# Bankart Repair With Subscapularis Augmentation in Athletes With Shoulder Hyperlaxity

Marco Maiotti, M.D., Raffaele Russo, M.D., Antonio Zanini, M.D, Roberto Castricini, M.D., Gianluca Castellarin, M.D., Steffen Schröter, M.D., Carlo Massoni, M.D., and Felix Henry Savoie III, M.D.

**Purpose:** The purpose of this study was to demonstrate that arthroscopic Bankart repair with associated arthroscopic subscapularis augmentation (ASA) could be a valid surgical option in the treatment of anterior shoulder instability, in collision and contact sports athletes, affected by shoulder hyperlaxity. **Methods:** In total, 591 arthroscopic Bankart repairs plus ASA were performed in 6 shoulder centers from 2009 to 2017. Inclusion criteria were the following: collision and contact sports activities, recurrent anterior instability associated with hyperlaxity and glenoid bone loss (GBL) < 15%. Exclusion criteria were GBL > 15%, voluntary instability, multidirectional instability, pre-existing osteoarthritis and throwing athletes. The minimum follow-up was 24 months. Hyperlaxity was clinically evaluated according to Neer and Coudane-Walch tests. Before surgery, all patients underwent magnetic resonance imaging and computed tomography scanning. Pico area method was used to assess the percentage of GBL. Patients were operated on by 6 surgeons, and their functional outcomes were evaluated by 2 independent observers. The Western Ontario Shoulder Instability Index (WOSI), Rowe, American Shoulder and Elbow Surgeons (ASES) scores were used to assess results. **Results:** Overall, 397 patients with evidence of shoulder hyperlaxity (positive sulcus sign in ER1 position and Coudane-Walch test > 85°) met all inclusion criteria. The mean WOSI score was 321; the mean Rowe score rose from 68.5 to 92.5 ($P = .037$), and the ASES score rose from 71.5 to 97.4 ($P = .041$). Seven patients (1.6%) had atraumatic redislocation, and 9 patients (2.2%) had post-traumatic redislocation. At final follow-up the mean functional deficit of external rotation was 15° with the arm in adduction (ER1 position) and 10° in abduction (ER2 position). **Conclusions:** The Bankart repair plus ASA has been demonstrated to be safe and effective for restoring joint stability in patients practicing collision and contact sports or affected by chronic anterior shoulder instability associated with GBL (<15%) and hyperlaxity, without compromising external rotation. **Level of Evidence:** Level IV, case series.

*See commentary on page 2063*

*From the Shoulder Unit Villa Stuart Hospital (M.M.) and the Orthopedics and Traumatology Unit, Pio XI Hospital (C.M.), Rome, Orthopedics and Traumatology Unit, Pineta Grande Hospital (R.R.), Castelvolturno, Orthopedics and Traumatology Unit, San Clemente Hospital (A.Z.), and Orthopedics and Traumatology Unit, Suzzara Hospital (G.C.), Mantua, the Orthopedics and Traumatology Unit, Villa Verdi Hospital (R.C.), Fermo, Italy, the Department of Orthopedics, Eberhard Karls University (S.S.), Tübingen, Germany, and Tulane Institute of Sports Medicine, Tulane University (F.H.S), New Orleans, LA, USA.*

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*Address correspondence to Marco Maiotti, M.D., Via Archimede 153, Rome, Italy. E-mail: maiotti.marco@gmail.com*



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Arthroscopic Bankart repair (ABR) has, for almost 3 decades, remained the most popular surgical option to treat recurrent anterior dislocation of the shoulder joint. However, some studies have reported that its failure rate may be higher than 20%.[1-4] The main risk factors for ABR failure include younger age, male sex, bony defects, contact sports, poor quality capsule, and shoulder hyperlaxity.[5-7]

More recently, the remplissage procedure[8,9] has been widely suggested to address humeral bone defects (engaging Hill-Sachs lesions). The remplissage procedure[10,11] is an excellent addition to ABR, but it may be less effective in the presence of anterior capsular deficiency, with failure rates ranging from 4% to 15%. Currently the open or arthroscopic Latarjet procedure is considered to be the most effective technique in case of bone defects or poor-quality anterior capsule in individuals involved in contact sports. Its low recurrence

rate (0%-5%) is related to the stabilizing action of the transferred coracoid process, the changed path of the conjoined tendon, and the tenodesis effect on the subscapularis tendon.[12] However, it has to be considered a nonanatomic reconstruction procedure and has been associated with a number of intraoperative and postoperative complications.[13,14] The use of coracoid or other bone transfer procedures in young active patients with shoulder hyperlaxity is still controversial.[15,16]

More recently, a procedure defined arthroscopic subscapularis augmentation (ASA), consisting of partial tenodesis of the upper third of the subscapularis tendon, plus Bankart repair, has been demonstrated to be effective for treatment of recurrent anterior shoulder dislocation in young active individuals with capsular deficiency and mild glenoid bone loss (GBL) without compromising external rotation.[17-20] The purpose of this study was to demonstrate that arthroscopic Bankart repair with associated ASA could be a valid surgical option in the treatment of anterior shoulder instability in collision and contact sports athletes, affected by shoulder hyperlaxity. We hypothesized that ASA technique improves shoulder stability without compromising external rotation.

## Methods

### Study Population

Ethical committee approval of the local institution was obtained for our study. A total of 591 athletes with recurrent shoulder dislocation were retrospectively reviewed after arthroscopic ASA procedure performed by six surgeons (MM, RR, G.C., R.C., AZ, S.S.), in 6 different hospitals from 2009 to 2017. Those patients who met inclusion criteria were enrolled in the present study (Table 1). The inclusion criteria were as follows: surgery with at least 2 years follow-up, involvement in contact sports activities, evidence of shoulder hyperlaxity according to Neer (sulcus sign) and Coudane-Walch[21] tests and GBL less than 15% as assessed by computed tomography (CT).

Patients with Hill-Sachs lesion (regardless of the size) were also included. The exclusion criteria were as follows: GBL greater than 15%; voluntary instability, multidirectional instability pre-existing glenohumeral osteoarthritis, overhead sports activities, assuming that a loss of external rotation might interfere with the sport specific gesture of throwing athletes.

### Functional and Radiologic Assessments

The Rowe score, American Shoulder and Elbow Surgeons (ASES) score and Western Ontario Shoulder Instability Index (WOSI) were used for functional assessments. Two independent observers conducted preoperative and postoperative ratings of functional outcomes using consistent methods. The sports activity level was evaluated using the following rating system: grade I, no limitations in sports (100% of premorbidity level); grade II, mild limitations in sports (90%-99% of premorbidity level); grade III, moderate limitations in sports (71%-90% of premorbidity level); and grade IV, severe limitations in sports (<70% of premorbidity level).[22] These assessments could quantify apprehension, subluxation or recurrence of instability, functional level restrictions in activity, range of motion (ROM) assessed by goniometer with the arm at the side (ER1 position), and with the arm in abduction (ER2 position) and strength. Preoperative investigations for all patients were performed using CT (Optima CT660 64-slice multidetector CT; General Electric, Little Chalfont) and the Pico surface area method[23] to assess the percentage of GBL compared with the contralateral shoulder, with multiplanar reconstruction of the glenoid neck and digital substraction of the humeral head. All patients underwent magnetic resonance imaging to assess pre-existing osteoarthritis, the presence of labral damage and Hill-Sachs lesions.

**Table 1.** Demographic Data

| Parameters | Bankart | Additional Pathology | Whole Series |
|---|---|---|---|
| Number | 229 | 180 Capsular deficiency and labrum hypoplasia<br>48 engaging Hill-Sachs<br>13 loose body<br>11 Partial-thickness RC tear | |
| Age (yr) | 25 (18-29) | 21 (15-27) | 23 (15-29) |
| Follow-up (mo) | 28.7 (24-109) | 27.5 (24-100) | 30.5 (24-109) |
| Male/Female | 172/57 | 130/38 | 295/102 |
| Dominant arm (right/left) | 151/78 | 128/40 | 294/103 |
| Dislocation before surgery | 3 (2-20) | 7 (4-20) | 4 (2-20) |
| Failure of ASA procedure | 11 | 5 | 16 |
| Traumatic | | | |
| Sports-related | 3 | 1 | 4 |
| Accidental fall | 2 | 3 | 5 |
| Atraumatic | 4 | 3 | 7 |

ASES, American Shoulder and Elbow Surgeons; RC, rotator cuff.

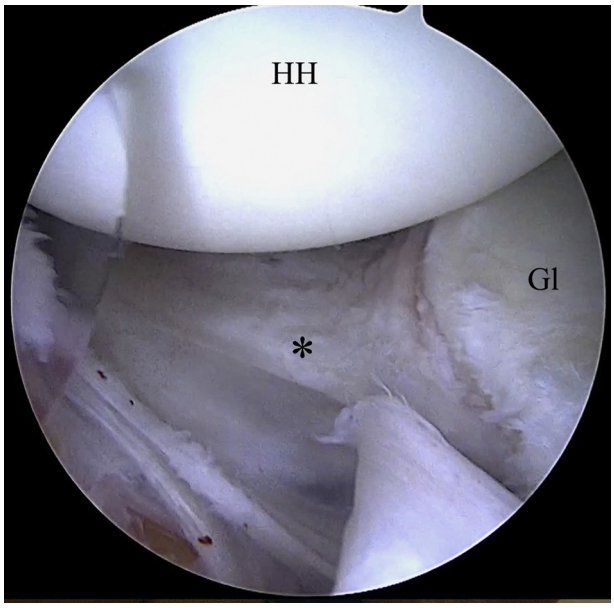


**Fig 1.** (Right Shoulder) Lateral decubitus position Anterosuperior view: capsulolabral tissue deficiency(*) and absence of the labrum, Humeral head (HH), Glenoid (Gl).

Postoperative magnetic resonance imaging was not performed routinely.

### Surgical Technique

The arthroscopic procedure was performed with the patient under locoregional anesthesia in a lateral decubitus position; standard posterior, anterior and anterosuperior portals were used. According to original ASA technique[17-19] the anterior portal was placed just over the superior border of the subscapularis tendon to obtain an easy approach for the suture-passing devices through the tendon tissue. Articular structures were carefully inspected to assess capsular redundancy or any capsule-labral insufficiency (Fig 1), anterior glenoid defects, hypoplastic labrum; the presence of Hill-Sachs lesions was documented according to Koo's arthroscopic evaluation score.[24] The labrum repair (Bankart) was always performed using 1 or 2 nonmetallic suture anchors. Subscapularis fixation bone hole should be done over the top of the glenoid corner, slightly posterior to the anterior margin of the glenoid surface to ensure a good bone stock for the anchor fixation. The superior portion of the subscapularis tendon has to be perforated at least 5mm from its upper border, almost at the same level of the glenoid surface, with a penetrator and the tenodesis was performed with a 3.5 or 2.9 Pushlock loaded with multistrand tape (LabralTape Arthrex, Naples, FL).[17-19] The tendon should be fixed at the 2-o'clock position on the right shoulder and the 10-o'clock position on the left shoulder to re-tension subscapularis tendon, reinforce anteroinferior capsule and reduce the rotator interval. The closure of the anterior capsule and centering of the humeral head in the glenoid cavity, was assessed by arthroscopic examination from the anterosuperior portal (Fig 2).

### Postoperative Protocol

After surgical repair, the shoulder was immobilized in a brace with the arm adducted for 4 weeks. The rehabilitation program consisted of 4 phases. The first phase was initiated at the end of the fourth week, using both shoulder passive and active ROM and exercises to increase joint mobility. In the second phase, at 6 to 8 weeks, the physiotherapy was focused on the recovery of shoulder full ROM. The third phase aim, from 8 to 9 weeks, was the recovery of strength and proprioceptive abilities. In the fourth phase, at 10 weeks, resumption of certain sport-specific activities was permitted. Return to sports was allowed at 4-6 months. The same protocol was used in all patients.

### Statistical Analysis

Statistical analyses were performed using the SPSS software program (version 22.0; IBM, Armonk, NY). The Wilcoxon signed-rank test was implemented to compare preoperative and postoperative values. Statistical significance was set at $P < .05$.

## Results

In total, 397 patients who met inclusion criteria were available for last follow-up (mean, 30.5 months; range, 24-109 months). One hundred ninety-four patients were excluded: in 127 patients exclusion was due to

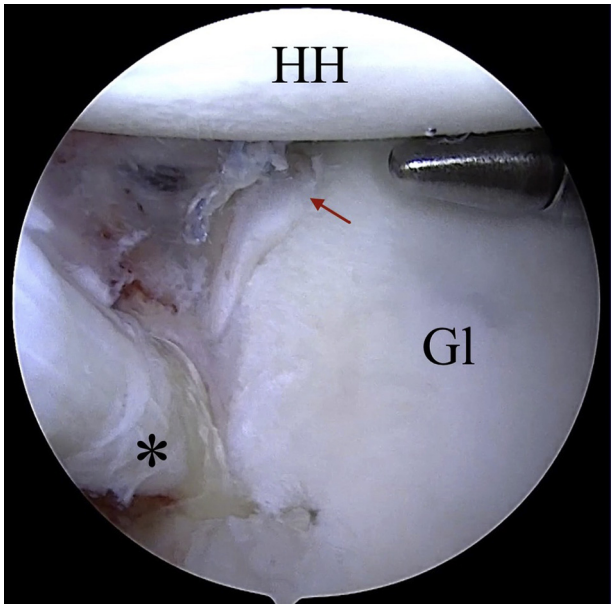


**Fig 2.** (Right Shoulder) Lateral decubitus position anterosuperior view: complete closure of anterior capsule (*red arrow*), subscapularis tenodesis (*). HH, humeral head; GI, glenoid.

**Table 2.** General Functional Outcomes

| Parameters | Before Surgery | Final FU | *P* Value | Bankart | Additional Pathology | *P* Value |
|---|---|---|---|---|---|---|
| Rowe total* | 68.5 ± 4.5 | 92. 7 ± 2.5 | .037 | 90.9 ± 3.5 | 88.2 ± 4.5 | .13 |
| ASES total* | 71.5 ± 7.5 | 97.4 ± 2.0 | .041 | 91.7 ± 4.5 | 92.8 ± 5.5 | .46 |
| WOSI final [%]† | | | | 321 (0-690) [84.7%] | 335 (0-677) [83.7%] | .25 |
| Physical | | | | 120 (0-510) [82.7%] | 125 (0-527) [80%] | .14 |
| Sports/work | | | | 69 (0-290) [81.5%] | 71 (0-305) [80.7%] | .31 |
| Lifestyle | | | | 76 (0-250) [81 %] | 75 (0-265) [80%] | .19 |
| Emotion | | | | 56 (0-190) [81.3%] | 54 (0) [81%] | .27 |

ASES, American Shoulder and Elbow Surgeons; FU, follow-up; WOSI, Western Ontario Shoulder Instability Index.
*Data are presented as mean ± SD.
†Data are presented as mean (range); data in [] parentheses indicate calculated score.

absence of shoulder hyperlaxity and in other 16 patients to concomitant type-II SLAP lesions. 51 patients were lost at final follow-up. Two hundred ninety-four patients (74.3%) were right-hand dominant, and there were 295 men and 102 women included in the study. The mean age was 23 years (minimum, 15 years; maximum, 29 years).

The mean number of shoulder dislocations before surgery was 4 (range, 2-20). All patients had history of traumatic sports-related shoulder dislocations.

Pathological anatomy at the time of surgery is detailed in Table 1: 229 (57.6%) Bankart lesions without any coexistent pathologies. In the other patients a Bankart lesion was always associated with one or more concomitant pathologies: 180 (45.3%) hypoplasias of the labrum or insufficiency of the anterior capsulolabral tissue was present (type IV) according to Habermayer's classification,[25] 48 (12%) engaging Hill-Sachs lesions, and 11 (2.7%) intra-articular partial thickness rotator cuff tears a loose body was found in 13 patients (3.2%). The mean anterior GBL was 8.9% (range, 0%-15%)

ASA plus the Bankart procedure was performed in all patients in addition to debridement of partial-thickness rotator cuff tears in 11 patients (2.7%). At the final follow-up (Table 2), the mean scores were the following: Rowe score, 92.7 ± 2.5 ($P = .037$); ASES score, 97.4 ± 2 ($P = .041$).

The average total WOSI score was 321 calculated for an average percent of 84.7% with 100% being perfect. The average for the WOSI physical symptom score was 82.7%, sports and recreation average was 81.5%, lifestyle score average was 81.0%, and emotions score average was 81.3% (corresponding raw scores: physical symptoms score, 120.00; sports and recreation score, 69.0; the lifestyle score, 76.0; emotions score, 56). For patients with an additional pathology, the average total WOSI score was 83.7% (physical symptom score average, 80%; sports and recreation average, 80.7%; lifestyle score average, 80%; emotions score average, 81%). There was no statistical difference in WOSI scores for patients with an additional pathology compared to the rest of the study population (Table 2). On the contrary statistically significant difference was found in patients who returned to sports at lower level with an average percentage score of 65.3% (Table 3). Failed repairs had lower total WOSI scores than stable repairs ($P = .009$).

A complaint of mild discomfort when placing the arm in external rotation and touching the back of the head was noted in 22 patients (5.6%). Failure of ASA procedure was observed in 16 patients (4.0%); posttraumatic shoulder redislocation occurred in 9 patients (2.2%): in 4 of the patients, redislocation was due to a sports injury, whereas in 5 patients, redislocation was due to an accidental fall. Atraumatic shoulder redislocation occurred in 7 patients (1.6%). Four of these patients underwent a repeat ASA procedure, and 7 underwent an open Latarjet stabilization procedure. No intraoperative or early postoperative complications related to the ASA procedure were reported. At the final follow-up, a negative Neer sign (Sulcus sign) and Coudane-Walch test $< 85°$ were observed in all patients; furthermore, no significant differences were observed in shoulder forward flexion ($P$=.537),

**Table 3.** Return to Sport and Functional Outcomes

| Parameters | Return to Sports/Same Level (n = 351) | Return to Sports/Lower Level (n = 62) | *P* Value |
|---|---|---|---|
| Rowe total | 95.1 ± 4.5 | 85.5 ± 2.5 | .13 |
| ASES total° | 98. ± 2.0 | 85.3 ± 7.5 | .46 |
| WOSI Final [%]° | 290 (0-690) [86.3%] | 510 (210-690)[65.3%] | .019 |

NOTE. Data are presented as mean ± SD or mean (range); data in brackets indicate calculated score.
ASES, American Shoulder and Elbow Surgeons; WOSI, Western Ontario Shoulder Instability Index.

**Table 4.** Comparison of Active Shoulder Range of Motion at Final Follow-Up Between Operated Shoulder and Contralateral Side

| | Operated Shoulder (n = 413) | Contralateral (n = 413) | Mean Difference | *P* Value |
|---|---|---|---|---|
| Forward flexion | 175.0 (150-180) | 180.0 (160-190) | −3.0 ± 2 | .537 |
| Extension | 60 (30-90) | 63 (35-90) | −2.5 ± 1.4 | .625 |
| Abduction | 165 (100-160) | 170 (100-165) | −5 ± 0.5 | .391 |
| Lateral elevation | 174 (160-180) | 180 (160-185) | −6 ± 1.5 | .235 |
| IR* | 5.4 (4-10) | 5.8 (2-10) | −1.5 ± 2.0 | .245 |
| ER1 | 60 (35-80) | 68 (40-90) | −15.0 ± 1.5 | .027 |
| ER2 | 78 (55-90) | 82 (55-100) | −8 ± 1.8 | .019 |

Data are presented as mean (range) and SD.

ER1, external rotation measured with arm at the side; ER2, external rotation measured with the arm in abduction; IR, internal rotation.

*Number of the thoracic vertebra reached by the thumb: the first thoracic vertebra is numbered 1, proceeding to the twelfth thoracic vertebra, which is numbered 12.

extension ($P = .625$), abduction ($P = .391$), lateral elevation ($P = .235$), or internal rotation ($P = .245$) compared with the normal contralateral side. In contrast, compared with the normal contralateral side, shoulder external rotation at the side ($P = .027$) and in abduction ($P = .019$) significantly differed (Table 4); moreover, the mean deficit of external rotation was 15° with the arm at the side of the trunk (ER1 position), and the mean deficit was 8° with the arm in 90° of abduction (ER2 position). All of these functional and subjective results enabled all patients to return to full work activities. At the final follow-up, no limitation in sports activities (grade I) was reported in 345 patients (87%), a mild limitation of the premorbidity level (grade II) was reported in 33 patients (8.3%), and a moderate limitation of sports activities (grade III) in 19 patients (4.7%). No grade IV was observed in our series.

## Discussion

The most important finding of this study was that ASA reduced the high risk of recurrence of a simple Bankart repair in athletes who practice collision and contact sports and are affected by anterior shoulder instability and hyperlaxity without compromising external rotation. In these patients we sought to develop an additional technique to improve patient outcomes.[26-33] The degeneration process of capsule-ligamentous structures has been shown to be irreversible and directly related to the age of onset of shoulder instability and to the number of preoperative dislocations.[25] The literature in this subject seems to be regional. In the Unites States, many surgeons underscore the need of the "Bankart plus" procedure either with the use a higher number of anchors to achieve good stabilization and better healing of the capsulolabral complex[34-36] or the Bankart plus the Remplissage,[37] which consists of a tenodesis of the infraspinatus tendon in the posterior humeral defect. In Europe the Latarjet procedure is considered the gold standard even without severe GBL.[38] Capsular laxity of the glenohumeral joint is one of the main contributing factor in recurrent shoulder instability.[39,40] Several studies have demonstrated capsular stretch and permanent plastic deformation after repetitive glenohumeral dislocations in both biomechanical evaluations and arthroscopic inspection and have suggested that the lax capsule, not the Bankart lesion, may be as much of an essential lesion that permits glenohumeral dislocation as the labral tear itself.[41-44] Residual capsular redundancy and plastic deformation coexisting with Bankart lesions have been suggested as a possible reason for recurrent shoulder dislocation after a simple arthroscopic Bankart repair.[45-48] Some surgeons have emphasized the effective reduction of capsular laxity in the arthroscopic treatment of recurrent shoulder instability and have recommended concomitant capsular shift for tensioning of the redundant capsule.[42,45] This arthroscopic capsular shift can reduce the capsular volume and reinforce the redundant capsule, which may lead to improved glenohumeral stability and function.[45] Furthermore, this might not be sufficient to avoid recurrence, because the capsuloligamentous structure has viscoelastic properties, and it is possible that the shifted and tensioned capsule of the glenohumeral joint may slowly stretch out again over time, resulting in an increased capsular volume, which may cause recurrence of shoulder instability symptoms after surgery if the degree of capsular restretching is large.[39] Deficiency of the rotator interval and laxity of the anteroinferior capsuloligamentous complex are highly associated with instability in patients with hyperlaxity. This gives rise to 2 of the cardinal clinical features of this condition: coracohumeral ligament laxity and a patulous redundant anteroinferior capsule with a positive sulcus Sign (Neer) and anterior laxity with a positive Coudane-Walch test.[21]

In traumatic anterior instability the humeral head comes out anteriorly and inferiorly; the rotator interval always separates as a part of the dislocation. As the interval tears and stretches, force is applied to the subscapularis upper border, which can become lax as it drops inferiorly.[44,49-60]

In addition, the coracohumeral ligament has 2 bands, 1 of which is attached to the subscapularis tendon that may be torn or stretched with anterior shoulder instability.[61-63] In most cases of Bankart repair, even with complete repair, there may be residual capsule stretching and capsular deficiency left; some of that is posterior, and we address it with the "Remplissage," and some of that is anterior, which means that the upper part of the subscapularis has to be lax as it stretches out. When subscapularis tenodesis with ASA is performed, we produce a triple effect: address the stretched portion of the subscapularis, amend capsular insufficiency, and restore the physiological coracohumeral ligament tension, so it will work without causing external rotation restriction.[18-20]

The historical surgeries like Putty-Platt and Magnuson-Stack procedures[64,65] were dealing with the entire tendon shortening it, thus causing a problem to the external rotation; on the contrary ASA procedure deals only with the stretched portion upper border of the subscapularis tendon, leaving the middle and inferior subscapularis in the normal, anatomic position. In addition, we believe that the remodeling process of the scar tissue of the tenodesis, could improve the biological healing of the Bankart repair.

Biomechanical data confirm that the ASA is more effective than Bankart repair alone in stabilizing the shoulder joint in anteroinferior translation[66,67]; furthermore, this procedure demonstrated similar clinical results to the Latarjet in presence of mild GBL.[63]

The main significant finding of this medium-term study was that the ASA plus Bankart repair has yielded good clinical outcomes in patients involved in collision contact sports affected by recurrent anterior shoulder instability and shoulder hyperlaxity without affecting external rotation and athletic gesture. No early intraoperative or postoperative complications were reported after this procedure. In our study, a WOSI score of 84.7 demonstrates that most of our patients have developed good stability and returned to their original sport at preinjury level. Similar statistically significant differences were found in all WOSI domains. On the contrary, the total WOSI score showed significantly lower average in patients who returned to sports at a lower level. In this subgroup of patients the emotions section of the WOSI score showed significantly lower average compared to the other sections with an average percentage of 61.5. In our opinion, this result must probably be attributed to the high expectations of young athletes in which even mild limitations in the execution of the athletic gesture can deeply depress their motivation.

The overall re-dislocation rate was 4%. On the basis of these results, we think that this technique is an option in the treatment of anterior shoulder instability in young athletes involved in contact sports affected by hyperlaxity without severe GBL, avoiding the recourse to a more complex procedure such as Latarjet with a high rate of complications.[13,68]

### Limitations

There are a number of limitations in this study: First, it is a medium-term follow-up study of a retrospective nature. Second, we did not have a control study group operated with another procedure by the same surgeons. Third, a radiological study, useful for evaluating a follow-up arthropathy, was not done. Last, no specific strength test in internal rotation for subscapularis was measured after surgery.

## Conclusions

The Bankart repair plus ASA has been demonstrated to be safe and effective to restore joint stability in patients practicing collision and contact sports who are affected by chronic anterior shoulder instability associated with GBL (<15%) and hyperlaxity without compromising external rotation.

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