"Bipolar Fixation": A Novel Concept in the Treatment of Recurrent Anterior Shoulder Instability—A Prospective Study of 26 Cases With Minimum 2-year Follow-Up

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Abstract: The purpose of this study is to introduce a novel concept of arthroscopic "bipolar fixation" in the treatment of recurrent anteroinferior shoulder dislocations. Between January 2008 and January 2011, 297 patients with the history of recurrent anteroinferior dislocations underwent either open Latarjet procedure or arthroscopic Bankart repair along with the tenodesis of infraspinatus and the posterior capsule (bipolar fixation) on to the bare area irrespective of the presence or absence of Hill-Sachs lesions and hyperlaxity. Twenty-six patients who underwent arthroscopic bipolar fixation in 2008 with a minimum follow-up of 2 years were included in this study. Hyperlaxity was noticed in 53% of the population. Seventy-four percent had Hill-Sachs lesions and glenoid defects were found in 30%. The average instability severity index score was 5.07. The patients were followed up with Walch-Duplay score and Subjective Shoulder Value. At 2-year follow-up, 100% had full range of motion without any deficits. Thirteen percent experienced some residual posterior pain, but all the 26 patients could get back to their sports activities. Eighty-five percent could get back to their previous level of sports. Subjective Shoulder Value improved from 53% to 95% postoperatively. The Walch-Duplay score was 95%. The lone failure (3.84%) was a case of attritional glenoid when he had a redislocation at 1 year postoperatively after a minor injury. Arthroscopic bipolar fixation restores a good balance between the injured anterior and the posterior capsuloligamentous structures. The technique is reliable and reproducible in posttraumatic recurrent anteroinferior dislocations regardless of the presence or absence of Hill-Sachs lesions. The absolute contraindication is a type 3 anterior glenoid defect. Nevertheless, further comparative studies need to be performed to confirm our results, and so far one should correct the pathology as found rather than routinely performing a "bipolar" tightening regularly.

Key Words: instability, glenoid bone loss, Hill-Sachs, Bankart, arthroscopy, remplissage

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Arthroscopic Bankart repair has become the standard of care in the treatment of recurrent anteroinferior instability of the shoulder. The outcomes of conservative management are poor with a high percentage of recurrent instability, especially in the young. Various studies from the year 2000 to 2006 have reported 11% average failure rates after isolated Bankart repair.[1–3] Despite advanced techniques, newer and sophisticated suture anchors and suture materials, this average seems to have only gone up in the recent years.[4–7] The posterior musculotendinous structures may be stretched out along with the anteroinferior capsuloligamentous structures with recurrent episodes of anteroinferior instability. These structures undergo plastic deformation as a result of multiple episodes both anteriorly and posteriorly. In this setting, a one-sided repair alone (repair of the anteroinferior capsulolabral complex) may not give expected results in all the cases. As quantifying these lesions are difficult, we propose a combined arthroscopic anterior classic Bankart stabilization along with posterior capsulotenodesis of infraspinatus and capsule on to the bare area of the humeral head ("bipolar fixation") routinely in all the cases of anteroinferior instability, without taking account of the presence or absence of Hill-Sachs lesions and hyperlaxity. The purpose of this study is to evaluate the recurrence rate of shoulder instability with arthroscopic Bankart repair with posterosuperior capsulotenodesis to the bare area. We hypothesize that posterosuperior capsulotenodesis will diminish the postoperative recurrence rate of shoulder instability.

METHODS

The procedure can be performed in either the beach chair or lateral position. We have found it more comfortable to place the 5-mm double-loaded titanium anchors on to the bare area in the latter position. The visualization of the bare area is better in this position as the posterior space opens up.

The routine examination of the joint is performed with the scope in the posterior portal. One can internally rotate the head to visualize the Hill-Sachs lesion if present. Two accessory percutaneous portals are made for anchor insertion. A 13-G spinal needle is used to determine the appropriate transtendon angle for the insertion of the double-loaded titanium anchors passing lateral to the musculotendinous junction of the infraspinatus. The bare area is freshened using the tip of a 13-G spinal needle (to lessen injury to the cuff) inserted percutaneously and multiple penetrations are made into the soft bone in this area with the tip to promote healing of the tenodesed structures (Fig. 1).

Viewing from the posterior portal, the superior anchor is put into the superior and medial part of the bare area through the first percutaneous portal 3 cm lateral and 2 cm anterior to the posterolateral corner. The insertion handle is left in place and is used to push the head anteriorly to open up the posterior space. Through the second percutaneous portal located about 4 cm inferior to the posterolateral corner, the second anchor is inserted into the inferior and lateral part of the bare area at right angles to the first anchor. They converge into the joint taking a large area of posterior cuff in between them (Figs. 2A, B).

Care must be taken to identify the direction of the anchor to avoid penetration into the joint surface. Both the anchor handles are left in place. Scope is now moved into the subacromial space through the posterior portal and through a

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FIGURE 1. Freshening of the bare area with a 13-G needle.

FIGURE 3. The shaver introduced into the subacromial space in between the 2 anchor handles to clear off the bursal tissue.

portal situated in between the anchor handles; the bursal tissue in the posterior aspect of the space is cleared off with the shaver in order to visualize the exit points of the insertion handles through the infraspinatus tendon (Fig. 3).

With the scope still in the subacromial space with the handles in the view, one of them is taken off exposing the 4 suture limbs. A suture manipulator is inserted through the same portal and the 4 suture limbs are grabbed (Fig. 4A).

The manipulator is then moved over the infraspinatpus posteriorly and inferiorly to grab the second insertion handle. The second handle is removed, and now all the 8 suture limbs in the suture manipulator are delivered out (Figs. 4B, C).

The scope is reintroduced into the joint posteriorly and anterior stabilization of the Bankart lesion is done using the standard techniques. We routinely use a single anterior portal for the anterior labral repair. We use minimum of 2 double-loaded biobsorbable anchors in our practice.

The knots are tied down and now the attention is turned to the posterior tenodesis. The scope is now moved into the anterior portal. The 8 suture limbs exiting the skin through a single portal are separated according to their color. Now you have 2 sets of suture limbs, 4 limbs in each set (2 limbs from each anchor) with identical colors (Fig. 5). The suture limb from 1 anchor is tied to the suture limb from the other anchor. The first set of suture limbs are tied down on to the infraspinatus percutaneously using the double-pulley technique and the sutures are cut. The step is repeated with the remaining set of 4 suture limbs. The technique creates 4 suture bridges between the 2 anchors over a wide area compressing the infraspinatus capsular complex on to the bone (Figs. 6A-C).

The anchoring of the infraspinatus capsular complex on to the bare area that results in the centering of the humeral head can be observed from the anterior portal (Figs. 7A, B).

Activo-passive mobilization is performed on the first day after surgery. There is no restriction in internal rotation (IR) or external rotation (ER1). Conversely, in the classic "isolated" Bankart procedure, we just propose pendular movements for 1 month. Then activo-passive mobilization without any ER1 is done. After 3 months, we started ER1.

Twenty-six patients who underwent arthroscopic bipolar fixation for recurrent anteroinferior dislocations from January 2008 to January 2009 by the senior surgeon were included in the study. Mechanism of injury was always traumatic. Exclusion criteria were bony Bankart type 3 or attritional glenoid. Excluded patients were treated with open Latarjet procedure. The 26 study patients were followed up for a minimum of 2 years and none were lost to follow-up.

The study population included 23 males and 3 females with mean age of 27 years (range, 15 to 59 y). Seventy percent of the patients were involved in competitive sports, and of these, 57% did contact sports. Hyperlaxity (ER1 > > 90 degrees) was noticed in 53% of the cases. Bony lesions

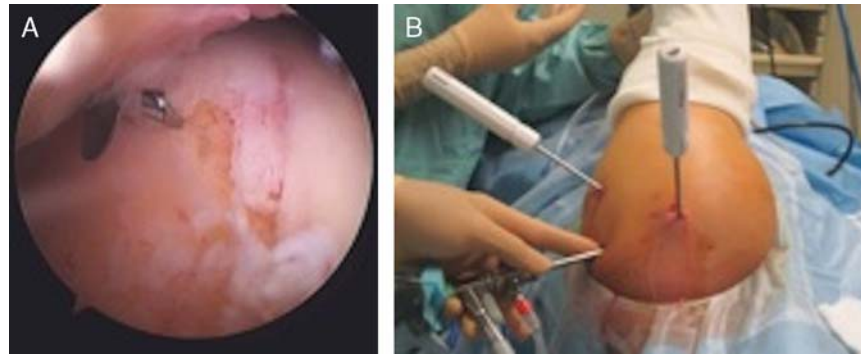

FIGURE 2. A, First anchor inserted over the superior aspect of the bare area. B, The 2 anchors introduced at right angles to each other capturing a wide area of infraspinatus and the capsule in between.

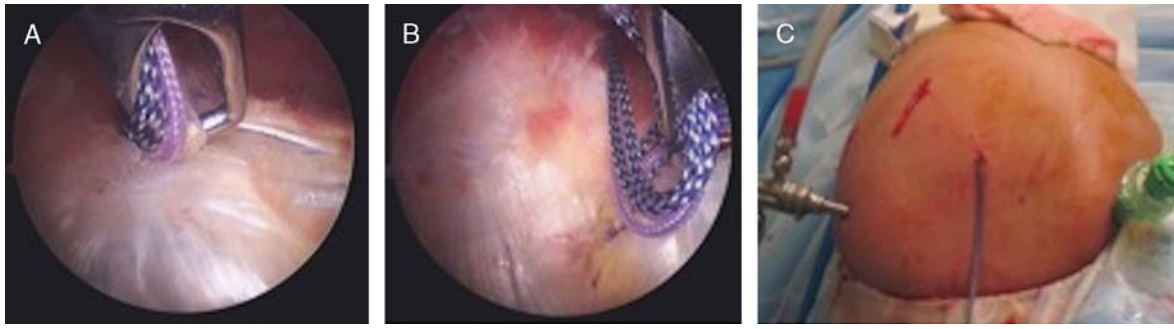

FIGURE 4. A, The manipulator with the 4 suture limbs moved over the infraspinatus toward the second handle. B, All the 8 suture limbs in the manipulator. C, Suture limbs from the 2 anchors withdrawn outside.

including Hill-Sachs lesions were found in 74% of the cases and glenoid bone defects in 30% [evaluated by contrast computed tomography (CT) scan]. The average instability severity index score (ISIS) was found to be 5.07.

Results were analyzed with visual analog scale (VAS) for pain, Walch-Duplay score, Subjective Shoulder Value (SSV), range of motion (ROM), return to sports activities, and rate of recurrence.

RESULTS

The patients were followed up for a minimum of 2 years (Table 1). At 3 months, 65% of the patients had normal ROM, and at 2 years, 100% had their full ROM. Objective data measurements of ER1 are presented in the table at the third month and at 2-year follow-up. No external rotation or internal rotation deficits were noted in any of the patients. Thirteen percent experienced some residual posterior pain without any sense of instability (2 patients had VAS 2, 2 patients had VAS 1). All the 26 patients could get back to their sport activities. Eighty-five percent of the patients could get back to their previous level of sports (even contact sports like rugby). Seventeen patients did competitive sport before the trauma; only 3 patients did not recover the same level (only recreational sport activity): the reason for this decision was not in relationship with the operated shoulder. Fourteen patients played contact sport before the trauma; only 2 could not get back to the same contact sport because of residual apprehension. The SSV improved from 53% preoperatively to 95% postoperatively at 2 years. The Walch-Duplay score was 95%. One case (3.85%) was considered to be a failure when he had a redislocation at 1 year after a major trauma.

FIGURE 5. The 2 sets of suture limbs separated according to their colors.

DISCUSSION

The significance of glenoid bone loss, Hill-Sachs lesion, dynamic stabilizers, plastic deformation of the capsuloligamentous structures and hyperlaxity and their influence on Bankart repair has been well documented in the literature.[8–10] The evaluation of the bony defects especially of the glenoid from standard radiographs are unreliable.[8] The percentage of glenoid defects after recurrent anteroinferior dislocation is quite variable, range 2% to 90%.[9,11,12] Sugaya et al[12] reported the supremacy of 3-dimensional CT in evaluating glenoid defects more accurately as compared with other methods. Arthroscopic evaluation of the glenoid defect based on the bare spot[13] may not be always accurate as the interobserver variability exists. The position of the posterior portal, the scar, and soft tissue covering the anterior aspect of the glenoid can influence the measurements.

The role of posterior head defects described by Malgaigne in 1855 and then later on by Hill-Sachs in 1940 in recurrent dislocation has been well studied. The prevalence of the Hill-Sachs lesions ranges from 47% to 93%.[14–16] There are no universally accepted methods available today to size them accurately.[17] Owing to the uncertainty around the size of the defects and when to treat them, these lesions are usually not addressed along with the anterior repair, leading to recurrent instability in a few cases. Since the description of the engaging and nonengaging variants of the Hill-Sachs lesions,[9] the line of treatment has been aimed at managing only the engaging lesions in most of the techniques available today. All the Hill-Sachs lesions have to be engaged atleast once to be produced.[18] Interobserver variability exists in evaluating the engagement of a Hill-Sachs lesion on to the anterior glenoid rim at the time of arthroscopy. Moreover with the increased laxity of the joint under general anesthesia the variability is more pronounced.

The instability resulting from Hill-Sachs lesions does not only depend on their size but also on their location relative to the anterior glenoid rim. It has been our observation that in most chronic cases, the bony defects are multiple rather than the classic single one, usually located superior and medial to the bare area. In few cases, we have observed the extension of the Hill-Sachs defect over to the bare area. In these circumstances, we make sure that the anchors are not inserted medially into the defect near the intact articular cartilage. If the anchors are inserted medially near to articular cartilage, into the bony defect, remplissage it may result in limitation of

FIGURE 6. A, The first set of sutures being tied down using double-pulley technique. B, The step repeated for the second set of sutures. C, Suture bridge between the anchors.

external rotation. The concept of glenoid track has been proposed by Yamamoto et al.[19] Despite being large, if the defect is located lateral to the track, it does not cause engagement of the glenoid rim. Even if the defect is small but is situated medial to the glenoid track, involving a significant area of the articular cartilage, it will engage the anterior rim resulting in instability and a standard Bankart repair in this scenario will fail.

Filling of the large engaging Hill-Sachs lesions described by Purchase et al[18] can be used in the clinical practice to prevent recurrent instability. Tenodesis of the infraspinatus and the posterior capsule into the defect is done, preventing the engagement of the defect on to the anterior glenoid rim. The Hill-Sachs lesion is usually situated superior and medial to the bare area. The filling of this defect situated medially can result in limitation of external rotation.[20,21]

ISIS score proposed by Balg and Boileau[22] is a good tool to identify the preoperative risk factors for an arthroscopic Bankart repair. An ISIS score <3, between 3 and 6, and >6 predicts a recurrence rate of 5%, 10%, and 70%, respectively. The glenoid and head defects are determined using plain x-rays. The supremacy of CT over the standard radiographs has been discussed previously. If that is the case, with the prevalence of 90% anterior glenoid[12] and 93% Hill-Sachs lesions[15] after anteroinferior instability, only <10% of the patients are eligible for a standard Bankart repair. The scoring system does not take into account the presence of humeral avulsion glenohumeral ligament lesions and the plastic deformity. With our ISIS score of 5.07, we should have had a failure rate of 10%. We had just 1 failure in 26 patients (3.85%).

Studies have shown that the anterior stabilization may have inferior outcomes in the presence of capsular laxity.[23,24] In cases with increased capsular volume, anterior repair along with a capsular shift and closure of the rotator interval has been proposed,[25] but no consensus has been obtained so far. It has been almost >90 years since the description of the anterior rim lesion by Bankart in 1924. We still continue with the routine anterior capsulolabral repair alone or bony block procedures, neglecting other posterior lesions involved in the pathology of recurrent anteroinferior instability. Our hypothesis is that when the humeral head goes anteriorly over the anterior rim, there has to be a tear or stretching of the posterior stabilizing structures. This is a constant phenomenon. Neglecting this event can lead to the failure of the isolated Bankart repair.

Plastic deformation of the capsuloligamentous structures with or without hyperlaxity may result in the failure of a Bankart repair.[26,27] In all our cases of anteroinferior instability, considering the plastic deformity of anterior and posterior structures, we perform a standard Bankart repair along with tenodesis of infraspinatus and the posterior capsule on to the bare area, located inferior and lateral to a classic Hill-Sachs lesion. The aim is not to fill the defect. Even in the presence of Hill-Sachs lesions or hyperlaxity, the region of tenodesis is not changed. As the fixation is more lateral, there is no restriction of external rotation postoperatively. A loss of even 5 degrees of external rotation can severely affect the performance of a throwing athlete.[28] In contrast to the double-pulley technique described by Koo et al,[29] our technique involves 2 transtendon double-suture anchors placed in the bare area rather than into the Hill-Sachs defect resulting in a 4-bridge configuration.

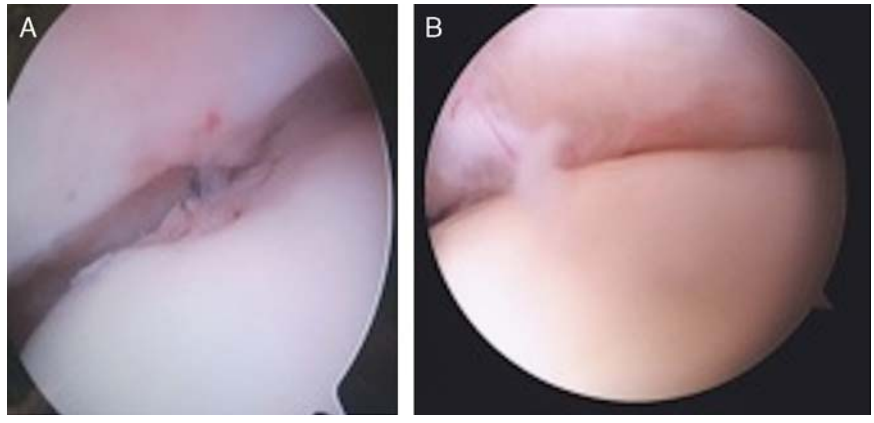

FIGURE 7. A, Visualization of the bare area from the anterior portal. B, Tenodesis of the infraspinatus and the capsule over the bare area.

TABLE 1. Clinical Data

Patient No.	Age	Competition	Armed	Hyperlaxity	Hill-Sachs	BB	ISIS Score	ER1 M3	ER1 FU	Pain	Recurrence	Sport	Sport Same Level
1	21	0	0	0	0	2	2	70	NL	0	No	Yes	Yes
2	37	2	1	0	2	0	5	50	NL	0	No	Yes	Yes
3	28	2	1	1	0	2	6	90	NL	0	No	Yes	Yes
4	34	0	0	0	2	0	2	70	NL	0	No	Yes	Yes
5	22	2	1	0	2	0	5	50	NL	2	No	Yes	No
6	23	0	0	1	0	0	1	70	NL	0	No	Yes	Yes
7	15	2	1	0	2	0	7	50	NL	0	No	Yes	Yes
8	21	2	0	1	2	2	7	70	NL	0	No	Yes	Yes
9	18	2	1	1	2	0	8	90	NL	0	No	Yes	Yes
10	32	2	1	0	2	2	7	70	NL	0	No	Yes	Yes
11	32	0	0	1	2	0	3	70	NL	0	No	Yes	Yes
12	19	2	1	1	0	0	6	90	NL	0	No	Yes	Yes
13	24	2	1	0	2	2	5	50	NL	0	No	Yes	Yes
14	19	2	1	1	2	2	10	90	NL	1	Yes	Yes	No
15	21	2	1	0	2	0	5	70	NL	0	No	Yes	Yes
16	23	0	0	1	2	0	3	90	NL	0	No	Yes	Yes
17	28	0	0	1	2	0	3	90	NL	0	No	Yes	Yes
18	17	2	1	0	2	0	7	70	NL	2	No	Yes	No
19	16	2	1	0	2	0	7	70	NL	0	No	Yes	Yes
20	39	2	0	0	2	0	4	70	NL	0	No	Yes	Yes
21	30	2	1	1	0	0	4	90	NL	0	No	Yes	No
22	30	0	0	1	2	1	4	70	NL	0	No	Yes	Yes
23	17	2	0	1	0	0	5	70	NL	0	No	Yes	Yes
24	26	0	0	1	2	2	5	70	NL	1	No	Yes	No
25	28	2	1	0	2	2	7	60	NL	0	No	Yes	Yes
26	27	0	0	1	0	2	3	90	NL	0	No	Yes	Yes

BB indicates bony Bankart; ER1 FU, external rotation at follow-up; ER1 M3, external rotation at 3 months; VAS, visual analogue scale.

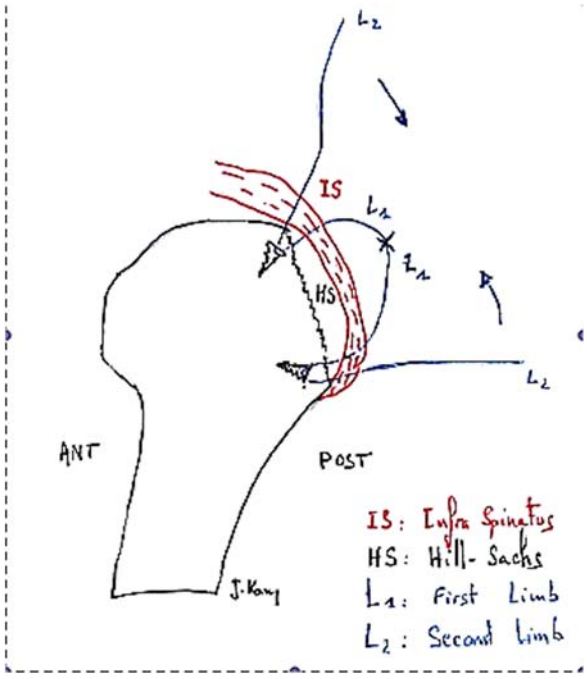

FIGURE 8. Draw of the posterosuperior capsulotenodesis onto the bare area.

No cannulas are used in order to reduce injury to the posterior cuff. The bare area is freshened using the tip of the 13-G needle instead of a burr or a shaver with the same aim. We use titanium anchors rather than bioabsorbable or PEEK variants requiring additional instrumentation before the anchor insertion to minimize the posterior soft tissue damage.

Clearing of the bursal tissue around the insertion handles prevent entangling of the deltoid fibers in the tenodesis when the knots are tied down on to the cuff percutaneously. Earlier in our practice, we did not routinely clear out the posterior subacromial space and the sutures were tied down percutaneously on to the cuff blindly. This may result in the anchorage of a part of the deltoid into the tenodesis causing increased tension on to the anchors during mobilization and may result in anchor pullouts and persistent posterosuperior pain (13% experienced some residual posterior pain without any sense of instability).

One may doubt the superiority of this method over the common practice of plication of the posterior capsule alone on to the labrum in cases of redundant posterior capsule. Very often we have noticed the posterior capsule to be very thin and hence may not hold to the repair. Studies have documented inferior quality and biomechanical properties of the posteroinferior capsule as compared with the anteroinferior capsule.[30]

The lone failure we had can be attributed to a new major trauma, rather than a bad technique. It is now a universally accepted fact that glenoid defects measuring >21% of the glenoid surface area should be treated using bone block procedures.[31]

This novel arthroscopic technique is less invasive than the open Latarjet procedure performed in recurrent anteroinferior dislocation without significant glenoid defect. The anterior capsulolabral complex is left intact, without distorting the normal anatomy.

Our failure rate of recurrence is only 3.85% (1 of 26), which can be attributed to the severe trauma. We can confirm our hypothesis that bipolar fixation provides a stable fixation and prevents recurrences as compared with a classic Bankart repair alone.[1–7]

Limitations of this study are a small number of patients and lack of a multicenteric study. Our study has a few weaknesses. First, presently there is no precise method to quantify our hypothesis that the posterior capsuloligamentous structures may undergo a plastic deformity after multiple recurrent anteroinferior dislocations. Second, in our study the posterior fixation was carried out in all the cases irrespective and regardless of presence or absence of the Hill-Sachs lesions, without analyzing the severity of engagement of these lesions over the anterior rim in the middle of functional range of movements.

Further comparative studies need to be performed on a larger population with a control group of similar patients in whom only the anterior stabilization is performed to validate the incorporation of the posterior structures in the repair routinely in all the cases of recurrent anteroinferior instability. Until then the bipolar fixation should be carried out in those cases with preoperative prediction of engagement of Hill-Sachs lesion based on CT arthrogram and intraoperative evaluation and those with clinically evident posterior laxity.

CONCLUSIONS

Average failure rate after arthroscopic isolated Bankart repair does not decrease despite advanced techniques. We hypothesized that posterior lesions (not only Hill-Sachs but infraspinatus and capsule tear or plastic deformity) are underappreciated, as a result untreated. The technique of arthroscopic bipolar fixation is a reliable and reproducible method for the treatment of recurrent anteroinferior dislocation, irrespective of the presence or absence of Hill-Sachs lesions, acquired plastic deformity of the capsule, musculotendinous units. The posterior fixation is done on to the lateral aspect of the bare area rather than into the defect (done with the aim of filling) to prevent restriction of external rotation. The bipolar fixation restores a good balance between the anterior and posterior capsuloligamentous structures, decrease rate of recurrence, and confirm our hypothesis. The absolute contraindication for the procedure is attritional glenoid. Nevertheless, further comparative studies need to be performed on a larger population with a control group of similar patients in whom only the anterior portion of the procedure is performed to validate the incorporation of the posterior structures. Therefore, one should correct the pathology as found rather than routinely performing a "bipolar" tightening regularly, and so far, we limit the indication of the bipolar fixation at the posttraumatic anterior recurrent dislocation of the shoulder (Fig. 8).

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