Relationship Between Age at Initial Shoulder Instability and Overall Outcomes After Arthroscopic Bankart Repair

Mean 6-Year Follow-up

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Background: Age at surgery plays a crucial role in the frequency of recurrent shoulder instability. However, there are few studies that evaluate the relationship between age at initial shoulder instability and overall outcomes after stabilization surgery.

Purpose: To compare clinical outcomes and structural changes after arthroscopic Bankart repair in patients who experienced initial shoulder instability during adolescence versus those with later onset instability.

Study Design: Cohort study; Level of evidence, 3.

Methods: This study included patients who underwent arthroscopic Bankart repair at a single institution between 2007 and 2017. Comparisons were made between patients who experienced initial shoulder instability during adolescence (age 13-19 years; group A) and those with later onset instability (age 20-35 years; group B). Clinical outcomes (recurrence rate, postoperative pain, functional scores, active range of motion, and return to sports) and structural changes demonstrated by magnetic resonance imaging (MRI) were evaluated at minimum 2-year follow-up. In addition, functional outcomes within each group were compared between the patients with and without postoperative recurrence.

Results: A total of 58 patients were included (24 patients in group A and 34 patients in group B). The mean follow-up was 72.1 months. Group A demonstrated a significantly higher recurrence rate than group B (41.7% vs 11.8%, respectively; $P = .009$; risk ratio, 5.36 [95% CI, 1.43-20.09]) as well as significantly lower Rowe (76.9 ± 20.1 vs 88.7 ± 13.2, respectively; $P = .01$) and Constant-Murley scores (92.2 ± 7.6 vs 96.3 ± 4.2, respectively; $P = .01$). Postoperative MRI revealed no significant structural differences between the groups regarding the glenoid labrum, glenohumeral cartilage, or osseous reaction around the implanted anchors. In group A, patients with recurrence had less satisfaction regarding postoperative sports level than those without recurrence, whereas in group B, patients with recurrence had more postoperative pain and functional impairment compared with those without recurrence.

Conclusion: Initial shoulder instability during adolescence was associated with a higher recurrence rate and lower functional scores after arthroscopic Bankart repair compared with later onset instability, although no significant structural differences were found between the groups on MRI at a mean 6-year follow-up.

Keywords: initial shoulder instability; adolescence; arthroscopic Bankart repair; clinical outcome; postoperative imaging of shoulder

Recurrent shoulder instability can affect the daily lives of all people, especially young, athletic individuals. It has long been a consensus that young age at initial shoulder instability is a predictor for recurrent shoulder instability, demonstrated by much higher recurrence rates.[28-30] According to the literature, adolescent shoulder instability makes up approximately 20% of all shoulder instability cases,[2] whereas up to 96% of adolescents have experienced recurrent dislocations after initial instability.[6,12,18] Although multiple studies have recommended surgical intervention to reduce recurrence and adverse sequelae, postoperative recurrence rates are still less than satisfactory.[16,22,33]

Previous studies focused mainly on the reasons behind high recurrence rates in a skeletally immature population.[6,11,22,26,40]

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Less attention has been paid to overall outcomes after stabilization surgery by means of detailed functional and radiographic assessments that concentrate on the effect of age at initial instability rather than age at surgery.[14-16] Notably, recurrent shoulder instability has been reported to be associated with progressive glenohumeral structural damage, especially cartilage degeneration due to altered shoulder kinematics.[3,8,13,19,32] It is increasingly thought that age at initial instability plays a crucial role in the development of shoulder arthropathy, even after surgery.[21,27] Due to a lack of overall evaluations, the relationship between age at initial instability and possible postoperative structural changes of the glenohumeral joint is not known. Therefore, it is essential to investigate the relationship between age at initial instability and the overall outcome after shoulder stabilization surgery.

The primary purpose of this study was to compare clinical outcomes and structural changes after arthroscopic Bankart repair in patients who sustained initial shoulder instability during adolescence versus those with later onset instability. We hypothesized that those with shoulder instability during adolescence would have a higher recurrence rate and lower functional scores, although the postoperative glenohumeral joint structure would not differ between groups. Moreover, we compared the functional outcomes of patients with and without postoperative recurrence within each age group.

METHODS

Study Design

This study was approved by the health sciences institutional review board of our hospital, and informed consent was obtained from all patients. The patients were included between September 2007 and December 2017 according to the following criteria: (1) diagnosed anterior shoulder instability with a Bankart lesion or an anterior labral periosteal sleeve avulsion lesion in the affected shoulder, (2) initial shoulder instability between the ages of 13 and 35 years, (3) arthroscopic Bankart repair, and (4) follow-up for at least 2 years after surgery with complete postoperative clinical assessments.

Patients were excluded if they (1) had posterior shoulder instability or multidirectional instability, (2) had a severe rotator cuff tear or frozen shoulder, (3) had a glenoid bone loss >25% determined during arthroscopy, or (4) had undergone remplissage, Latarjet, or open surgery.

The included patients were divided into 2 groups according to age of initial instability: group A for patients who experienced initial shoulder instability during adolescence (age 13-19 years)[34] and group B for patients with initial shoulder instability after adolescence (age 20-35 years). The age at initial shoulder instability was defined as the age at which the first dislocation occurred and was reported by the patients. The surgeon (S.F.) and radiologist (Y.X.) who performed postoperative assessments as well as the included patients were blinded to the group assignment.

Surgical Technique

Arthroscopic Bankart repair was performed by a senior surgeon (S.C.) with assistants using a previously established surgical method.[23] According to the size of glenoid labral tear under arthroscopy, the Bankart lesion was repaired with 2 to 5 suture anchors made from polylactic acid. Hill-Sachs lesions without a tendency to become engaged were considered insignificant and did not require a remplissage procedure. Glenoid bone loss was evaluated, and shoulders with <25% glenoid loss were not reconstructed with a bone block procedure. Concomitant injuries such as superior labral anterior-posterior (SLAP) lesion, chondral damage, injury of the long head of the biceps tendon, and rotator cuff tear were assessed under arthroscopy. Arthroscopic SLAP repair was simultaneously performed using 1 or 2 additional anchors if needed.

Postoperative Rehabilitation

All patients received the same standardized rehabilitation protocol and were required to place the operated arm in a sling in 15° of abduction for 6 weeks after surgery. No raising of the arm was allowed for at least 4 weeks. All patients were instructed to attend the clinic for a follow-up visit at 2, 4, and 8 weeks after their operation. During these follow-up visits, patients were provided with guidance on rehabilitation in which passive shoulder flexion, external rotation, and isometric strengthening exercises were assigned with regard to individual condition. Usually, passive external rotation and lifting started after 6 weeks, whereas strengthening exercises were initiated after 12 weeks. The patients who recovered well were permitted to return to activities at their previous level around 6 months after surgery.

Evaluation

The preoperative evaluations were performed on admission, and the demographic characteristics as well as

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Ethical approval for this study was obtained from Huashan Hospital.

intraoperative findings were obtained from medical records, all of which were double-checked with the patients at the final follow-up. Postoperative evaluations were conducted at the final follow-up, including both clinical and radiographic assessments, by the same surgeon and radiologist.

Clinical Assessment. Recurrence was defined as postoperative shoulder dislocation or subluxation. At final follow-up, subjective pain was scored by the patients using a visual analog scale (VAS) for pain ranging from 0 (no pain) to 10 (extreme pain). Functional scores were completed by the patients through standardized questionnaires, including the Rowe score,[31] Constant-Murley score,[5] and American Shoulder and Elbow Surgeons (ASES) score.[20] The Constant-Murley score and the ASES score were not included in the preoperative assessments because these scores are not usually obtained before surgery. Active range of motion (ROM) of both shoulders, including forward flexion, abduction, external rotation at 90° of abduction, and internal rotation, was measured based on standardized criteria. Outcomes of return to sports were assessed as "return to sports at any level" and "return to sports at previous level." Patients who did not participate in sports preoperatively were not included in the calculation. Furthermore, patients' satisfaction with their postoperative sports level was assessed by asking the patients whether their postoperative sports level had fulfilled their expectations.

Radiographic Assessment. At the time of final follow-up, magnetic resonance imaging (MRI) was performed on a 3.0-T system (Siemens Verio) using a standardized scanning protocol. An 8-channel shoulder coil (Siemens) was used with the arm in neutral rotation at the side of the trunk. The entire shoulder was imaged by coronal-oblique, sagittal-oblique, and axial proton-density turbo-spin echo fat-saturated sequences. The glenohumeral cartilage was evaluated by an axial 3-dimensional proton-density sequence with fat suppression and water excitation.[10] All MRI measurements were performed by the same 2 specialists (radiologic and orthopaedic) using software on a Siemens station (Figure 1). MRI signals were recorded as relative values calculated by target signal and background signal. The labral glenoid height index (LGHI) and labral slope were assessed according to the literature,[42] with parameters measured on axial images for the anterior capsulolabral complex and on coronal images for the inferior area (Figure 2). Cartilage thickness on both the humeral head side and the glenoid side was measured from 3 consecutive axial planes around the largest diameter of the humeral head in 3 areas (anterior, middle, and posterior). Osseous reaction around anchors was classified as grade 0 through 3 in T2-weighted sequences, and the grade of the most severe anchor reaction was recorded.[39]

Statistical Analysis

A sample-size estimation was performed for patient enrollment, with recurrence rate chosen as the endpoint. To our knowledge, no previous study has conducted a comparison regarding age at initial instability, thus we used rates of recurrence in 2 previously published studies based on age

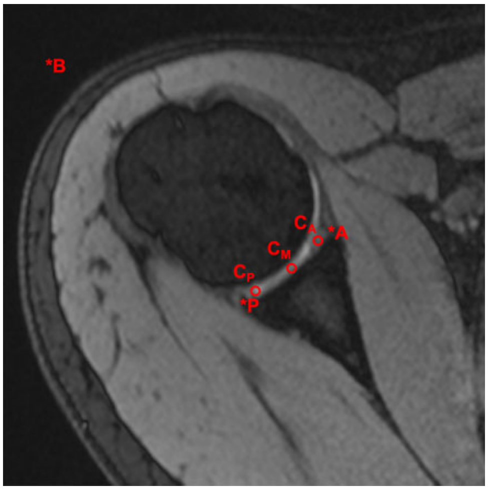

Figure 1. Magnetic resonance imaging scan of a 27-year-old woman after arthroscopic Bankart repair. *A, *P, and *B indicate the regions where signals of the anterior labrum, posterior labrum, and background were measured, respectively. Red circles demonstrate the regions where signal and thickness of cartilage on both the glenoid side and the humeral head side were measured, with C_A, C_M, and C_P indicating the anterior, middle, and posterior cartilage.

at surgery (1 study for the adolescent group[9] and 1 study for the adult group[1]). Under a statistical power of 0.9 and an α level of .05, calculation indicated that the minimum sample size was 23 in each group for the difference to reach statistical significance ($P < .05$). Patient demographic characteristics, intraoperative findings, clinical outcomes, and structural changes were compared between groups. Continuous variables were analyzed using 2-tailed t tests with a 95% CI and were recorded as means with standard deviations, whereas categorical variables were compared using chi-square tests. A univariate analysis of patients with and without postoperative recurrence ($P < .1$) was first performed as a threshold to select factors to include in the multiple logistic regression. Then a multivariable analysis was conducted to verify the possible factors influencing recurrence. Statistical analyses were performed with SPSS Statistical Software (Version 26; IBM) and Excel Office (Microsoft). $P < .05$ was considered statistically significant.

RESULTS

Between September 2007 and December 2017, a total of 168 shoulders underwent shoulder stabilization surgery in our center. Among them, 81 underwent arthroscopic Bankart repair alone, 70 underwent arthroscopic Bankart repair with remplissage, 6 underwent Latarjet procedure, and the others underwent open or combined surgery. In total, 75 patients met the inclusion criteria, of whom 58 (77.3%) were available for the final follow-up (24 in group A and 34 in group B); 17 patients were lost to follow-up. A postoperative MRI scan was obtained for 70.7% of the 58 patients,

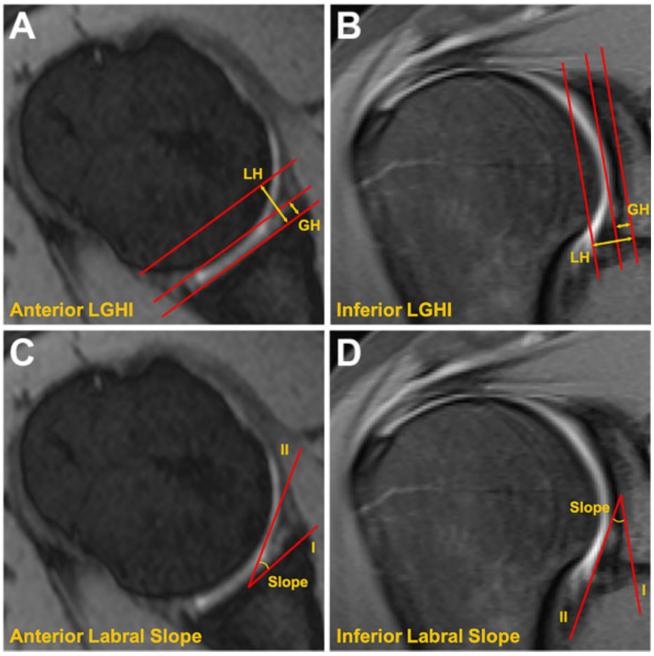

Figure 2. Magnetic resonance imaging T2-weighted slices showing the restored labrum. Labral glenoid height index (LGHI) indicates the quotient of labral height (LH) to glenoid height (GH). The labral slope refers to the angle between the tangent to the lowest portion of the glenoid (I) and the segment from the tip of the maximum labral height to the lowest portion of the glenoid (II). (A) Anterior LGHI. (B) Inferior LGHI. (C) Anterior labral slope. (D) Inferior labral slope.

according to their willingness to undergo imaging. The mean follow-up was 72.1 months (range, 25-140 months), and the mean age at surgery of all patients was 25.5 years. No severe complications, including postoperative infection, neurovascular injury, and anchor displacement, were found at the final follow-up. The patient demographic characteristics and preoperative results (Table 1) as well as intraoperative findings (Table 2) were comparable between the 2 groups, except for age at initial instability (16.3 ± 1.8 vs 25.3 ± 4.2 for group A vs B, respectively; $P < .001$) and age at surgery (20.0 ± 5.0 vs 29.3 ± 4.6, respectively; $P < .001$).

Clinical Outcomes

At final follow-up, a significantly higher recurrence rate was found in group A compared with group B (41.7% vs 11.8% respectively; $P = .009$; risk ratio, 5.36 [95% CI, 1.43-20.09]) (Table 3). A total of 13 patients experienced postoperative shoulder dislocations (9 patients in group A and 4 patients in group B); the mean time from surgery to the first postoperative dislocation was 27.6 months. Among the 13 cases of redislocation, 5 were caused by sports, 4 by accidents, 2 by forceful movements, and 2 by activities of daily living. One patient in group A reported subluxation. None of the patients with recurrence underwent revision surgery. Comparison of the changing survival rate from recurrence between the 2 groups was demonstrated in a Kaplan-Meier survival analysis, showing a lower survival rate in group A over time (Figure 3).

Univariate analyses comparing patients with postoperative recurrence (n = 14) and those without (n = 44) indicated that age at initial instability, age at surgery, and

TABLE 1
Patient Demographic Characteristics and Preoperative Results[a]

	Group A (n = 24)	Group B (n = 34)	P Value
Follow-up time, mo	71.9 ± 37.3	72.3 ± 36.5	.97
Age at initial instability, y	16.3 ± 1.8	25.3 ± 4.2	<.001
Age at surgery, y	20.0 ± 5.0	29.3 ± 4.6	<.001
Duration of symptoms, mo	41.5 ± 49.7	48.3 ± 54.7	.63
Sex, male/female, n	22/2	29/5	.46
Body mass index, kg/m^2	24.2 ± 3.7	23.7 ± 2.8	.56
Dominant arm affected, n (%)	15 (62.5)	24 (70.6)	.52
Preoperative dislocation, n (%)			
1 time	5 (20.8)	5 (14.7)	.54
2-5 times	6 (25)	12 (35.3)	.40
>5 times	13 (54.2)	17 (50)	.75
Sports participation, n (%)	24 (100)	31 (91.2)	.14
Competitive/recreational, n	4/20	1/30	.09
Contact or forced overhead/other, n	19/5	22/9	.49
Reason for the initial shoulder instability, n (%)			
Competitive sports	13 (54.2)	16 (47.1)	.59
Noncompetitive sports	2 (8.3)	4 (11.7)	.67
Falling	3 (12.5)	7 (20.6)	.42
Other injuries	5 (20.8)	5 (14.7)	.54
No apparent causes	1 (4.2)	2 (5.9)	.77

[a]Data are presented as mean ± SD unless otherwise indicated.

TABLE 2
Intraoperative Findings[a]

	Group A (n = 24)	Group B (n = 34)	P Value
Bankart lesion	18 (75.0)	24 (70.6)	.72
ALPSA lesion	6 (25.0)	10 (29.4)	.72
Hill-Sachs lesion	12 (50.0)	11 (32.4)	.18
Glenoid bone loss	6 (25.0)	7 (20.6)	.69
Concomitant SLAP lesion	5 (20.8)	8 (23.5)	.81
Chondral damage	6 (25.0)	3 (8.8)	.09
LHBT injury	1 (4.2)	0	.23
Rotator cuff tear	0 (0)	0 (0)	—
Total number of anchors	3.8 ± 0.7	3.7 ± 0.7	.54
No. of anchors for Bankart repair	3.4 ± 0.8	3.4 ± 0.6	.97
Operative time, min	81.9 ± 23.0	93.1 ± 37.0	.21

[a]Data are presented as n (%) or mean ± SD. ALPSA, anterior labral periosteal sleeve avulsion; LHBT, long head of biceps tendon; SLAP, superior labral anterior-posterior. Dash refers to values that are unavailable or cannot be calculated.

TABLE 3
Clinical Outcomes[a]

	Group A (n = 24)			Group B (n = 34)			
	Preoperative	Postoperative	*P*	Preoperative	Postoperative	*P*	*P* (Group A vs B)[b]
VAS pain score	1.3 ± 2.5	1.5 ± 2.0	.80	1.1 ± 2.0	0.6 ± 1.5	.26	.08
Functional scores							
Rowe	49.4 ± 21.8	76.9 ± 20.1	<.001	50.0 ± 18.1	88.7 ± 13.2	<.001	.01
Constant-Murley	—	92.2 ± 7.6	—	—	96.3 ± 4.2	—	.01
ASES	—	88.6 ± 13.7	—	—	93.2 ± 10.6	—	.17
Active range of motion, deg							
Forward flexion	166.7 ± 22.5	176.3 ± 13.2	.08	168.8 ± 20.3	178.8 ± 5.3	.008	.32
Abduction	160.0 ± 32.1	178.3 ± 6.2	.01	165.3 ± 25.6	179.7 ± 1.7	.002	.24
External rotation	70.0 ± 22.3	82.7 ± 12.7	.02	73.6 ± 20.6	84.3 ± 9.6	.009	.60
Internal rotation, median	T9	T10	.21	T9	T8	.72	.08
	Group A (n = 24)			Group B (n = 34)			
Recurrence, n (%)	10 (41.7)			4 (11.8)			.009
Return to sports, n (%)							
RTS rate	18/24 (75.0)			27/31 (87.1)			.25
RTSP rate	12/24 (50.0)			15/31 (48.4)			.91
Satisfaction with sports level	13/24 (54.2)			15/31 (48.4)			.67

[a]Data are presented as mean ± SD unless otherwise indicated. ASES, American Shoulder and Elbow Surgeons; RTS, return to sports at any level; RTSP, return to sports at previous level; VAS, visual analog scale.
[b]Comparison of postoperative scores.

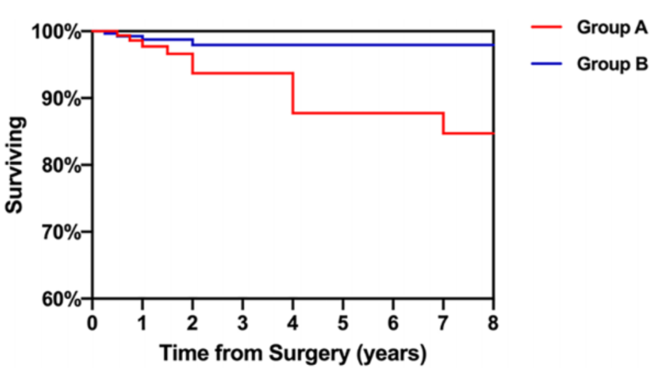

Figure 3. Kaplan-Meier survival analysis demonstrating survival from recurrence (%) after arthroscopic Bankart repair in groups A and B (41.7% vs 11.8%, respectively; *P* = .009; risk ratio, 5.36 [95% CI, 1.43-20.09]).

preoperative type of sports participation should be included in the multiple regression ($P < .1$). However, because age at initial instability and age at surgery were positively correlated ($r = 0.798$; $P < .001$), multiple logistic regression analysis was conducted. The results revealed that only age at initial instability during adolescence ($R^2 = 0.258$; power = 0.9; odds ratio, 4.88 [95% CI, 1.25-19.08]; $P = .023$) and age at surgery <21 years ($R^2 = 0.286$; power = 0.9; odds ratio, 5.88 [95% CI, 1.52-22.81]; $P = .010$) were prognostic of postoperative recurrence in the present study.

The Rowe scores significantly increased in both groups from pre- to postoperative assessments (group A, pre- vs postoperative: 49.4 ± 21.8 vs 76.9 ± 20.1, respectively, $P < .001$; group B, pre- vs postoperative: 50.0 ± 18.1 vs 88.7 ± 13.2, respectively, $P < .001$). Postoperatively, both the Rowe and the Constant-Murley scores were significantly lower in group A than in group B (Rowe score for A vs B: 76.9 ± 20.1 vs 88.7 ± 13.2, respectively, $P = .01$; Constant-Murley for A vs B: 92.2 ± 7.6 vs 96.3 ± 4.2, respectively, $P = .01$). No significant differences were found between the 2 groups regarding VAS for pain, ASES score, active ROM in all directions, and the outcome of RTS (Table 3). The proportions of postoperative sports played by the patients were analyzed, indicating a similar intensity of sports after surgery in the 2 groups (Figure 4).

Structural Changes

Postoperative MRI assessments revealed similar data for anterior and inferior labra in the 2 groups. The cartilage signal as well as thickness on both the humeral head and the glenoid side showed no significant differences. All suture anchors for arthroscopic Bankart repair were detected at the original drill holes without dislocations. No differences of osseous reaction around anchors regarding all severity grades were detected between the 2 groups (Table 4).

Comparisons Regarding Recurrence

Comparisons between patients with and without recurrence were made in groups A and B. A significantly lower Rowe score was shown in patients with recurrence in both groups (group A: 60.5 ± 14.4 vs 87.1 ± 14.7, $P < .001$; group B: 61.3 ± 6.5 vs 92.3 ± 8.8, $P < .001$) (Figure 5). In group A, patients with recurrence exhibited significantly less satisfaction with their postoperative sports level than those without recurrence (20.0% vs 78.6%, respectively; $P =$

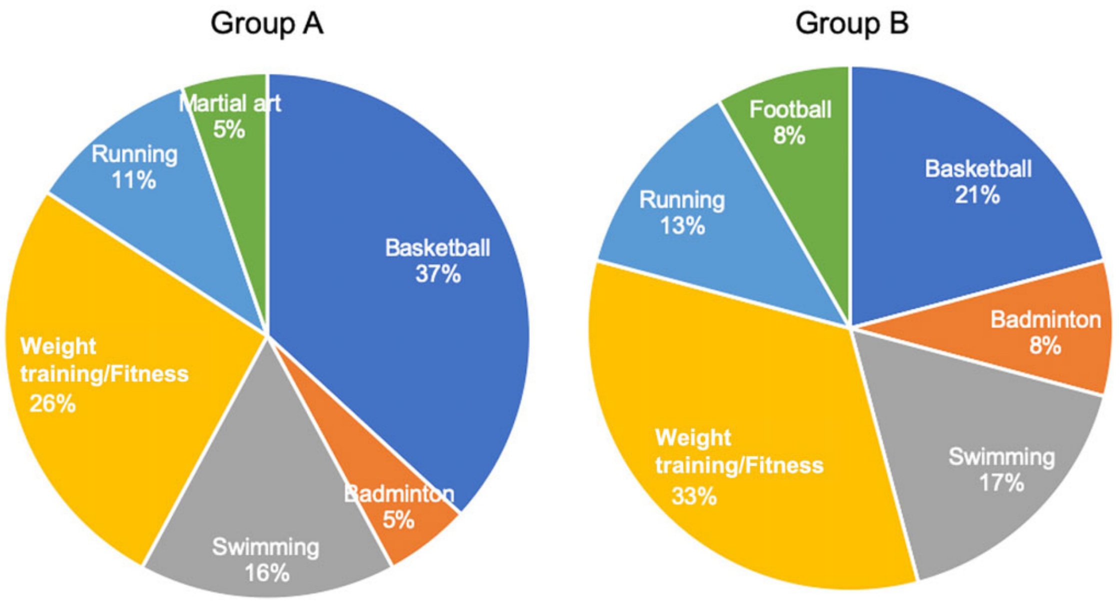

Figure 4. Postoperative sports played by the patients in groups A and B.

TABLE 4
MRI Assessment[a]

	Group A (n = 24)	Group B (n = 34)	*P* Value
Labrum			
Anterior/posterior labral signal	3.4 ± 2.3	3.7 ± 2.2	.64
Anterior LGHI	3.2 ± 0.7	3.0 ± 0.6	.55
Inferior LGHI	2.5 ± 0.4	2.6 ± 0.4	.55
Anterior slope, deg	26.1 ± 2.7	26.0 ± 3.5	.90
Inferior slope, deg	26.4 ± 1.8	25.6 ± 1.9	.20
Cartilage			
Signal on humeral head side	23.0 ± 14.8	26.6 ± 16.5	.48
Signal on glenoid side	19.2 ± 11.8	26.5 ± 15.1	.13
Thickness on humeral head side, mm	1.4 ± 0.2	1.4 ± 0.1	.45
Thickness on glenoid side, mm	1.3 ± 0.1	1.4 ± 0.1	.14
Osseous reaction around anchors, %			
Grade 0 (no changes)	66.7	65.4	.93
Grade 1 (changes <1 mm around the anchor)	0	11.5	.86
Grade 2 (changes 1-3 mm around the anchor)	13.3	19.2	.63
Grade 3 (changes >3 mm around the anchor)	20.0	3.8	.09

[a]Data are presented as mean ± SD unless otherwise indicated. LGHI, labral glenoid height index; MRI, magnetic resonance imaging.

.005) (Figure 6). In group B, patients with recurrence, when compared with the patients without recurrence, demonstrated significantly higher VAS score for pain (2.3 ± 2.8 vs 0.4 ± 1.0, respectively; $P = .02$), lower Constant-Murley score (92.0 ± 3.7 vs 96.8 ± 3.9, respectively; $P = .03$), and lower ASES score (78.3 ± 18.5 vs 95.2 ± 7.0, respectively; $P = .002$) (Figure 4). Active ROM in all directions, outcome of return to sports, and data measured on MRI were comparable between patients with and without recurrence in both group A and group B.

Among the patients with minimum 5-year follow-up (n = 31), 9 patients experienced postoperative recurrence. The patients who experienced recurrence showed higher labral signals, smaller LGHI, and thinner cartilage on both sides than the patients who did not experience recurrence, although no significant difference was found (Table 5).

DISCUSSION

To the best of our knowledge, this is the first investigation attempting to assess both clinical outcomes and structural changes after arthroscopic Bankart repair in patients with initial shoulder instability during adolescence compared with patients who had a later onset of instability. The most important finding of this study was that the patients with initial instability during adolescence showed significantly higher recurrence rates and lower functional scores after arthroscopic Bankart repair, but our results revealed little effect on glenohumeral joint structure.

The recurrence rate for patients with initial instability during adolescence was comparable with that of adolescent patients reported in the literature, which ranged from 18.75% to 44%.[4,14,15] Previous authors reported that anatomic factors including lateral insertion of the joint capsule on the glenoid, high composition of type III collagen fibers, capsule lack of elasticity, and closed proximal humeral physis in the adolescent population could contribute to recurrent instability.[6,22,26,40] Furthermore, adolescent patients who underwent nonoperative treatment at the initial instability tended to restart high-intensity activities within a shorter period of time while at the same time showing less compliance during rehabilitation, which could have a

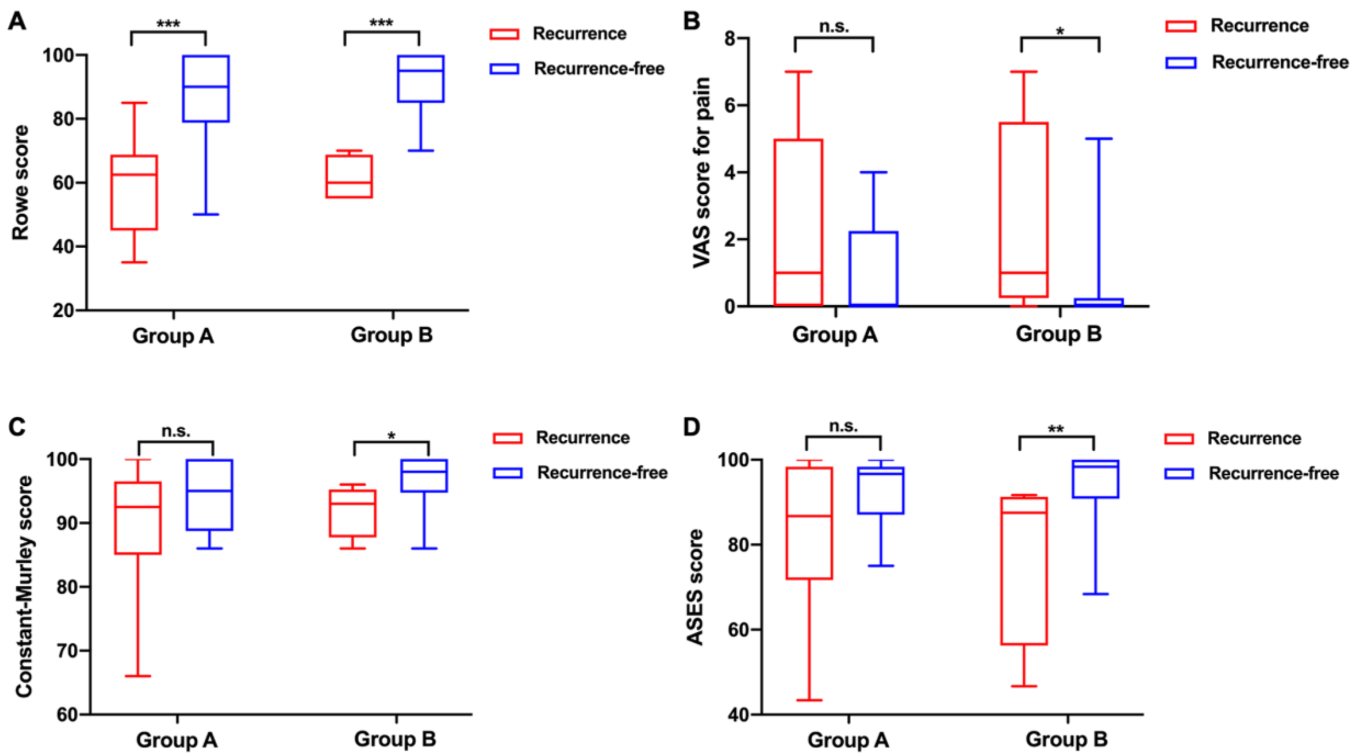

Figure 5. Box-and-whisker plots showing comparisons of (A) Rowe score, (B) visual analog scale (VAS) pain score, (C) Constant-Murley score, and (D) American Shoulder and Elbow Surgeons (ASES) score between the patients with and without recurrence in groups A and B. The box denotes 25th to 75th percentile, the line within the box denotes the median, and the whiskers denote the minimum and maximum. n.s., nonsignificant. *$P < .05$, **$P < .01$, ***$P < .001$.

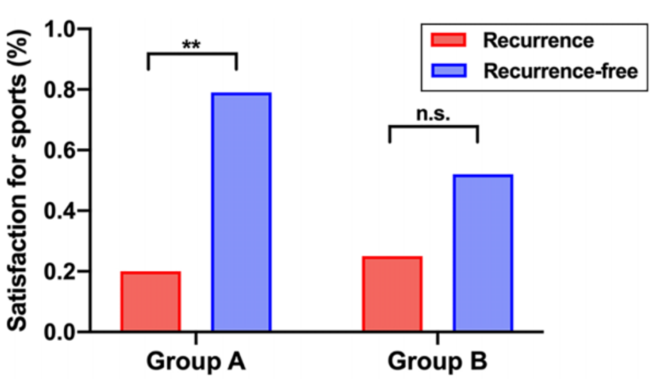

Figure 6. Comparison of satisfaction with postoperative sports level (%) between the patients with and without recurrence in each group. n.s., nonsignificant. **$P < .01$.

TABLE 5
MRI Results of Patients With Minimum 5-Year Follow-up[a]

	Recurrence (n = 9)	No Recurrence (n = 22)	P Value
Anterior/posterior labral signal	4.7	3.6	.49
Anterior LGHI	2.8	3.2	.21
Inferior LGHI	2.5	2.6	.95
Signal on humeral head side	22.4	22.3	.99
Signal on glenoid side	21.6	21.1	.94
Thickness on humeral head side, mm	1.37	1.39	.82
Thickness on glenoid side, mm	1.29	1.30	.92

[a]Data are presented as the mean. LGHI, labral glenoid height index; MRI, magnetic resonance imaging.

negative effect on the later surgical procedures and contribute to a high recurrence rate after surgery.[6,17] In the current study, we presumed that the patients who experienced initial instability during adolescence might choose to undergo stabilization surgery later, which would result in continued symptoms with high-intensity activities, limited access to physical therapy, and low compliance with medical advice. Compared with adults who had a symptom duration of similar length, adolescents could experience more negative effects from a delayed surgical intervention, thus adding to the risk of postoperative recurrence.[15,22]

Satisfactory functional scores after arthroscopic Bankart repair in adolescents were reported in several studies without a control group.[4,16,36] However, in the present study, significantly lower Rowe and Constant-Murley scores were found in the patients with initial instability during adolescence compared with the patients who had a later onset. It was difficult to clarify the exact relationship between age at initial instability and postoperative functional scores, because the postoperative recurrence could impair shoulder function both physiologically and psychologically. The failure of arthroscopic surgery such as rotator cuff repair is usually perceived by patients gradually after surgery, with increasing pain or restricted ROM, and is finally diagnosed by doctors after physical and radiological examination. However, the failure of stabilization surgery would be discovered when a postoperative instability event occurs. In such cases, patients could experience impaired shoulder function as well as frustration due to the recurrence. Therefore, the difference we noted in functional scores could be partially attributed to the significant difference in recurrence rates between the 2 groups. Furthermore, when the initial instability occurs, younger patients who participate in high-intensity sports often show high expectations for sports participation and activity level after surgery.[25] Postoperative outcomes that fail to live up to such patients' expectations could lead to low subjective scores.

Recurrent shoulder instability has been reported to cause structural damage to the glenohumeral joint.[41] Previous studies revealed that shoulder dislocations could result in an altered stress distribution, giving rise to progressive cartilage degeneration.[7,13] Surgical interventions might damage the joint, because implanted devices could produce complications and lead to a loss of normal structure.[38] Therefore, shoulder arthropathy might occur, especially among patients with onset of instability in old age.[3,7,13,17,24] The water excitation MRI sequence used in the present study was reported to be capable of detecting subtle cartilage alterations at an early stage and identifying individuals with a risk of accelerated cartilage degeneration.[10] The mean cartilage thickness in groups A and B in the current study was similar to that of healthy volunteers,[35] indicating no significant morphological glenohumeral cartilage degeneration. An MRI-based study suggested that recurrent dislocations played an important role in structural changes of the glenohumeral joint.[39] Although initial instability during adolescence was associated with a higher recurrence rate and lower functional scores in the present study, we found no significant adverse structural changes of the glenohumeral joint postoperatively. Therefore, the glenohumeral soft tissues of adolescents might be able to withstand repetitive trauma, which is in agreement with a long-term study with a follow-up of 20 years.[37] We postulated that patients with an early onset of instability could recover from possible structural damage caused by recurrent instability, owing to a superior potential for healing due to young age. Additionally, the postoperative MRI assessments showed well-restored glenoid labra, demonstrated by favorable labral signals, LGHI, and slope, in both groups without significant differences between groups, a finding that is comparable with a previous study with patients from all age groups.[39] This evidence indicated that regardless of age at time of surgery, arthroscopic Bankart repair seemed to prevent early degenerative changes of the glenohumeral joint. This could partially contribute to the fact that around 50% of the patients in both groups experienced <5 dislocations before surgery.

This study focused mainly on the influence of age at initial instability on overall outcomes after arthroscopic Bankart repair. However, we could not rule out that age at surgery also had an effect on the outcomes, as these 2 factors were correlated. Nevertheless, the current results indicate that when doctors are making decisions about surgical techniques and rehabilitation plans, individualized treatment should be adopted that take into consideration the patient's age at initial instability. Based on the present findings, it seems reasonable that the choice of surgical technique should consider whether a patient experienced initial instability during adolescence. Because these patients might experience a much higher recurrence rate after surgery, the threshold of an additional remplissage procedure or open surgery could be moderately lowered for them. Furthermore, surgical intervention might be recommended for first-time dislocations in this age group to prevent recurrent instability, which could help to achieve a well-restored joint structure after stabilization surgery. However, because patients with initial instability during adolescence might better withstand repetitive trauma given the structure of the glenohumeral joint, attention to adverse structural changes should be paid mainly to older patients.

These are several limitations to the current study. First, the sample size was relatively small. However, the sample size estimation confirmed that the number of patients could be sufficient for the difference to reach a level of statistical significance. Because strict inclusion and exclusion criteria were established to ensure a homogeneous background of the included patients and a comparable baseline between the 2 groups, the patient number was unavoidably reduced. Second, a mean 6-year follow-up might not be long enough to discover significant glenohumeral structural changes. Therefore, studies with longer follow-ups are needed. Nevertheless, because the mean time from initial instability to the postoperative MRI scan was around 10 years (symptom duration plus follow-up time) in the present study, the results are still considered reliable. Third, the current conclusions may not be applicable to patients with initial instability at age 35 years or later, as these patients were excluded from this study. Considering that most patients experience initial instability at a young age, the information provided by this study is in agreement with this epidemiological feature. Fourth, preoperative ASES and Constant-Murley scores were unavailable given the retrospective nature of this study. Fifth, the number of collision athletes (eg, American football and rugby) was small in the current cohort, which might have led to selection bias.

CONCLUSION

Initial shoulder instability during adolescence was associated with higher recurrence rate and lower functional scores after arthroscopic Bankart repair in a mean 6-year follow-up with no significant structural changes on MRI.

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