Arthroscopic stabilization and capsulorraphy for the treatment of traumatic anterior shoulder instability in skeletally immature patients

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Background
Traumatic instability of the shoulder joint in skeletally immature patients is rare. Recurrent instability is a common complication after traumatic dislocation, especially in younger patients. The purpose of this study was to evaluate the functional outcome of arthroscopic capsulolabral repair in adolescent patients.

Materials and methods
Over a period of 5 years, 13 patients (age 13.5–17 years) with traumatic anterior shoulder instability were included in this study. There were 11 male and two female patients with a mean age of 15.1 years at the time of surgery. There were 11 right and two left shoulders involved. Arthroscopic stabilization and capsulorraphy were performed before skeletal maturity and after failure of conservative treatment for 6 months. Functional outcomes were measured using the modified Constant–Murley and Rowe scores preoperatively, 6 weeks, 3, 6 months, and 1 year postoperatively and yearly for 2 additional years.

Results
At the final follow-up (average 28.8 months), the mean modified Constant–Murley score was 93.8 points (range, 87–100) and the mean Rowe score was 96.1 points (range, 90–100). The mean forward flexion and the external rotation with 90° abducted arm did not change from the preoperative values. Eleven patients (84.6%) returned to their preinjury level of recreational activities or sport. One patient (7.7%) suffered from redislocation 7 months after surgery because of sport injury.

Conclusion
This study showed that arthroscopic capsulolabral stabilization and thermal capsulorraphy is a reliable and successful surgical procedure for the treatment of recurrent traumatic anterior shoulder instability in young patients before the completion of skeletal maturity. There were no complications for the biodegradation of anchors or growth disturbance, and so the delay of arthroscopic surgery until skeletal maturity is not preferable.

Level of evidence
Level IV, therapeutic case series.

Keywords:
biodegradable anchor, capsulolabral, skeletally immature, traumatic instability

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Introduction

Before completion of growth, joint injuries result in metaphyseal fractures rather than dislocation or ligamentous injuries, and so traumatic dislocation of the shoulder is rare in this age group [1]. Jonasch and Bertel [2] found that among 260 000 injuries in skeletally immature patients, there were only 29 dislocations of the shoulder (0.01%), compared with 1152 (0.4%) proximal fracture of the humerus. More than 50% of the dislocations occurred during sporting activities [3].

Despite comprehensive nonoperative treatment, recurrence of shoulder instability still remains a frequent problem, and several risk factors have been proposed, the most significant of them being a younger age [4,5]. A paucity of literature exists regarding the outcome of skeletally immature patients who sustain a traumatic anterior shoulder dislocation [6]. As in adults, anterior shoulder dislocations account for 90% of the cases, and usually occur after a fall on the abducted, externally rotated arm [7].

Deitch *et al.* [8] found that after conservative treatment of traumatic shoulder dislocation in young patients, the redislocation rate was 75%. In 2/3 of these patients, surgical stabilization was performed, and it resulted in improved stability in comparison with shoulders that continued to be treated conservatively. Bankart lesion is described as an essentially pathological lesion in over 40% and up to 100% of cases of traumatic anterior shoulder dislocation in children and adolescents [3].

Multiple recurrent instability events may cause articular cartilage damage to the glenohumeral joint and

compromise soft tissue stabilizers that interfere with sports and activities of daily living [9]. Hence, many investigators and surgeons confirmed the advantages of surgical treatment of post-traumatic recurrent shoulder dislocation in children and adolescents, and the indication criterion for surgery was redislocation and/or persistent instability [1,10,11]. After assured success of arthroscopic stabilization techniques after traumatic shoulder dislocations in adults, this technique can be used successfully in rare cases of traumatic shoulder instability in skeletally immature patients.

The purpose of the present study was to evaluate the outcome of arthroscopic labrocapsular stabilization using biodegradable anchors and thermal capsulorraphy (to shorten the joint capsule and reduce the size of any dislocation pocket that may present) for the treatment of recurrent anterior dislocation of the shoulder in skeletally immature patients.

Materials and methods

From September 2007 to August 2012, 13 cases with recurrent traumatic anterior dislocation of the shoulder were treated. Five of them were referred from other regions to our hospital for management. There were 11 male and two female patients, with a mean age of 15.1 years (range, 13.5–17 years) at the time of surgery. There were 11 right and two left shoulders involved. The dominant shoulder was involved in 10 cases (76.9%). All the patients had suffered at least one redislocation after conservative treatment of the first dislocation event. The mechanism of injury was sport related in eight patients, fall from a height in two cases, bicycle accident in two cases, and motor vehicle accident in one case. All patients suffered between two and five attacks of dislocation with a mean of 3.1 attacks (Table 1).

Preoperative clinical examination (range of motion, apprehension test, sulcus sign, and translation test) and radiographs (anteroposterior and axial views) were performed for all cases. Anteroposterior radiographs were made with the arm in neutral rotation and with the arm in internal rotation for better visualization of the inferior border of the glenoid and the Hill–Sachs defects, respectively. The modified Constant score [12] and the Rowe score [13] were used for all cases. Using MRI with contrast, avulsion of the glenoid labrum was detected in all cases, the SLAP lesion was present in one case, the Hill–Sachs lesion in seven patients (small-sized), and partial tear of the supraspinatus tendon was detected in one patient.

The mean time elapsed from the time of injury to surgery was 21.3 months (range, 9–41 months); arthroscopic surgery was performed for all cases using biodegradable anchors for labrocapsular refixation and thermal capsular shrinkage, after at least 6 months of failed nonoperative treatment.

The surgical technique

All operations were carried out under general anesthesia in the beach-chair position. The affected shoulder was examined for instability and compared with the opposite sound shoulder. All the patients had unidirectional anteroinferior laxity. A standard posterior portal was established to assess the glenohumeral joint, including tissue integrity (Bankart lesion and capsular laxity).

After diagnostic arthroscopy was performed, and through the anteroinferior portal, the anterior glenoid rim was prepared using a motorized shaver (Figs 1 and 2) and the capsulolabral tissue was mobilized from its position using a small elevator to allow superior and medial shift of the capsulolabral tissue (capsular retensioning).

Then, the cannulated guide was placed through the anteroinferior portal with the dovetail tip on the

Table 1 Preoperative data of the patients

Number of patients	Age (years)	Sex	Side	Mechanism of injury (first dislocation)	Number of recurrences	Preoperative duration (months)	Preoperative constant score (points)	Preoperative rowe score (points)
1	14	Male	Right	Sport	2	9	58	40
2	14.5	Male	Right	Sport	3	16	52	35
3	13.5	Male	Right	Fall from a height	3	11	36	25
4	15	Female	Right	Sport	2	17	44	30
5	16.6	Male	Left	Bicycle accident	5	34	28	20
6	15.3	Male	Right	Sport	2	28	54	45
7	13.5	Male	Right	Sport	2	10	42	40
8	15.6	Male	Right	Motor vehicle accident	3	23	34	25
9	16.4	Male	Right	Sport	4	31	28	20
10	14.7	Female	Right	Fall from a height	3	19	48	35
11	13.7	Male	Left	Sport	2	10	58	50
12	16	Male	Right	Sport	4	28	32	25
13	17	Male	Right	Bicycle accident	5	41	36	25

glenoid rim at 5 O'clock in the right shoulder, and the starter penetrator was used to determine the entry point for the first anchor (Fig. 3). Then, the suture anchor was advanced until the laser line was flush to the bone.

Once the anchor was placed (Fig. 4), and its security was tested by traction on the suture limbs. A suture hook device was introduced through the capsule 1 cm inferior and under the labrum, which then grasped one limb of the suture limbs (Fig. 5) and was retrieved through the anterior portal; the knot was then tied with a simple overhang technique and introduced intra-articularly by a knot introducer (Fig. 6). These steps were repeated for the second and the third anchors if needed at the 3 O'clock and the 2 O'clock position.

Lastly, thermal capsular shrinkage (capsulorraphy) was performed, in which the loose glenohumeral capsular ligament was shrunk with a radiofrequency probe, which was moved from the medial to the lateral and from the inferior to the superior position.

Postoperatively, the arm was immobilized in a shoulder immobilizer for 3 weeks; the sling was removed to allow wrist and elbow movement, isometric deltoid contractions, and pendulum exercises from the first postoperative day. At 3 weeks postoperatively, passive forward flexion and elevation of the shoulder to 90° in addition to external rotation to 0° were allowed. At 6 weeks postoperatively, full active range of motion and strengthening exercises for deltoid, rotators, and scapular muscles were allowed. At 12 weeks postoperatively, resistive exercise was performed. Return to sport was allowed at 5 months postoperatively.

Patients could be clinically followed up for an average of 28.8 (range 8–46) months. The modified Constant score [12] and the Rowe score [13] were

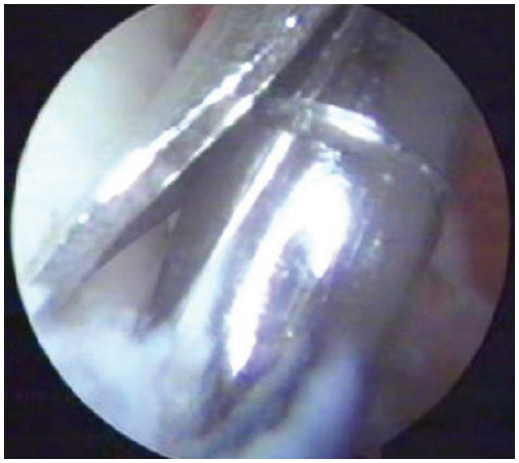
Figure 1

The Beach-chair position with the freely hanging arm and the two portals used.

Figure 2

Preparation of the anterior glenoid rim using a motorized shaver.

Figure 3



The starter penetrator is used to determine the entry point of the first anchor.

Figure 4

The first anchor is introduced in a previously prepared site.

used to evaluate the results. Postoperative laxity was measured clinically by the translation of the humeral head in the anteroposterior direction, and graded as no translation (grade 0), subluxation over the glenoid rim with spontaneous reduction (grade I), or subluxation without spontaneous reduction (grade II).

Statistical analysis

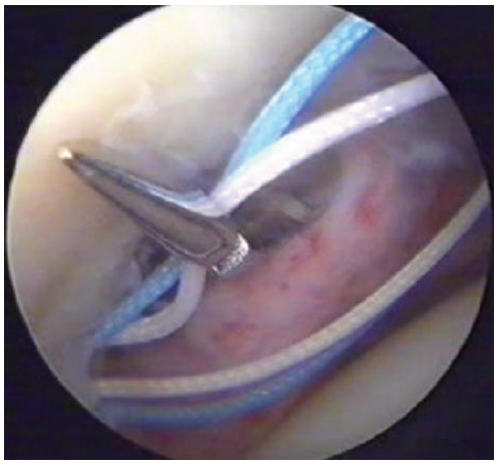
For statistical analysis, preoperative and follow-up modified Constant and Rowe scores were compared using Student's paired *t*-test by means of an SPSS program (SPPS Inc., Chicago Illinois, USA). For all comparisons, a *P* value of less than 0.05 was considered significant.

Results

Arthroscopic findings correlated with the MRI findings, except for the fact that arthroscopy revealed only six Hill–Sachs lesions and no supraspinatus tear or SLAP lesions (Table 2). A Hill–Sachs defect was visible in 46.2% of the cases; the prevalence was higher (62.5%) in patients who had three or more recurrences (five of eight cases). In one patient (the last case) who was 17 years old at the time of surgery, radiographs showed mild osteoarthritis of the glenohumeral joint. One anchor was used in two patients (15.4%), two anchors in seven patients (53.8%), and three anchors in four patients (30.8%).

The average follow-up period was 28.8 months (range 8–46 months). At the follow-up examination, all the patients and parents were satisfied with the course of treatment. All the patients were able to return to school after 7 (range 5–11) days. According to the modified Constant–Murley score, the mean score after arthroscopic refixation was 93.8 (range 87–100) points with significant improvement ($P < 0.001$). According to the Rowe score, all patients were excellent with a mean score of 96.1 (range 90–100) points ($P = 0.001$)

Figure 5



The arthropierce grasps the suture limb.

Figure 6

The knot introducer is used to insert the knot intra-articularly.

Table 2 Postoperative data of the patients

Number of patients	Arthroscopic findings	Number of anchors	Duration of follow-up (months)	Postoperative constant score	Postoperative rowe score
1	Bankart+H-S	2	46	96	100
2	Bankart	2	43	94	95
3	Bankart+H-S	3	41	88	90
4	Bankart	2	37	95	100
5	Bankart+H-S	3	35	96	100
6	Bankart	2	31	98	100
7	Bankart	1	28	100	100
8	Bankart	2	27	94	95
9	Bankart+H-S	3	24	89	90
10	Bankart+H-S	2	21	93	95
11	Bankart	1	18	98	100
12	Bankart+H-S	3	16	92	95
13	Bankart	2	8	87	90

H-S, Hill–Sachs lesion.

(Table 2). At the last follow-up, all clinical tests (apprehension test, sulcus sign, and translation test) revealed no instability.

Regarding the range of motion, the mean postoperative forward flexion and external rotation with an abducted arm at 90° did not change from the preoperative value of 180° for abduction and 87° for external rotation.

One patient had significant pain after returning to heavy work 4 months after surgery; this settled after a short period of rest, analgesic, and physiotherapy. Another patient (7.7%) suffered from redislocation 7 months after arthroscopic surgery because of sport injury, and was managed with revision arthroscopic anchor stabilization and laser capsular shrinkage. The end results of both cases were satisfactory and were rated as excellent and good, respectively, at the end of follow-up.

No major intraoperative or postoperative surgical complications such as wound infection, nerve injury, deep venous thrombosis (DVT), or complications from suture anchors (growth disturbance or complications related to the degradation of the anchors) occurred. Eleven patients (84.6%) returned to their preinjury level of recreational activities or sport. Two patients (15.4%) returned to normal daily activities, but practiced sport at a lower level because they were not confident.

Discussion

Shoulder dislocation is associated with young age, and the younger age is considered to be the most important risk factor regarding recurrence after first-time dislocation [14]. Flinkkila *et al.* [4] in their study concluded that young age remains the most important risk factor of recurrence of shoulder instability even after surgery, and early surgery can lower the recurrence rate compared with nonoperative treatment. In the current study, up to a follow-up of 46 months, one patient (case no. 2) (7.7%) suffered from recurrence after 7 months of arthroscopic anchor refixation because of another sports injury and was managed with revision arthroscopic anchor stabilization. Hence, a high incidence of repeated injuries may reflect the high risk of recurrence among young patients, [15,16] which is proved by the current study.

We found the prevalence of Hill–Sachs defect to be lower in shoulders that had suffered fewer than three redislocations than in those with a higher number of recurrences. This suggests that in adolescents, the defect in the humeral head may occur either at the time of the primary dislocation or during the redislocations. Our findings indicate that the prevalence of Hill–Sachs defects is correlated with the number of recurrences. This, in turn, is in keeping with the observation that a shoulder with a humeral defect is more prone to recurrence.

Earlier, arthroscopic techniques for the stabilization of labrocapsular injuries using anchor systems was the gold standard for the treatment of recurrent shoulder dislocations in adults [17]. However, the literature on younger skeletally immature patients is less clear in terms of the risk of future instability and the necessity of surgical intervention; in athletic patients aged above 14 years with a Bankart lesion, early surgical intervention may be warranted because of the high risk of recurrent instability [18]. Lawton *et al.* [10] confirmed the advantages of surgical treatment of post-traumatic recurrent shoulder dislocation in children and young patients and reported promising results. Hence, this technique can be used successfully in skeletally immature patients without modification of the technique (no difference in young patients compared with adults), especially because there is no bony growth complication related to the anchor implant or its degradation, which was proved by Kraus *et al.* [1] and the current study.

For some patients who have recurrent dislocations, arthroscopic techniques have resulted in higher recurrence rates than open procedures. Possible explanations for the higher recurrence rate include capsular redundancy and subsequent contact sport, especially in young athletes [19]. Also, Bigliani *et al.* [20] have shown that plastic deformation of the capsular ligaments often occurs even in classic Bankart lesion, and such deformation can increase capsular laxity and is associated with recurrent instability.

The development of a radiofrequency heat probe for capsular shrinkage has created interest in its potential use as an adjunct for arthroscopic stabilization of shoulder dislocation. In our study, all patients suffered from recurrent dislocation and were of young age. The mechanism of injury in most of them was sport related, and so arthroscopic capsulorraphy was performed in all cases to deal with capsular laxity, with heat-generated shrinkage of the collagen in the capsule and glenohumeral ligaments as an adjunct to Bankart repair.

Radiographic evidence of bone defects was rare in young patients, and the effect of the bone defect could be analyzed statistically [4]. In the current study, no significant difference was found between young patients with bony lesions (Hill–Sachs or glenoid erosion) and those without bony lesions.

Jones and colleagues reported an 18.7% rate of recurrence in their series of delayed arthroscopic Bankart repair in an adolescent population. In their study, 84% of the athletes returned to their preinjury sport level [17]. Also, Castagna *et al.* [21] concluded that the recurrence rate was not related to the postoperative scores or the number of preoperative episodes of instability, and the time between the first dislocation and the time of surgical stabilization does not affect the end results; there was a statistically significant relation between recurrence and the type of sport practiced ($P = 0.0021$). In the current study, the only case of recurrence after arthroscopic stabilization was because of sport injury despite high Constant and Rowe postoperative scores.

Also, Rose and colleagues published a study on 65 adolescent patients (13–18 years) with post-traumatic shoulder instability subjected to arthroscopic surgery. The mean follow-up was 63 months, and the mean postoperative Rowe score was 85 (range: 30–100); the recurrence rate was not related to the postoperative score, the number of preoperative episodes of instability, or the time that elapsed between the first instability episode and the surgery. A statistically significant association ($P = 0.0021$) was found between recurrence and the type of sport practiced [22].

There are certain limitations in this study. First, this study had a small number of patients, but the rareness of the injury itself can explain this point. Second, long-term results are needed after longer periods of follow-up, and so further studies are necessary to continue to validate the efficacy of arthroscopic stabilization and capsulorraphy in skeletally immature patients.

Conclusion

Recurrent post-traumatic shoulder dislocations are rare in skeletally immature patients. Arthroscopic stabilization of the labrocapsular complex with a biodegradable anchor and capsulorraphy is a reasonable option in the young population and has led to permanent stability. No growth disturbance was detected, and so delay of arthroscopic surgery until adulthood is not preferred, and no modifications of the adult technique are required. However, recurrence could be expected after arthroscopic stabilization, and it is often related to the practiced sport.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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