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Pathology and surgical outcomes of unstable painful shoulders

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Background: Boileau et al have reported on the unstable, painful shoulder (UPS), which was defined as painful shoulders without any recognized anteroinferior subluxations or dislocations that were associated with roll-over lesions (ie, instability lesions) on imaging or at arthroscopy. However, they included various pathologies, probably due to the ambiguity in their definitions of UPS. We redefined UPS as follows: (1) shoulder pain during daily or sports activities, (2) traumatic onset, (3) no complaint of shoulder instability, and (4) soft-tissue or bony lesions, such as Bankart or humeral avulsion of glenohumeral ligament lesion, confirmed by arthroscopy. The purpose of this study was to retrospectively investigate pathologies of UPS based on our definitions. We also aimed to assess the outcomes after arthroscopic soft-tissue stabilization for UPS.
Methods: We reviewed patients who were retrospectively diagnosed as UPS based on our definition and underwent arthroscopic stabilization between January 2007 and September 2018. Patients' demographics, physical and radiographic findings, intraoperative findings, clinical outcomes (Rowe scores, Subjective Shoulder Value [SSV], and the visual analog scale [VAS] for pain), and return to play sport (RTPS) were investigated.
Results: This study included 91 shoulders in 91 patients with a mean age of 23 years (range, 15-51). The mean follow-up was 37 months (range, 24-156). Eighty-seven patients were involved in sports activities: collision/contact, 55 patients (60%); overhead, 26 patients (29%). The pain was reproduced during the anterior apprehension test in 86 shoulders (95%). Normal type (49%) predominated in glenoid morphology followed by fragment (bony Bankart) type (37%). Most fragment-type lesions were seen in collision/contact athletes. Intraoperative findings demonstrated that Bankart lesions were found in all patients and Hill-Sachs lesions only in 42%. Magnetic resonance arthrography in the abducted and externally rotated positions showed a Bankart lesion in 76 shoulders (84%). Rowe score, SSV, and pain VAS significantly improved postoperatively ($P < .001$ for each). Forty-two of 70 athletes (60 %) with > 2-year follow-up returned to the sport at a complete or near-preinjury level. Six (9%) athletes experienced reinjury.
Conclusion: All shoulders that were diagnosed as UPS with our definition had a Bankart lesion. There seemed to be two different types of pathologies: Bankart lesions in lax shoulders and bony Bankart lesions in collision/contact athletes. The pain experienced during the anterior apprehension test may be useful for the diagnosis of UPS. Arthroscopic soft-tissue stabilization yielded good clinical outcomes with a high RTPS rate, but the reinjury rate was relatively high.

Shoulder pain associated with minor instability of the glenohumeral joint has been discovered in the last decade.[2,7,10,20-22,25] Previous articles have proposed a variety of pathologies as possible causes of this shoulder disorder; this may be due to the ambiguity in the definition of the disease. This issue may have made the diagnosis and treatment of this shoulder disorder difficult.

The most famous report of this disorder may be the one by Boileau et al.[5] They have reported on painful shoulders associated with unrecognized anteroinferior instability and named them 'unstable painful shoulder (UPS)'. They defined UPS as (1) shoulder pain related to anteroinferior instability without any apparent

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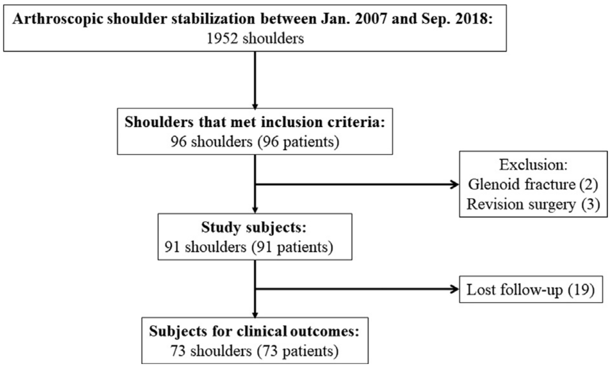

Figure 1 Patient selection.

history of dislocation or subluxation and (2) anteroinferior instability confirmed by the discovery of roll-over lesion, which means posttraumatic soft tissue or bony lesions detected with imaging or arthroscopy. These definitions, however, pose a couple of problems. First, they included patients without any proceeding trauma. Second, they included shoulders without roll-over lesions despite the definitions above. As a result, a variety of pathologies were indicated as causes of UPS, including atraumatic multidirectional shoulder instability (MDI). We questioned whether atraumatic pathologies should be included as causes of UPS and assumed that Bankart lesions would be the main cause of UPS. Based on the question, we redefined UPS as follows: (1) shoulder pain during daily or sports activities, (2) traumatic onset, (3) no complaint of shoulder instability, (4) soft-tissue or bony lesions, such as Bankart or humeral avulsion of glenohumeral ligament (HAGL) lesion, confirmed by arthroscopy.

The purpose of this study was to retrospectively investigate pathologies of UPS based on our definitions. We also aimed to assess the outcomes after arthroscopic soft-tissue stabilization for UPS. We hypothesized that Bankart lesion would be the main cause of UPS. We also hypothesized that arthroscopic soft-tissue stabilization for patients with UPS would yield good clinical outcomes, including a high return to play sport (RTPS) rate.

Materials and methods

This was a retrospective case-series study on the pathology and diagnosis of UPS and treatment outcomes after arthroscopic soft tissue stabilization for UPS. This study was conducted at a single orthopedic sports medicine center, which specializes in shoulder and elbow surgery. The institutional review board of our institute approved the study protocol.

Patient selection

We retrospectively searched patients who underwent arthroscopic shoulder stabilization at our institute between January 2007 and September 2018. The inclusion criteria of this study were as follows: (1) shoulder pain during daily or sports activities, (2) traumatic onset, (3) no complaint of shoulder instability, and (4) soft-tissue or bony lesions, such as Bankart or HAGL lesion, confirmed by arthroscopy. Exclusion criteria were as follows: (1) acute glenoid fracture[12,14] and (2) revision surgery (Fig. 1)

Data collection

Medical records were reviewed to collect patients' data, including sex, age at surgery, affected side, sports participation and types, initial injuries, the time between initial injury and diagnosis, and reinjury. Types of sports were categorized as (1) collision or contact, (2) overhead, and (3) other sports. Collision and contact sports were defined according to the criteria proposed by the American Academy of Pediatrics Committee on Sports Medicine.[1] Although judo and sumo (Japanese wrestling) were not listed on the criteria, we included them in collision and contact sports. Overhead sports included baseball, softball, handball, water polo, tennis, and badminton.[26]

Surgical procedures

Arthroscopic soft tissue stabilization was applied for all UPS, which is the same procedure as those for traumatic recurrent anterior shoulder instability that were described in previous articles.[15,23,24] All surgeries were performed in the beach chair position under general anesthesia by or under close supervision of one of the senior surgeons (H.S., N.T., K.M., and M.T.). Routine diagnostic arthroscopy was performed throughout the glenohumeral joint. Then, the labroligamentous complex was separated from the glenoid neck starting from the 2 o'clock position to the 7 o'clock or 7:30 position (in a right shoulder). After the extensive labral release, a small amount of articular cartilage at the anteroinferior glenoid face was removed to promote tissue healing. The labroligamentous complex was fixed with at least four suture anchors loaded with a #2 high strength suture (Gryphon BR, Depuy Mitek, Raynham, Massachusetts, USA; Osteoraptor OS, Smith and Nephew, Andover, Massachusetts, USA), cranially pulling up the complex using a grasper. The bony Bankart lesion was repaired without resection of the fragment.[15,23,24] Other pathological lesions such as the superior labrum anterior to posterior (SLAP) lesion, capsular tear, HAGL lesion, and rotator cuff tear were also repaired as necessary. Rotator interval closure was performed as an augmentation for patients that were at a high risk of recurrence, such as younger athletes (<20 years) or collision and contact athletes.[15,23,24] Hill-Sachs remplissage was also performed for young collision and contact athletes with a Hill-Sachs lesion and glenoid bone loss.[15]

Postoperative protocol

The postoperative protocol was also the same as that for recurrent shoulder instability.[15,23,24] After three to four weeks of immobilization using a sling, passive and assisted-active range of motion exercises were initiated while avoiding the provocation of pain. Twelve weeks after surgery, a strengthening program was started, followed by sports practice. Full return to play was allowed at postoperative 4 to 6 months according to the functional recovery of each patient.

Patient assessment

Each patient's active ranges of motion (forward elevation, external rotation at the side, and internal rotation) were preoperatively and postoperatively examined by one of the experienced shoulder surgeons (H.S., N.T., K.M., and M.T.). Flexion and external rotation were measured using a goniometer. Internal rotation was scored as greater trochanter, 0; buttock, 2; sacrum, 4; L3, 6; Th12, 8; Th7-8, 10.[4]

Patients were preoperatively examined with glenohumeral hyperlaxity, which was defined as $>85°$ of external rotation at the side,[5] and the anterior apprehension test. Patients were preoperatively and postoperatively assessed with the Rowe score,[20] Subjective Shoulder Value (SSV),[13] and pain during daily activities or sports using the 100-mm visual analog scale (VAS). We used a questionnaire at the final follow-up to assess RTPS by self-assessment.[8] According to Cho's report,[8] we divided the levels of postoperative sports activity into 5 grades: 1, complete return to preinjury activity level; 2, return to near preinjury activity level (>90% recovery); 3, return to preinjury activity with moderate limitations (>70% recovery); 4, return to preinjury activity with severe limitations or inability to return to preinjury activity but without any discomfort or pain in the shoulder during daily activities (>50%); and 5, inability to return to preinjury activity with discomfort or pain in the shoulder during daily activities.

Radiographic evaluation

All radiographic findings were assessed by an experienced shoulder surgeon (S.H.). We assessed preoperative glenoid morphology with three-dimensionally (3D) reconstructed CT images (Alexion, Toshiba, Tochigi, Japan). The scanning parameters were as follows: image matrix, 512 × 512; pixel size, 0.5 × 0.5 mm; slice pitch, 0.5 mm. Glenoid morphology was evaluated with the en face view of the glenoid using Digital Imaging and Communications in Medicine (DICOM) viewer (ShadeQuest/ViewC, Yokogawa Medical Solutions, Tokyo, Japan) and classified into three types: normal, attritional, and bony types.[23,24]

We also assessed Bankart lesions with magnetic resonance arthrogram (MRA) using a 0.3 T open-type scanner (Airis Vento, Hitachi, Tokyo, Japan) or 1.5 T closed-type scanner (Intera; Philips, Amsterdam, the Netherlands) with a phased-array surface coil. Images were taken in two arm positions: abducted and externally rotated (ABER) position and adducted and internally rotated (ADIR) position.[3]

For MRA with the 0.3-T scanner, 20 ml of gadoteridol solution (0.3 ml gadoteridol [Prohance, Bracco Diagnostics Inc, Cranbury, New Jersey, USA] with 20 ml saline) was injected into the glenohumeral joint under fluoroscopic guidance. T1-weighted transverse images in the ADIR position and T1-weighted oblique transverse images in the ABER position (parallel to the humeral shaft) were obtained with an echo-train length of 20, a 4.0-mm slice thickness, and a 3.5-mm slice gap. The parameters for the ADIR images were as follows: repetition time (TR), 145 ms; echo time (TE), 27 ms; field of view (FOV), 160 mm; matrix, 288 × 224. The parameters for the ABER images were as follows: TR, 350 ms; TE, 14 ms; FOV, 160 mm; matrix, 260 × 224.

For MRA with the 1.5-T scanner, 10-ml saline was injected into the glenohumeral joint under fluoroscopic guidance. T2-weighted images in the same directions as those with the 0.3-T scanner were obtained using an echo-train length of 13, a 4.0-mm slice thickness, and a 0.4-mm slice gap. The parameters for both ADIR and ABER images were as follows: TR, 2000 ms; TE, 40 ms; FOV, 160 mm; matrix, 512 × 512.

Statistical analysis

The paired t-test was used for the comparison of preoperative and postoperative functional outcomes. The chi-square test was used to compare categorical variables. A two-sided P value of less than .05 was considered to indicate statistical significance. All analyses were performed with the IBM SPSS Statistics 18 software for Windows (IBM Japan Inc., Tokyo, Japan).

Results

Patients

A total of 1952 shoulders underwent arthroscopic shoulder stabilization, and 96 shoulders met the inclusion criteria (Fig. 1). Two shoulders with a glenoid fracture and three shoulders with revision surgery were excluded from the study. The remaining 91 shoulders (4.7% of all arthroscopic stabilization) in 91 patients were involved in this study (Table I). The patients consisted of 79 males and 12 females with a mean age at surgery of 23 years (range, 15-51). Eighty-seven (96%) patients participated in sports activities: 55 (60%) patients were involved in collision or contact sports, and 26 (29%) patients were involved in overhead sports. The dominant arm was affected in 63 (69%) patients. Initial injuries included falling on the shoulder in 31 (34%) shoulders, head-first sliding in 18 (20%) shoulders, and tackling in 14 (15%) shoulders. The mean time between initial injury and diagnosis was 9 months (range, 1-64).

Table I
Patient demographics.

	Data
Total number of shoulders	91
Sex, n (%)	
Male	79 (87)
Female	12 (13)
Age at surgery, years (range)	23 (15-51)
Affected shoulder, n (%)	
Dominant	63 (69)
Nondominant	28 (31)
Types of sports, n (%)	
Collision/contact	55 (60)
Overhead	26 (29)
Others	6 (7)
None	4 (4)
Initial injury, n (%)	
Falling	31 (34)
Head-first sliding	18 (20)
Tackling	15 (15)
Others	27 (31)
Time between injury and diagnosis, months (range)	9 (1-64)

Preoperative findings

Glenohumeral hyperlaxity was seen in 35 (38%) shoulders (Table II). The anterior apprehension test was positive only in 18 shoulders (20%), while the pain was reproduced during the test in 86 shoulders (95%).

Preoperative 3DCT of the glenoid demonstrated normal type in 45 (49 %), fragment (bony Bankart) type in 33 (37 %), and attritional type in 13 (14 %) shoulders (Table II). Twenty-eight (85%) out of 45 fragment-type lesions were found in collision or contact sport athletes (Table III). Bankart lesions were detected in 76 (84%) shoulders on preoperative MRA with the ADIR position and 77 (85%) shoulders with the ABER position (Table II).

Intraoperative findings

All 91 shoulders had a Bankart lesion, and arthroscopic Bankart repair was performed in all shoulders (Table IV). Hill-Sachs lesions were found in 38 (42%) shoulders. Rotator interval closure was carried out as an augmentation in 36 shoulders. Hill-Sachs remplissage was performed in four shoulders in combination with rotator interval closure. Concomitant SLAP lesion, capsular tear, HAGL lesion, and rotator cuff tear were seen in 32 (35%), two (2%), one (1%), and two (2%) shoulders, respectively, and all lesions were repaired (Table IV).

Clinical outcomes

Seventy-three out of 91 shoulders (80%) were followed up for more than 24 months after surgery (Fig. 1). The mean follow-up was 44 months (range, 24-72 months). There were no significant

Table II
Preoperative findings.

	No. of shoulders (%)
Clinical findings	
Hyperlaxity	35 (38)
Anterior apprehension test, instability	18 (20)
Anterior apprehension test, pain	86 (95)
Radiographic findings	
Glenoid morphology on 3DCT	
Normal	45 (49)
Fragment (Bony Bankart)	33 (37)
Attritional	13 (14)
Bankart lesion on MRA	
ADIR	76 (84)
ABER	77 (85)

MRA, magnetic resonance arthrogram; *ADIR*, adducted and internally rotated position; *ABER*, abducted and externally rotated position.

Table III
Relationship between types of sports and glenoid morphology.

Types of sports	Glenoid morphology		
	Normal (n = 45)	Fragment (n = 33)	Attritional (n = 13)
Collision/contact	21 (47%)	28 (85%)	6 (46%)
Overhead	20 (44%)	2 (6%)	4 (31%)
Others	2 (4%)	2 (6%)	2 (15%)
None	2 (4%)	1 (3%)	1 (33%)

Table IV
Intraoperative findings.

	No. of shoulders (%)
Bankart lesion	91 (100)
Hill-Sachs lesion	38 (42)
SLAP lesion	32 (35)
Rotator cuff tear	2 (2)
Capsular tear	2 (2)
HAGL lesion	1 (1)

SLAP, superior labrum anterior to posterior; *HAGL*, humeral avulsion of the inferior glenohumeral ligament.

changes between preoperative and postoperative active ranges of motion (Table V). VAS for pain, SSV, and Rowe scores significantly improved after surgery ($P < .001$ for each).

Seventy of 73 patients preoperatively participated in sports activities. The mean time to sport return was 7 months (range, 3-36), and 42 (60 %) patients returned completely or to a near-preinjury level (grade 1 or 2 in Cho's grading[7]) based on the self-assessment (Table VI). Six shoulders (9%) experienced reinjury. Of

Table V
Preoperative and postoperative shoulder function.

	Preop.	Postop.	*P* value
Active range of motion			
Forward elevation, degrees	169 (140-180)	168 (135-180)	.08
External rotation, degrees	65 (60-90)	62 (20-90)	.8
Internal rotation, points*	9 (4-10)	9 (4-10)	.9
Pain VAS	34 (10-80)	8 (0-60)	<.001
Rowe score	71 (20-100)	95 (45-100)	<.001
SSV score	42 (0-95)	86 (0-100)	<.001

VAS, visual analog scale; *SSV*, subjective shoulder value.
Values are given as mean (range).
*Active internal rotation was scored as greater trochanter, 0; buttocks, 2; sacrum, 4; L3, 6; Th12, 8; Th7-8, 10.

Table VI
Sport return.

	Data
Total number of shoulders	70
Reinjury, n (%)	6 (9)
Time to sport return, month (range)	7 (3-36)
Reached proficiency level, n (%)	
Grade 1	32 (46)
Grade 2	10 (14)
Grade 3	19 (27)
Grade 4	9 (13)
Grade 5	0 (0)

the six shoulders with recurrence, five shoulders were involved in collision or contact sports (Table VII). Three shoulders only had Bankart repair, two of which had hyperlaxity of the glenohumeral joint. No shoulders had Hill-Sachs remplissage. All patients experienced reinjury around postoperative 1 year except for one non-collision/contact athlete (54 months). There were no significant differences in types of sports, hand dominance, augmentation procedures, and hyperlaxity by sport return level (Table VIII).

Discussion

This study demonstrated that all shoulders that were diagnosed as UPS based on our definition had a Bankart lesion, confirming the first hypothesis. Preoperative CT showed almost half of the shoulders with normal glenoid morphology. Most patients participated in sports activities, especially collision/contact and overhead sports. The anterior apprehension test was positive only in 20% of shoulders, but the pain was reproduced in most shoulders. Arthroscopic soft-tissue stabilization yielded good clinical outcomes, including a high RTPS rate, confirming the second hypothesis, although the reinjury rate was relatively high.

Although Boileau's definitions of UPS[5] are widely accepted, they do not include traumatic onset. Due to this issue, it is possible that shoulders with only capsular laxity were included in their patients, which may be compatible with MDI. As we believe that MDI is a different pathology than UPS, we included traumatic onset in our definition of UPS to contrast the two disorders. As a result, all shoulders had a Bankart lesion in this study, which we propose to be the principal cause of UPS.

It has been reported that UPS is common in young, female, and overhead athletes.[5] In this study, 38% of patients had glenohumeral joints with hyperlaxity, and glenoid morphology was normal in almost half of the shoulders. The incidence of normal glenoid morphology was considerably high compared to the previous report on traumatic anterior shoulder instability.[23] In addition, more than half of the shoulders did not have a Hill-Sachs lesion. These findings suggest that the laxity of the glenohumeral joint is high in many patients.[18] Labral injuries that were added to lax shoulders may have caused subclinical instability and pain. Laxity of the glenohumeral joints is a possible factor associated with UPS, although it may not be a primary cause.

The subjects of this study included more contact/collision than overhead athletes, and most contact/collision athletes had a fragment-type Bankart lesion. Funk has also reported that some rugby players had subclinical shoulder instability without frank dislocation, which was associated with shoulder pain.[11] This study suggested that bony glenoid lesions in contact/collision athletes may have caused the shoulder pain due to subclinical instability. Thus, we suppose that UPS includes two different pathologies: (1) Bankart lesions in lax shoulders and (2) bony Bankart lesions in collision/contact athletes.

Table VII
Details of patients with reinjury.

Patients	Sports	Age	Sex	Hyperlaxity	Glenoid morphology	Augmentation procedures	Time to reinjury
1	Collision/contact	15	Male	Yes	Fragment	RIC	7
2	Collision/contact	26	Male	No	Fragment	RIC	11
3	Collision/contact	35	Male	No	Fragment	RIC	10
4	Collision/contact	23	Male	Yes	Attritional	None	15
5	Collision/contact	24	Female	No	Normal	None	5
6	Others	43	Female	Yes	Fragment	None	54

RIC, rotator interval closure.

Table VIII
Comparisons by sport return level.

	Cho's grading		*P* value
	Grade 1 & 2	Grade 3 & 4	
No. of shoulders	42	28	
Collision/contact sports	28 (67%)	19 (68%)	.8
Dominant shoulders	32 (76%)	18 (64%)	.2
Augmentations			.2
RIC	20 (48%)	9 (32%)	
RIC & HSR	3 (7%)	0 (0%)	
Hyperlaxity	17 (40%)	13 (46%)	.8

RIC, rotator interval closure; *HSR*, Hill-Sachs remplissage.

In this study, 3DCT evaluation revealed that the prevalence of bony Bankart lesions in UPS was considerably higher than previously reported.[5] The discrepancy might be due to differences in the evaluation methods, as well as the difference in study subjects. As previous studies did not use 3DCT, bony lesions may have been overlooked.[5] In addition, preoperative MRA detected Bankart lesions in 83% of shoulders in the ADIR position and 85% in the ABER position. MRA in the ABER position has been reported to have a superior ability of labral injury detection to the ADIR position.[9,16] We believe that 3DCT and MRA in the ABER position positively contribute to the diagnosis and understanding of the pathologies in patients with suspected UPS. However, surgical treatment should be applied to shoulders even if a Bankart lesion cannot be observed on MRA as long as they demonstrate the clinical features of UPS.

There may be difficulties in making a diagnosis of UPS because no unique clinical tests or radiographic examinations exist.[5,19] In this study, the pain was reproduced during the anterior apprehension test in 94% of shoulders. This finding should be helpful for the diagnosis of UPS in painful shoulders with a traumatic onset, but this type of pain is sometimes observed in other pathologies such as SLAP or MDI.[17] The diagnosis of UPS should be made comprehensively with a careful patient interview, physical examinations, and radiographic examinations.

This study demonstrated that 9% of athletes experienced reinjury. Most reinjuries occurred in collision/contact athletes around postoperative 1 year, and no shoulders had Hill-Sachs remplissage. In addition, half of the reinjured patients showed hyperlaxity of the glenohumeral joint, and two out of the three shoulders with hyperlaxity had no augmentation procedures. Our previous study on collision athletes with traumatic anterior shoulder instability indicated that arthroscopic Bankart repair with selective augmentations yielded good clinical outcomes with a low recurrence rate (3.5%).[15] Other studies have also proved that Hill-Sachs remplissage is an effective arthroscopic augmentation procedure to minimize the recurrence rates.[6,12] We may consider adding some augmentation procedures for UPS depending on each patient's risks such as sports, bone morphology, and joint laxity to prevent postoperative reinjury.

This study had several limitations. First, this was a retrospective case-study series. Further research such as case-control or randomized studies may be required to validate our new definition of UPS. Second, this was a mid-term follow-up study. The results may vary with a longer-term follow-up. Third, the follow-up rate for clinical outcomes was not sufficient. Despite these limitations, we believe that this study will provide insightful information on the diagnosis and treatment of UPS.

Conclusion

All shoulders that were diagnosed as UPS with our definition had a Bankart lesion. There seemed to be two different types of pathologies: Bankart lesions in lax shoulders and bony-type Bankart lesions in collision/contact athletes. The pain experienced during the anterior apprehension test may be useful for the diagnosis of UPS. Arthroscopic soft-tissue stabilization yielded good clinical outcomes with a high RTPS rate, but the reinjury rate was relatively high.

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