the size of the remaining defect, as shown by computed tomography (CT), as well as the influence of fragment reduction and bony healing on postoperative failure and patient satisfaction.[1,11,15-17] However, as a general rule in orthopaedic trauma, meticulous surgical reconstruction of the joint anatomy is also mandatory to avoid secondary joint degeneration and osteoarthritis.[18]

The purpose of this study was to evaluate the outcome, return to sporting activity, and postoperative articular cartilage and bony morphology of shoulders that underwent arthroscopic suture anchor repair of bony Bankart lesions. We hypothesized that arthroscopic bony Bankart repair provides good clinical results, a low rate of recurrence, high patient satisfaction, and a high return to the previous activity level. Furthermore, we expected the rate of glenohumeral cartilage degeneration to correlate with the accuracy of glenoid joint surface reconstruction.

Methods

Patient Selection

The primary inclusion criterion for this retrospective study was traumatic anterior shoulder instability with a fracture of the anterior glenoid rim of type I or II according to Bigliani et al.,[2] diagnosed on preoperative imaging and confirmed during arthroscopy. Only patients who had undergone all-arthroscopic suture anchor repair without a previous stabilization procedure and had a follow-up period of at least 24 months were included.

The exclusion criteria were posterior or multidirectional instability, voluntary shoulder instability, full-thickness rotator cuff tears, septic arthritis, and neurologic disorders involving the shoulder girdle. A concomitant SLAP lesion was not considered an exclusion criterion.

Patients were allocated into acute and chronic bony Bankart lesion cases based on the surgical documentation. A hemarthrosis, bleeding at the fracture site, and fresh spongy edges of the fragment indicated an acute fracture of the glenoid rim, whereas absence of these features suggested a chronic lesion. The study protocol was approved by the local ethics committee, and all patients provided written informed consent to participate in this investigation.

Table 1. Risk Categories for Traumatic Shoulder Instability Based on Study of Owens et al.[25] and Recommendations of American Academy of Pediatrics Committee on Sports Medicine[26]

Category	Examples
High risk	Handball, rock climbing, windsurfing, surfing, wrestling, judo, ice hockey, football, rugby
Medium risk	Volleyball, basketball, soccer, tennis, squash, badminton, swimming, weightlifting, mountain biking, canoeing, boxing
Low risk	Cycling, running, rowing

Outcome Measurements

A questionnaire assessed the event and mechanism of initial dislocation, duration of postoperative rehabilitation, occurrence of redislocation, need for revision surgery, and overall satisfaction with the surgical outcome (very satisfied, satisfied, partly satisfied, or dissatisfied). Functional outcomes were rated by the Rowe score, Western Ontario Shoulder Instability Index (WOSI), Oxford Instability Score (OIS), and Subjective Shoulder Value.[19-22] All follow-up evaluations were performed by a single independent examiner (R.B.).

Return to Sports

A specifically designed questionnaire section based on previous orthopaedic sport-specific outcome studies inquired about the sport-specific outcome.[23,24] The patients were asked to state the type and number of performed sports disciplines before injury and postoperatively, sports duration (defined as hours per week), and sports level (recreational, competitive, or professional). In the case of postoperative reduction of sporting activities, the reason for reduction was requested. Sports and recreational activities were furthermore allocated into risk categories for traumatic shoulder instability (high, medium, or low risk) based on the study of Owens et al.[25] and recommendations of the American Academy of Pediatrics Committee on Sports Medicine[26] adjusted to meet the distribution of sporting activities in central Europe (Table 1).

Imaging

Magnetic resonance imaging (MRI) was performed on a 3-T system. The standardized examination protocol comprised the following pulse sequences:

1. Parasagittal and transverse T1-weighted turbo spine echo (TSE) sequences with a driven equilibrium pulse, repetition time of 500 milliseconds, echo time

Table 2. MRI Classification Based on Modified Noyes Score for Cartilage Lesions on MRI and Radiographic Samilson-Prieto Classification of Dislocation Arthropathy[28,29]

Feature	Characteristics on MRI
Cartilage	
Grade 0	Intact
Grade 1	Superficial lesion <50% of depth
Grade 2	>50% of depth
Grade 3	Full-thickness lesion
Osteophytes	
Grade 0	No osteophytes
Grade 1	≤3 mm in dimension
Grade 2	>3 mm
Grade 3	>7 mm
Subarticular bone marrow abnormality	
Grade 0	None/homogeneous
Grade 1	Bone marrow edema
Grade 2	Cysts ≤5 mm in diameter
Grade 3	Cysts >5 mm

MRI, magnetic resonance imaging.

of 18 milliseconds, echo train length of 5, sensitivity encoding factor of 2, section thickness of 3 mm, and in-plane resolution of 0.3 × 0.3 mm.

2. Standard paracoronal, parasagittal, and transverse intermediate weighted TSE sequences with spectral fat saturation and an in-plane resolution of 0.4 × 0.4 mm.

Examination findings were analyzed by an experienced musculoskeletal radiologist (K.W.) and an orthopaedic surgeon (J.E.P.) by consensus.

All MRI scans were assessed for bony union and glenoid fossa reconstruction judged by fragment reduction (step-off between fragment and glenoid surface) and remaining defect size. The defect was quantified according to Sugaya et al.[27] by drawing a best-fitting circle at the inferior two-thirds of the glenoid fossa on an en face view and digitally measuring the missing part of the circle.

For glenohumeral cartilage and osteoarthritis evaluation, 3 features were examined: articular cartilage, marginal osteophytes, and subarticular bone marrow abnormality. The MRI classification was based on the modified Noyes score for cartilage lesions on MRI and the radiographic Samilson-Prieto classification of dislocation arthropathy[28,29] (Table 2). These features were assessed in 3 different regions of the glenohumeral joint (anterior glenoid, posterior glenoid, and articular surface of humeral head).

Operative Technique and Rehabilitation

All surgical procedures were conducted by 1 author (A.B.I.). The patient was placed in the beach-chair position, and diagnostic arthroscopy was performed through the standard posterior portal. After creation of an anterosuperior working portal, the fracture site and the bone fragment were dissected free of scar tissue. The typical attachment of the labrum and inferior glenohumeral ligament complex to the bony fragment was preserved during dissection (Fig 1A). In case of Bigliani type II lesions, the osseous fragment was first freed off the glenoid neck using an osteotome.

For osseous fixation, a suture anchor loaded with a single nonabsorbable suture (titanium Bio-Fastak; Arthrex, Naples, FL) was placed at the lower fracture site through an accessory anteroinferior portal (Fig 1B). The medial suture limb was passed through the labroligamentous complex and under the bony fragment and was tied using a sliding knot (Fig 1 C and D). During knot tying, an arthroscopic grasping forceps introduced through the anterosuperior portal aided in holding the fragment in proper reduction. In case of inferior bone quality, larger single-loaded suture anchors (Bio-Corkscrew; Arthrex) were used.

Further anchors were placed superiorly in the same delineated way. The exact anchor position and number of anchors used to accomplish a stable fixation of the fragment varied among patients depending on fracture size and configuration.

In case of a reparable SLAP lesion, suture anchor repair was performed through a transtendinous lateral portal. Small bucket-handle tears or frayed labra were resected.

Postoperatively, a sling for comfort was used and progressive active and assisted range-of-motion exercises were initiated on the following day, limiting external rotation to $-30°$ and abduction, as well as flexion, to 45°. At 4 weeks postoperatively, abduction and flexion to 90° were allowed and external rotation was limited to 0°. Free active range of motion was allowed after 6 weeks postoperatively. Patients were permitted to return to sport-specific training after 3 months and to overhead activities after 6 months postoperatively. In case of an accompanying SLAP repair, active biceps training was prohibited for the first 6 weeks.

Statistics

Statistical analysis was performed with SPSS software (version 20.0; IBM, Armonk, NY). All data were tested for normal distribution using the Kolmogorov-Smirnov test. We used the paired and unpaired *t* tests for normally distributed data and the Wilcoxon signed rank and Mann-Whitney *U* tests (paired/unpaired) for non−normally distributed data. Dichotomous data were computed by the χ^2 test. Correlations were calculated using the Spearman correlation coefficient. The level of significance was set at $P < .05$.

Results

Demographic Characteristics

During the period from November 1999 to April 2010, a total of 81 patients underwent surgery for an

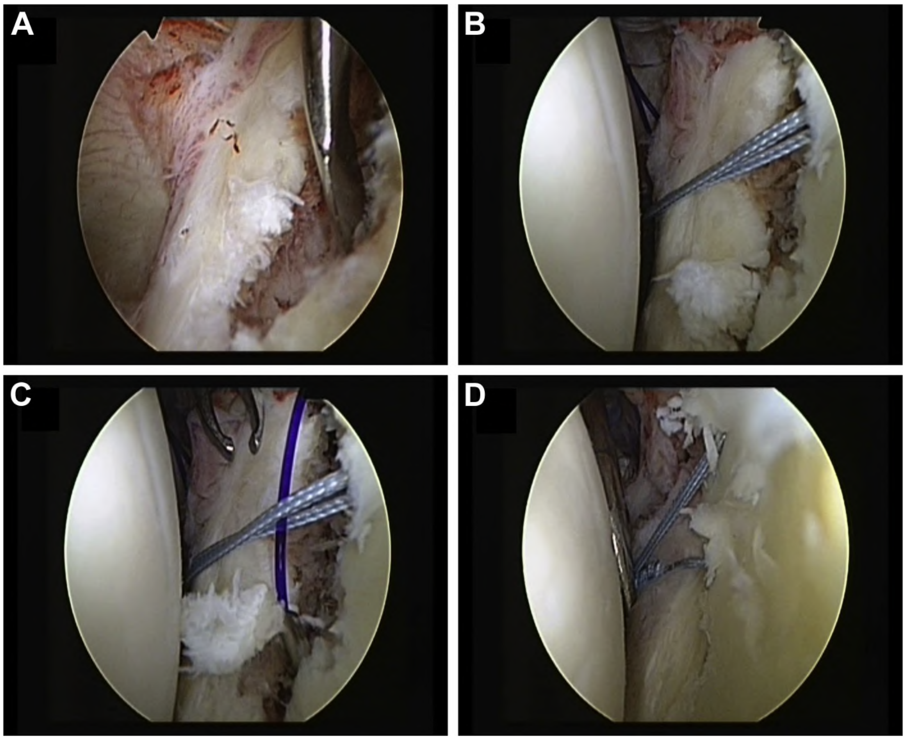

Fig 1. Arthroscopic photographs showing bony Bankart repair in a left shoulder (beach-chair position, viewed from posterior portal). (A) Fracture mobilization, (B) suture anchor placed at fracture site, (C) suture passage using suture shuttle, and (D) knot tying.

anterior bony Bankart lesion in our department (50 arthroscopic suture anchor repairs, 5 arthroscopic screw fixations, and 26 open repairs). The 55 arthroscopic repairs comprised a consecutive cohort of patients treated by a single experienced arthroscopic surgeon (A.B.I.). Arthroscopic screw fixation was chosen in cases with a large solitary fragment. All other patients were treated with suture anchor repair.

At a mean follow-up of 82 ± 31 months, 45 of 50 patients treated with all-arthroscopic suture anchor fixation were available for examination (follow-up rate, 90%). Three patients could not be found, and 2 patients had died.

The mean age at surgery was 41.2 ± 15.1 years. Of the patients, 80% were male patients and 51% were right handed. The dominant side was affected in 58%, with an average of 4.0 ± 5.2 dislocations before surgery. The mechanism of dislocation was a fall on the outstretched arm in 80% of patients, an overhead stroke or serve in 9%, and physical contact with an opponent during sports or an assault in 11% (Table 3). The entire study protocol including MRI was completed in 30 patients (67%), whereas 4 patients (9%) were available for clinical examination but refused MRI and 11 patients (24%) were assessed only by questionnaire.

The recurrence rate of shoulder dislocation among our population was 6.6%. Two patients reported a traumatic redislocation. One of them sustained 2 further dislocations. Both patients underwent revision repair (1 suture anchor repair and 1 arthroscopic screw fixation) and have been in stable condition since. Another patient had 3 atraumatic dislocations overall but refused to undergo revision repair.

A concomitant SLAP repair was performed in 4 cases (9%), and a small bucket-handle labral tear was resected in 1 case. There were no neurovascular complications, postoperative infections, or cases of postoperative shoulder stiffness that needed surgical intervention within our patient population. The detailed patient characteristics are provided in Table 3.

Outcome Assessment

At follow-up examination, the mean Rowe score in our patient population was 85.9 ± 20.5 points (range, 25 to 100 points), the mean WOSI was 89.4% ± 14.7% (range, 29.5% to 100%), and the mean OIS was 13.6 ± 5.4 points (range, 12 to 38 points). When compared with the healthy contralateral shoulder joint, the operated shoulder showed significantly reduced outcomes for all scores ($P < .001$, $P < .001$, and $P < .001$, respectively) and a passive external rotation deficit of 8.4° ± 11.6° (range, −10° to 60°) at 0° ($P < .001$) and of 8.3° ± 11.4° (range, 0° to 60°) at 90° of abduction ($P < .001$) (Table 4). No differences could be detected regarding shoulder outcome scores and external rotation between cases of acute and chronic glenoid fractures (Table 4).

Of the patients, 35 (78%) were very satisfied and 9 (20%) were satisfied with the results of surgery, whereas 1 patient reported being partly satisfied with the surgical outcome. Except for the aforementioned

Table 3. Patient Demographic Data

	Data
No. of patients	45
Type of lesion	
Acute	32 (71.1)
Chronic	13 (28.9)
Sex	
Male	36 (80.0)
Female	9 (20.0)
Side	
Right	23 (51.1)
Left	22 (48.9)
Dominance of affected side	
Dominant	26 (57.8)
Nondominant	19 (42.2)
Body mass index, kg/m^2	26.7 ± 3.7 (18.0-39.3)
Age at primary dislocation, yr	37.7 ± 16.7 (14-71)
Age at surgery, yr	41.2 ± 15.1 (15-71)
Duration of instability, mo	40.6 ± 90.8 (0.1-432.0)
No. of dislocations	4.0 ± 5.2 (1-21)
Median anchors used, n (range)	3 (2-5)
Postoperative physiotherapy, h	17.3 ± 11.3 (0-72)
Incident of primary dislocation	
Sports	35 (77.8)
Work	4 (8.9)
Daily situation	6 (13.3)
Mechanism of primary dislocation	
Fall on outstretched arm	36 (80)
Overhead stroke/serve	4 (8.9)
Contact with opponent	5 (11.1)
Reduction of primary dislocation	
Health care professional	20 (44.4)
Self-reduction/spontaneous	25 (55.6)

NOTE. Data are presented as mean ± standard deviation (range) or number of patients (percent) unless otherwise indicated.

patient, all patients stated that they would undergo surgery again. The mean Subjective Shoulder Value at follow-up was 91.5% ± 10.1% (range, 60% to 100%). Patients who had a recurrent shoulder dislocation showed a significantly lower Rowe score result than patients without a recurrent shoulder dislocation ($P < .001$) and were significantly younger at initial dislocation and at surgery ($P = .007$ and $P = .004$, respectively).

Table 5. Extent of Sport and Recreational Activities Before and After Arthroscopic Bony Bankart Repair (n = 45)

	Before Trauma	Follow-up	*P* Value
No. of sports disciplines	2.6 ± 1.0 (0-6)	2.0 ± 1.2 (0-6)	< .001
Sports duration, h/wk	5.1 ± 5.5 (0-30)	4.0 ± 4.8 (0-30)	.005
No sports	1 (2.2)	3 (6.7)	
Sports level			.02
Professional	2 (4.4)	0 (0)	
Competitive	5 (11.1)	4 (8.9)	
Recreational	37 (82.2)	38 (84.4)	
Risk category			.013
High	7 (15.6)	5 (11.1)	
Medium	29 (64.4)	21 (46.7)	
Low	8 (17.8)	16 (35.6)	
Overhead activities	21 (46.7)	11 (24.4)	< .001
Contact sports	13 (28.9)	9 (20)	< .001

NOTE. Data are presented as mean ± standard deviation (range) or number of patients (percent) unless otherwise indicated.

Sports and Recreational Activities

At follow-up, there was a significant reduction in sporting and recreational activities regarding number of sports disciplines ($P < .001$), duration of sports participation ($P = .005$), sports level ($P = .02$), and risk category ($P = .013$), as well as participation in contact and overhead activities ($P < .001$ and $P < .001$, respectively), compared with the pretrauma condition (Table 5). Overall, 42 of 44 patients (95%) who were active before the initial shoulder dislocation returned to at least 1 sporting or recreational activity after surgery. One patient reported persisting instability and pain as the reason for ceasing participation, whereas another patient indicated non–shoulder-related causes. When

Table 4. Side Comparison and Comparison Between Acute and Chronic Bony Bankart Lesions Regarding Outcome Scores (n = 45) and Passive External Rotation at 0° and 90° of Abduction (n = 34)

	Side Comparison			Type of Lesion		
	Affected Side	Contralateral Side	*P* Value	Acute Fracture (n = 32)	Chronic Fracture (n = 13)	*P* Value
Rowe score at follow-up, points	85.9 ± 20.5 (25-100)	100.0 ± 0.0	< .001	86.6 ± 19.2 (40-100)	84.2 ± 24.0 (25-100)	.410
Oxford score at follow-up, points	18.1 ± 8.2 (12-41)	13.7 ± 5.4 (12-38)	< .001	17.8 ± 8.0 (12-40)	18.9 ± 9.0 (12-41)	.568
WOSI score at follow-up, %	89.4 ± 14.7 (30-100)	98.6 ± 5.4 (68-100)	< .001	91.5 ± 11.4 (56-100)	84.4 ± 20.4 (30-100)	.401
Passive ERO at 0° of abduction, °	56.8 ± 10.4 (20-80)	65.2 ± 6.3 (60-80)	< .001	56.2 ± 10.6 (20-70)	58.0 ± 10.3 (50-80)	.956
Passive ERO at 90° of abduction, °	64.0 ± 10.4 (20-80)	72.0 ± 5.9 (60-80)	< .001	64.0 ± 11.3 (20-80)	64.0 ± 8.4 (50-80)	.615

NOTE. Data are presented as mean ± standard deviation (range) unless otherwise indicated.
ERO, external rotation; WOSI, Western Ontario Shoulder Instability Index.

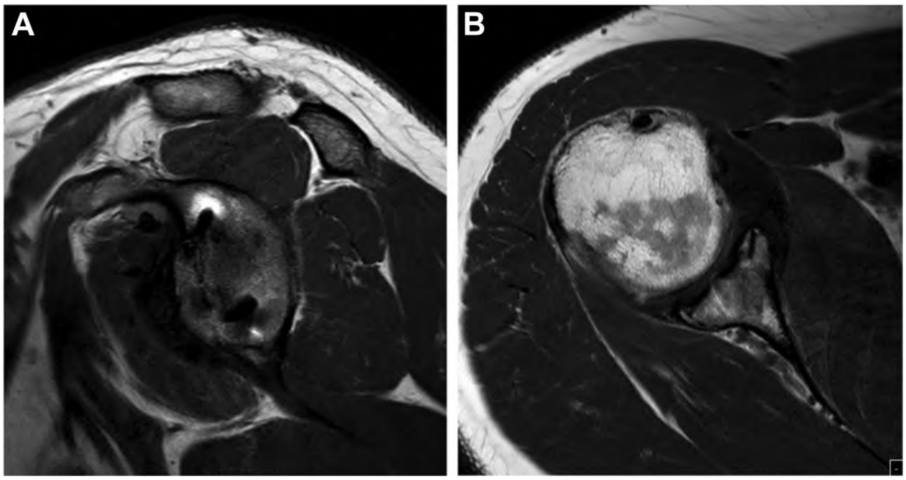

Fig 2. Postoperative magnetic resonance imaging of arthroscopically treated bony Bankart lesion on (A) sagittal and (B) axial views showing anatomic glenoid fossa reconstruction and only minimal medial malpositioning of fragment.

patients were questioned about their reasons for reducing the extent of sporting activity during the follow-up period, 19% reported shoulder-related causes (persisting instability, pain, and dysfunction); 44% stated that the shoulder was asymptomatic yet they were concerned about sustaining a further injury to the shoulder; and 37% indicated that non—shoulder-related reasons, such as professional career, family, and other interests, accounted for the activity change.

Postoperative Imaging Study

The mean follow-up period for postoperative imaging studies was 78 ± 32 months. MRI showed a nonunion of the bony fragment in 5 of 30 patients (16.6%). Osseous integration of the fragment was significantly dependent on the age of the lesion, with a nonunion in 1 of 20 patients (5%) with acute Bankart fractures and 4 of 10 patients (40%) with chronic lesions ($P = .031$). Bony healing was not affected by age at initial dislocation and at surgery ($P = .829$ and $P = .300$, respectively), number of preoperative dislocations ($P = .229$), or duration of instability ($P = .085$).

Patients with a nonunion did not show inferior clinical outcomes regarding Rowe score ($P = .481$), WOSI score ($P = .385$), OIS ($P = .627$), subjective patient satisfaction ($P = .914$), or risk category of performed sports activities ($P = .552$). Among the 25 patients with a healed bony fragment, a flush reduction was achieved in 18 cases (72%) whereas 6 patients (24%) showed medial malpositioning of 1.8 ± 0.9 mm (range, 1 to 3 mm) and 1 patient showed lateral malpositioning of 2 mm (Fig 2). Malpositioning of the fragment did not affect the clinical outcome regarding Rowe score ($P = .389$), WOSI score ($P = .534$), OIS ($P = .836$), subjective patient satisfaction ($P = .534$), or risk category of performed sports activities ($P = .701$).

A persisting postoperative glenoid defect was found in 18 of 30 patients (60%), with a mean postoperative glenoid defect size of 6.8% ± 7.3% (range, 0% to 24.6%) (Fig 2). The size of the defect did not correlate with the results of the Rowe score ($P = .542$), WOSI score ($P = .224$), OIS ($P = .317$), subjective patient satisfaction ($P = .758$), or risk category of performed sports activities ($P = .505$).

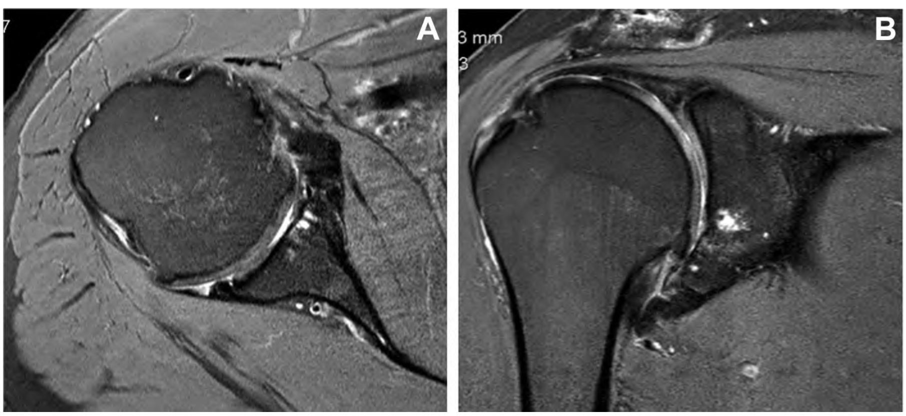

Fig 3. (A) Axial and (B) coronal postoperative magnetic resonance imaging views of 63-year-old patient 5 years after arthroscopic bony Bankart repair showing typical full-thickness anteroinferior cartilage defect.

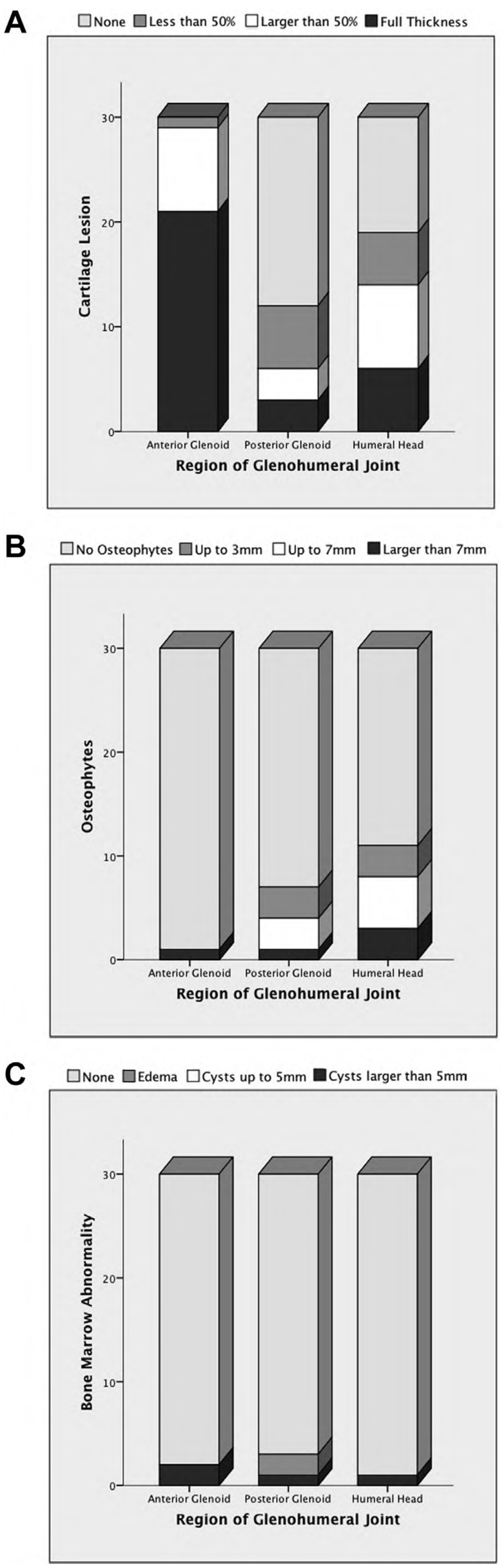

Fig 4. Depiction of osteoarthritis features in evaluated joint regions after arthroscopic bony Bankart repair (n = 30): (A) cartilage lesion, (B) osteophytes, and (C) bone marrow abnormality.

Chondral lesions of the anterior glenoid were shown on MRI in all patients, with full-thickness defects in 70% of patients (Fig 3). The posterior glenoid was affected in 40% of cases and the articular surface of the humeral head in 63% (Fig 4A).

Age at initial dislocation and at surgery correlated significantly with the cartilage lesion of the posterior glenoid ($P = .003$ [$r = 0.524$] and $P = .009$ [$r = 0.466$], respectively) and humeral head ($P = .001$ [$r = 0.563$] and $P < .001$ [$r = 0.698$], respectively), whereas no correlation could be detected for the anterior glenoid ($P = .829$ and $P = .624$, respectively). No correlation was found between the number of preoperative dislocations and chondral injuries at any region of the glenohumeral joint ($P = .331$ for posterior glenoid, $P = .415$ for humeral head, and $P = .152$ for anterior glenoid).

Osteophytes of the glenohumeral joint were a less frequent finding, involving predominantly the humeral head (37%) and the posterior glenoid (23%) (Fig 4B). Bone marrow abnormalities were rare (Fig 4C). All evaluated osteoarthritis features were not affected by nonunion or fragment malpositioning ($P > .05$) and did not correlate with the size of the persisting postoperative glenoid defect ($P > .05$).

Discussion

As hypothesized, arthroscopic suture anchor repair for bony Bankart lesions yielded successful midterm outcomes concerning clinical scores, recurrence, and patient satisfaction. Regarding glenoid fossa reconstruction, an anatomic reduction of the fragment with no or only minimal articular steps and small persisting overall postoperative glenoid defects was achieved in most cases. The reconstruction of the articular surface did not influence the clinical outcome.

The anterior glenoid on MRI showed chondral lesions in all patients, with full-thickness defects in 70% of cases, whereas cartilage lesions of the posterior glenoid and humeral head were less frequent. Contrary to our hypothesis, nonanatomic glenoid fossa reconstruction did not influence any of the evaluated osteoarthritis features.

Porcellini et al.[1] published the largest case series to date on the topic at hand, presenting the results of 65 patients (41 acute and 24 chronic) at a minimum of 4 years' follow-up. They found significantly worse clinical results in chronic cases than in acute cases, with a mean postoperative Rowe score of 61 points and mean external rotation deficit of 10° compared with 92 points and 4°, respectively. A redislocation occurred in 2 patients (3%): 1 from the acute group and 1 from the chronic group. Jiang et al.[15] recently published the results of 50 patients, showing a significant improvement in the Rowe score from 41 points preoperatively to 91 points at follow-up. The average external rotation deficit compared with the unaffected side was 2°, and 4 patients (8%) had a recurrent shoulder dislocation.

Overall, our patient population showed comparable clinical outcomes and recurrence rates to the aforementioned case series and high subjective patient satisfaction. However, a certain impairment of the operated shoulder persisted when compared with the healthy contralateral shoulder. Because Jiang et al.[15] and Porcellini et al.[1] reported values for the affected side only, we cannot compare our finding with their data.

Surprisingly, despite the generally active patient population with glenohumeral instability, no study to date provides detailed information on the sport-specific outcomes after arthroscopic bony Bankart repair. Although 95% of patients returned to some level of sporting activity, we observed a significant reduction in sporting activities concerning the number of sports disciplines, hours per week, sports level, and participation in risky activities. However, of the 5 patients who reduced participation in sporting activities, only 1 reported shoulder complaints such as persisting instability or pain as the reason for the reduction in activity, and about half of the patients stated that the shoulder felt stable and they were satisfied with the repair yet were concerned about sustaining a recurrent dislocation. This may be explained, to some extent, by the fact that the mean patient age at surgery in our cohort was higher (41.2 ± 15.1 years) than that of other populations undergoing bony Bankart repair, averaging 27.6 to 28.7 years.[1,15,16] Older patients may not be as focused on a specific sporting activity anymore and may prioritize general physical health over a return to sports of the same type, risk level, and intensity.

However, the higher mean age in our study does not necessarily mean that our study evaluated a consistently old population. Rather, the higher mean age is because of a few older patients who underwent bony Bankart repair in our department. This fact becomes obvious if one compares the age range of our study (15 to 71 years) with other studies on the same subject, such as those of Jiang et al.[15] (15 to 50 years), Kim et al.[16] (19 to 43 years), and Porcellini et al.[1] (20 to 42 years).

Unlike Porcellini et al.,[1] we did not detect differences regarding shoulder score outcomes and external rotation between cases of acute instability and cases of chronic instability. However, the term "chronic lesion" was defined differently in both studies. Porcellini et al. randomly selected a 3-month interval between initial dislocation and surgery as the cutoff point between acute and chronic lesions, whereas our patients were allocated to each group based on intraoperative arthroscopic findings. We believe that the latter method is more accurate because we do not know with certainty whether the glenoid fracture occurred during the initial event or during a recurrent event of shoulder dislocation.

In accordance with the findings of Porcellini et al.,[1] we found that osseous integration of the refixed fragment was significantly dependent on the age of the lesion. Therefore, because osseous healing potential will decline over time, we agree that early surgical stabilization of acute Bankart fragments is crucial to minimize the risk of nonunion.

Overall, 5 of 30 patients (16.6%) in our series had a nonunion of the bony fragment. This is comparable with the reported nonunion rate in the literature, ranging from 8.0% to 16.1%.[1,4,15,17] However, in our patient population, persisting glenoid defects due to nonunion as well as attrition were usually small, averaging 6.8% of the glenoid surface area. This is considerably smaller than the reported critical defect size of 20% to 25% in clinical and biomechanical studies.[30,31] Consequently, clinical outcome and stability in our study were not affected by glenoid bone deficiency or nonunion.

Jiang et al.[15] found that the reconstructed size of the glenoid was less than 80% in 3 of 4 failures, whereas none of the stable repairs had a glenoid of less than 80%. They concluded that anatomic reduction and healing of the bony fragment may be crucial in defect sizes that exceed 20% of the glenoid whereas a secure labroligamentous repair may be sufficient in cases with smaller defects. This conclusion was confirmed by Kim et al.[16] They divided their patient population into small-sized (<12.5%) and medium-sized (12.5% to 25%) defects and found a soft-tissue repair alone to be adequate in small defect cases.

Because the average bony defect in our study was small, this study does not allow any statement regarding a critical defect size for redislocation. Two of three patients with failures in this study reported adequate trauma as a reason for the recurrent dislocation. The third patient, who had atraumatic redislocations, had no osseous risk of recurrence, showing complete fragment healing, a fully reconstructed glenoid, and only a minimal medial step-off of 1 mm.

Nevertheless, there is strong evidence in the literature supporting the correlation between glenoid surface reconstruction and postoperative outcome.[15,16,30,31]

No study so far has evaluated the impact of articular reduction of glenoid fossa fractures on cartilage lesions and osteoarthritis. This paucity of evidence has been highlighted in a recently published review article on post-traumatic osteoarthritis.[32]

Basically, 2 different scenarios for the development of post-traumatic osteoarthritis must be distinguished: acute insult to the cartilage during injury with subsequent chondrocyte death and dysfunction and chronic local joint overloading due to instability and post-traumatic surface incongruity.[18] The high number of full-thickness anterior glenoid cartilage defects can be explained by the insult to the cartilage during acute dislocation and anterior glenoid fracture. Consequently, these defects were independent of the age of the patient, whereas lesions of the posterior glenoid and humeral head showed a strong correlation to the patient's age, most likely being degenerative in nature. However, chondral lesions of the anterior glenoid did not correlate with the number of preoperative dislocations. These findings may be explained by the small average number of preoperative dislocations and the fact that recurrent dislocation may not affect the cartilage of avulsed and displaced anterior glenoid fragments.

The impact of chronic overloading due to nonanatomic reduction cannot be judged conclusively based on our data because glenoid defects were small overall and anatomic repositioning was achieved in most patients. In cases of medial fragment malpositioning, articular step-off values were small and probably insignificant, averaging less than 2 mm.[33] The implication of minor defects is low. This is well supported by a biomechanical study by Greis et al.[34] They evaluated the impact of different extents of glenoid bone defects on contact pressure in a cadaveric model and found only minor alterations in contact pressure at an induced bone loss of 10%, which corresponds to the average defect in this study. Long-term outcome studies with larger numbers of patients are needed to clarify the effect of early joint defects on long-term function and osteoarthritis development.

Limitations

There are several limitations of this study that need to be considered. First, because the study was designed retrospectively, preoperative imaging did not meet the requirements for reliable defect measurements and was not complete in every case. Hence, we were unable to compare defect sizes and chondral defects between preoperative and postoperative imaging studies. Furthermore, only 30 patients were available for follow-up MRI examination.

Second, patients with an arthroscopic suture anchor repair were exclusively included in this study. During the survey period, 5 patients with large solitary fragments were treated by arthroscopic screw fixation and 5 patients from the suture anchor collective (10%) were lost to follow-up, which raises the possibility of a selection bias.

Third, despite use of a high-resolution 3-T system, MRI offers a limited evaluation of bony structures compared with CT. Complementary CT imaging, however, was not possible for ethical reasons. The same is true for performing magnetic resonance arthrography to improve the sensitivity for the depiction of articular cartilage lesions. To compensate for this limitation, we added a T1-weighted TSE sequence with a driven equilibrium pulse, which provides native arthrographic contrast.[35]

Fourth, osteophytes of the anterior glenoid were difficult to distinguish from bony fragments. The rate of anterior osteophytes is likely to be underestimated. Fifth, the chosen classification of acute and chronic lesions does not consider the possibility of an acute-on-chronic lesion. Finally, the mean age of our patients was significantly higher compared with other studies on bony Bankart repair. Degenerative changes may be overestimated.

Conclusions

Arthroscopic suture anchor repair may enable an anatomic reduction of bony Bankart lesions with no or only minimal articular steps and provides successful midterm outcomes concerning clinical scores, recurrence, and patient satisfaction. The return to activity is limited for various, mostly non—shoulder-related causes. Chronic lesions may have an inferior healing potential; therefore early surgical stabilization of acute Bankart fragments is suggested to avoid possible nonunion.

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