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SHOULDER

Recurrent shoulder instability among athletes: changes in quality of life, sports activity, and muscle function following open repair

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Abstract Background: Recurrent anterior shoulder instability is a disabling condition in young athletes with possibly underestimated impact on quality of life and sports activity. Commonly used clinical scoring systems do not reflect the impairment of quality of life and sports activity. It was our aim to assess the return to preinjury levels of quality of life and sports activity as well as the changes in muscle function among competitive and recreational athletes. Hypothesis: Patients suffering from post-traumatic recurrent shoulder instability have to adopt their participation in sports and therefore discover a reduction in quality of life. Open stabilization procedures are able to improve shoulder function and to reduce recurrence rates. However, return to preinjury shoulder function is not guaranteed. Study design: Retrospective longitudinal cohort study on 19 consecutive athletes with recurrent, post-traumatic shoulder instability. All patients were treated with an open, capsulo-labral repair. The minimum follow-up was 24 months. Methods: Life quality (SF12) and sports activity data (Athletic Shoulder Outcome Scoring System) were retrospectively collected for the time before injury (time 1) and for the time with recurrent instability (time 2). Two years after surgical stabilization (time 3), we followed our patients with different clinical outcome scores, rotator surface EMG measurement, isokinetic muscle strength testing, and a radiological evaluation. This design of a three-step follow-up allowed for calculating the impact on quality of life and sports activity following the injury. Results: Two years after surgery, the clinical scoring systems revealed good-to-excellent results in all patients. Quality of life physical component summary remained diminished by 9.2% despite the surgical procedure and was therefore significantly lower as compared to preinjury levels ($p < 0.05$). Sports activity was also significantly lower at the time of follow-up ($p < 0.05$). In this specific procedure, external rotation was not impaired postoperatively. EMG testing showed an overall reduction of muscle activity, however not significant. Isokinetic muscle strength was significantly diminished for external rotation and shoulder abduction. Conclusions: Open reconstruction procedures for recurrent shoulder instability can restore shoulder function and stability to near-normal values. Despite good-to-excellent clinical results, there is a significant impairment of quality of life and sports activity 2 years after surgery. Muscle activity and muscle strength are diminished. Recurrent shoulder instability remains a disabling condition to the young athlete. Future strategies have to emphasize restoration of quality of life, sports activity, and muscle function.

Keywords Recurrent post-traumatic shoulder instability · EMG · Isokinetic testing · quality of life · Athletes

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Introduction

Recurrent anterior shoulder instability following traumatic first-time shoulder dislocation is a common clinical problem, especially among athletes. Open Bankart repair and anterior capsulorrahphy has gained widespread acceptance as the surgical procedure of choice, demonstrating high success rates with only 3–5% of recurrence [9, 10, 12, 15]. Arthroscopic procedures are reported to achieve good and excellent results with a recurrence rate of 4% even in high-level athletes as long as there is no significant bony defect [3]. Several investigators have evaluated the success of surgery using clinical outcome scoring systems and a description of the ability to participate in prior performed sports [1, 4, 6, 9, 11, 15, 17, 23, 24, 26, 28, 37]. However, no data are available concerning changes in life quality, sports activity (using a scoring system), and functional changes of muscle activity in this specific patient group.

The purpose of this study was to evaluate life quality, sports activity, and muscle function after open shoulder reconstruction for recurrent traumatic instability in young athletes.

Materials and methods

Between 1 February 1999 and 30 April 2001, 27 consecutive competitive and recreational athletes were treated for recurrent shoulder instability with a capsulo-labral repair as described by Montgomery and Jobe [23]. Inclusion criteria were an age between 16 and 40 years, and at least one recurrence of shoulder dislocation that defined failure of conservative therapy. Exclusion criteria were prior shoulder surgery on the index side. Five patients who had undergone a prior operation for anterior instability were excluded from the study. One patient sustained a re-dislocation due to adequate trauma and had to be excluded. Two patients were lost to follow-up, leaving 19 available for final evaluation. In 14 patients, EMG and isokinetic testing were performed.

Operative technique

All procedures were done by one surgeon. All patients underwent a standardized open stabilization procedure as described by Montgomery and Jobe in 1994 [23]. The subscapularis muscle was visualized and the tendinous part of this muscle divided horizontally at the junction between its upper two-thirds and lower one-third levels. Attention was directed to the glenohumeral joint capsule, which was carefully dissected from the overlying subscapularis muscle, starting medially. The interval was maintained using a modified Gelpi retractor (W. Link GmbH & Co., Hamburg, Germany) and a three-pronged pitchfork retractor, the latter placed medially. Both retractors were necessary to provide complete exposure of the glenohumeral joint capsule (Fig. 1).

A horizontal capsulotomy was created at a point two-thirds from the top of the capsule and was extended medially beyond the rim of the glenoid. Stay sutures were placed in the leading edge of each capsular flap to allow easier handling of these tissues. Further exposure of the anterior glenoid rim was obtained by placing a narrow humeral head retractor across the joint and retracting the head laterally. The capsular flaps were then dissected from the anterior scapular neck and the glenoid rim. The extent of dissection was dependent on the amount of shift necessary to create a stable joint. The distal flap was subperiostally dissected to the 6 o'clock position, the upper flap to the level of the 2 o'clock position for the right, and the 10 o'clock position for the left shoulders.

Using a special drilling device with a defined maximum depth, three drill holes were placed at the anterior glenoid rim at the 2, 4, and 5:30 o'clock positions for the right and 10, 8, and 6:30 o'clock positions for the left shoulder. Three G III suture anchors (Mitek Division, Ethicon® GmbH & Co. KG, Norderstedt, Germany) were then positioned within the drill holes. Using nonabsorbable sutures, the inferior capsular flap was shifted superiorly with the use of the suture from

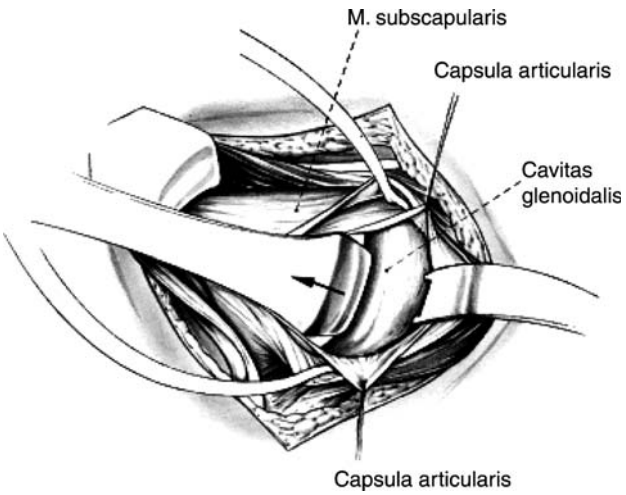

Fig. 1 Surgical exposure of the glenohumeral joint: horizontal dissection of the subscapularis muscle and tendon and horizontal capsulotomy

the most inferior anchor. In a similar fashion, the second and third sutures were tightened, which anchored the superior portion of the inferior capsular flap more proximally to the glenoid rim. This step was performed with the arm positioned in 60° of abduction and 30° of external rotation. The superior capsular flap was then shifted distally, overlapping the inferior flap, and secured with the previously placed sutures. The newly created double thickness anterior capsule was thought to provide reinforcement at the site of previous instability. Passive motion of the shoulder was then performed to ensure at least 90° of abduction and 45° of external rotation. Closure of the capsule was carried out with interrupted, nonabsorbable sutures followed by the re-apposition of the skin edges using a modified interrupted vertical mattress suturing technique.

Postoperative rehabilitation protocol

Rehabilitative exercises began on the first postoperative day. They started with ball squeezing exercises, active wrist and elbow flexion and extension exercises, isometric abduction and active-assisted horizontal adduction, and abduction strengthening exercises. An abduction splint was used for the first 4 weeks. Active internal rotation started at 3 weeks after surgery, and active external rotation beyond the neutral position after 6 weeks. Isokinetic strengthening and endurance exercises for internal and external rotation started at 12 weeks after surgery.

Clinical examination and clinical outcome measurement

The relocation test and apprehension sign were used to evaluate postoperative instability. Range of motion was measured and recorded according to the principles of the Society of American Shoulder and Elbow Surgeons [27]. The motion of the extremity being examined was compared with that of the opposite extremity. Active total elevation was measured in the upright position in the scapular plane, 20–30° from the sagittal plane. Active external rotation was documented with the patient seated in an upright position, and passive external rotation with the patient in the supine position. Measurements were performed with the arm at the side and in the 90° abduction position. Clinical outcome measurement was done according to five different scoring systems: the standardized form for the assessment of the shoulder of the ASES [27], Constant–Murley Score [5], Rowe Score [29], SST [19], UCLA Score [8].

Life quality and sports activity

Using the 12-item short-form Health Survey (SF-12) [34] and the Athletic Shoulder Outcome Scoring System [32], we asked our patients to recall their well being and sports activity in the course of their injury. Time 1 (preinjury) represented the time before injury when the subject was supposed to have full sports activity and unrestricted activities of daily living. Time 2 (preoperative) represented the period of recurrent instability after conservative treatment had failed, and surgery was determined. To exclude any bias, a test–retest design was chosen. Retest was performed by phone 4 weeks after the clinical follow-up examination. The data at follow-up (time 3) were collected prospectively. Using this three-step follow-up, we reconstructed the dynamic behaviour of life quality and sports activity in the course of recurrent shoulder instability. Physical component summary (PCS) and mental component summary (MCS) of the SF-12 were calculated.

Radiographic evaluation

Plain radiographs in the anterior and axillary-lateral view were obtained at time of follow-up and compared to the immediate postoperative radiographs. Signs of subluxation, anchor positioning, and the presence of degenerative changes were evaluated. Degenerative changes were classified according to the Samilson and Prieto grading system [30].

EMG–isokinetic testing

The isokinetic dynamometer (Biodex Pro System 3, Biodex Medical Systems, Shirley, NY, USA) was combined to the Naroxon surface EMG system (Myosystem 2000, Noraxon Europe, Berlin, Germany) via an analog outlet connection. This setup allowed an analysis of muscle activity and isokinetic muscle strength. Both the operated and the contralateral shoulder joints were examined. Side-to-side differences were calculated for muscle activity (EMG testing) and peak torque (isokinetic testing). Muscle activity was evaluated for three distinct rotator muscles: the supraspinatus, infraspinatus, and teres minor muscle. The side to be tested first was chosen randomly. Six electrodes (Blue Sensor, Ambu, Olstykke, Denmark) were placed on defined areas to get muscle-activity signals from the above-mentioned muscles.

The subject was then seated in the Biodex chair and the subject's trunk was stabilized with Velcro straps. Positioning specifications consisted of the following: flexion/extension was tested in the sagittal plane.

Abduction/adduction was tested in the plane of the scapula. External/internal rotation was tested in the transverse plane with the arm abducted 15°. Isokinetic testing was performed sequentially in the following order: 60, 120, and 180°/s. Each subject was allowed two repetitions before testing at each speed. Rest periods of 90 s were given between speeds, whereas rests of approximately 2 min were given between functions. The entire procedure was explained to each subject, emphasizing the necessity of exerting maximal effort during the examination. All isokinetic tests consisted of five maximal and reciprocal contractions. The best three contractions were used in the data analysis. Peak torque means were calculated for each test. EMG muscle activity data were simultaneously collected and correlated to the movements. The contralateral shoulder was tested in the same way. The mean EMG activity of the patient for each of the three muscles was calculated for each movement during Biodex testing. Integrated EMG for each phase of the six planar motions was averaged within and among subjects and expressed as a mean and standard deviation (Fig. 2).

Statistical analysis

The data were evaluated by a professional statistician using SPSS 11.5 (SPSS, Inc., Chicago, IL, USA). The paired *t* test was used for statistical analysis. A p value < 0.05 was considered significant.

Results

Mean time to follow-up was 32 months (range 24–47 months). The average age at time of injury was 21.8 (range 16–35) years. The history of the initial trauma is shown in Table 1. Plain radiographs at time of injury revealed no Bankart fracture and 16 Hill Sachs lesions in this patient group. All patients initially underwent nonoperative treatment with a rehabilitation program that emphasized strengthening of the rotator cuff and scapular rotator muscles as well as proprioceptive neuromuscular feedback exercises in the later stages of rehabilitation. The average duration of nonoperative treatment was 29 (range 1–108) months. The symptoms that determined failure of the rehabilitation program in all patients included recurrent instability, shoulder pain, and apprehension during participation in their primary sports activity. Each patient had at least one episode of redislocation, and the number of recurrent episodes ranged from 1 to 43.

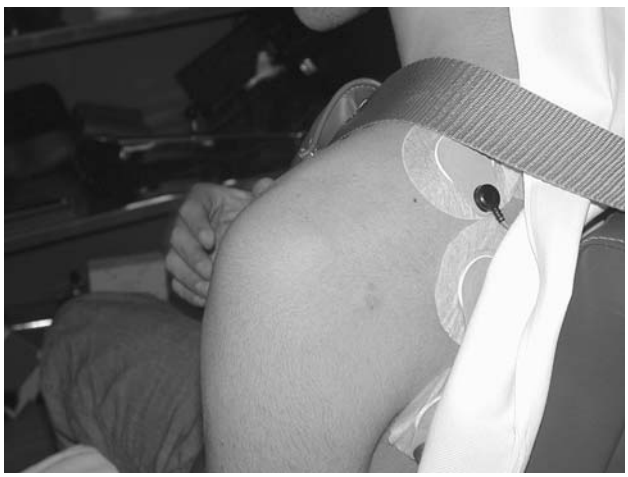

Fig. 2 Positioning of the electrodes above the index muscles: the supraspinatus, infraspinatus, and teres minor muscle

Arthroscopic and operative findings

A Bankart lesion was noted in 16 of the 19 patients. A Hill-Sachs lesion was present in 16 patients. No osseous Bankart lesion or rotator cuff tear was observed. One loose osteocartilaginous body was removed.

Clinical examination at time of follow-up

Two patients had a positive relocation test and a mild apprehension with abduction and external rotation of the shoulder. Both these individuals had had more than 10 episodes of instability before surgery. Loss of active external rotation was 5–10° in two patients. When measured passive in the supine position, the loss in these patients was 5°. All other patients had a loss of external rotation between 0 and 5°. There was no deficit for flexion/extension, elevation, and internal rotation.

Clinical outcome measurement

All patients reported that they would undergo the surgical procedure again for the same problem. The five scoring systems revealed a diminished shoulder function at time of follow-up. The average score results were: ASES 88.0 ± 11.4, Constant Score 85.4 ± 10.2, Rowe 84.8 ± 13.9, SST 11.0 ± 1.6, and UCLA 31.6 ± 2.5. Figure 3 demonstrates the mean overall values for each scoring system as the percentage of normal function.

Quality of life and sports activity

SF-12

Preinjury values for MCS were 58.5 (58.4 retest), and 55.6 (55.8 retest) for PCS. The values represented

Table 1 Demographics and injury-specific details

Patient	Sex	Age at injury (first-time dislocation)	Mechanism of injury	Affected side	Recurrence under conservative treatment	First-time dislocation to surgery (months)	Postoperative recurrence	Satisfied (according to UCLA)	Dominant side
1	F	24	Judo	Left	1	12	No	Yes	Right
2	M	16	Athletics	Left	1	21	No	Yes	Right
3	M	35	Soccer	Left	2	24	No	Yes	Right
4	M	21	Soccer	Left	4	18	No	Yes	Right
5	F	23	Volleyball	Left	14	14	No	Yes	Right
6	M	17	Baseball	Left	4	21	No	Yes	Right
7	M	22	Basketball	Left	1	84	No	Yes	Right
8	M	16	Volleyball	Right	4	10	No	Yes	Right
9	M	21	Weight lifting	Left	1	0	No	Yes	Right
10	M	24	Ice hockey	Left	1	0	No	Yes	Right
11	F	34	Volleyball	Right	2	8	No	Yes	Right
12	F	18	Badminton	Left	43	80	No	Yes	Right
13	F	16	Shot putting	Right	40	50	No	Yes	Right
14	M	18	Weight lifting	Left	25	60	No	Yes	Right
15[a]	F	20	Handball	Right	4	1	No	Yes	Right
16[a]	F	29	Volleyball	Right	9	8	No	Yes	Right
17[a]	M	17	Basketball	Right	10	108	No	Yes	Right
18[a]	M	21	Athletics	Left	13	6	No	Yes	Right
19f[a]	F	23	Volleyball	Right	8	8	No	Yes	Right

[a]No *EMG*/isokinetic testing performed

those of a normal population. Corresponding preoperative values during recurrent instability were 52.7 (52.6 retest) for MCS and 35.8 (35.8 retest) for PCS, representing a significant drop of life quality for this period. Two years after surgery, the MCS nearly reached the preinjury value [57.4 (57.7 retest)]. PCS remained significantly low with a mean of 51.7 (51.4) ($p < 0.05$; Fig. 4).

Athletic shoulder outcome scoring system

According to the specific design of this scoring system, preinjury value was 100. At time of follow-up, the mean value for our patients was 80.0 (81.1 retest), representing a good overall result. However, all patients had significantly diminished sports activity 2 years after surgery. Reasons for a reduced sports activity (according to this score) were diminished performance and intensity during participation (four patients), pain during peak performance (two patients), and diminished shoulder strength (four patients). The other patients remained their level of participation (five patients) or reduced it for reasons not shoulder related.

Radiographic evaluation

Anteroposterior and axillary lateral views were available for all 19 patients. All suture anchors maintained

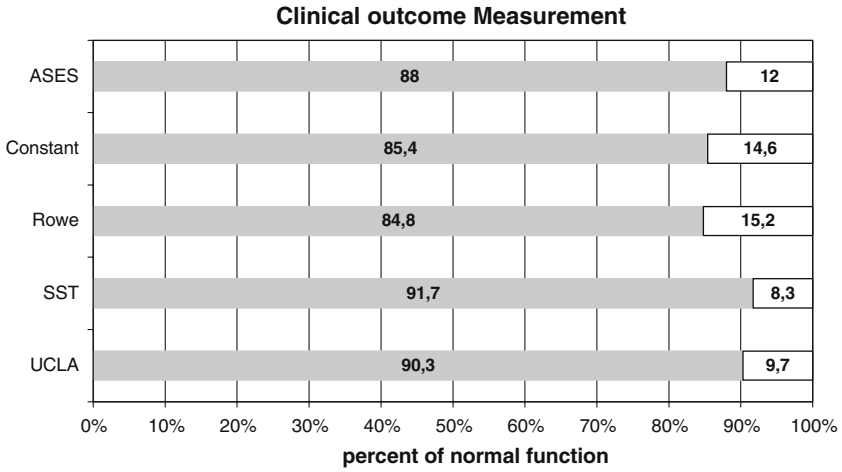

Fig. 3 Values at follow-up in percent, referred to possible maximum for each scoring system

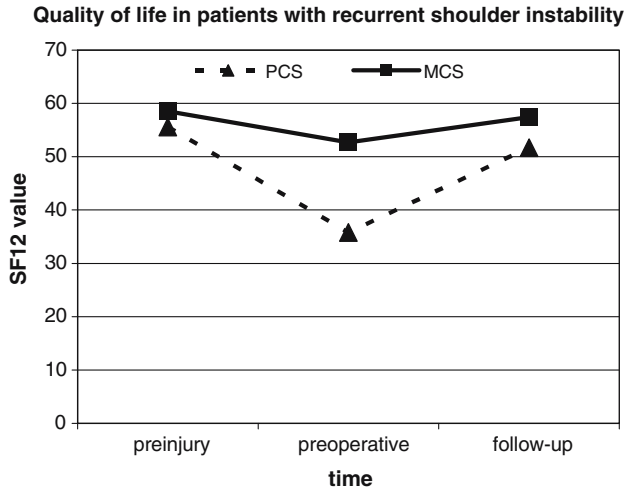

Fig. 4 Three-step follow-up of quality of life in patients with recurrent shoulder instability

their position in the anteroinferior part of the osseous glenoid. There was evidence of a subluxation in four patients preoperatively. Beginning degenerative changes of the glenohumeral joint were found as a grade I arthropathy according to Samilson and Prieto in four patients preoperatively and six patients postoperatively. No other major radiographic anomalies were noted.

EMG–isokinetic testing

EMG

Comparison of rotator muscle activity between normal shoulders and those with former anterior joint instability demonstrated no significant differences. However, the EMG activity of the teres minor muscle during external rotation was demonstrable lower in the stabilized shoulders ($p < 0.05$). Overall, there was a systematic trend that demonstrated a lower activity of all index muscles when compared to the normal shoulder.

Isokinetic testing

External rotation and abduction at 60 and 120 °/s differed significantly in side-to-side difference ($p < 0.01$). However, five patients revealed no peak torque deficits at these speeds for external rotation and abduction. In both shoulders, injured and unaffected sides, average peak torque values generally decreased as speed increased. The torque for shoulder extension was greatest followed by adduction, flexion, abduction, internal rotation, and external rotation movements. Average peak torque values and their standard deviations are shown in Table 2.

Discussion

Recurrent shoulder instability is a common disorder following traumatic first-time dislocation. Once non-operative therapy has failed, treatment options consist of a variety of arthroscopic and open procedures. Arthroscopic techniques do not seem to result in a superior clinical outcome [4, 10]. Recent studies by Burkhart and De Beer [3] report a similar low rate of recurrences after arthroscopic stabilization of first-time traumatic dislocations (4%), at least if the bony glenohumeral defect is small. In this study, we evaluated the Jobe procedure, once especially developed for elite athletes with shoulder pain [15, 23]. The specific difference to other open procedures is a double-horizontal incision of the subscapularis tendon and the underlying capsule, without any vertical component expanding to an L-shaped or T-shaped incision [15, 23].

Clinical examination and clinical outcome measurement

Consistent with our data, the commonly reported rate of dislocation after an open Bankart procedure is 3–5% [33]. The high success rate has set the standard by which all surgical reconstructions of the unstable shoulder are judged. However, treatment of recurrent anterior instability of the shoulder is a balance between gaining glenohumeral stability and minimizing loss of glenohumeral motion [9, 10]. In 1994, Montgomery and Jobe reported excellent-to-good results in all their 31 patients treated for recurrent instability. External rotation impairment was considered to be low in comparison to other procedures [11]. This finding was evident also in this study, revealing external rotational deficits of 0–5° in all but two patients. With regard to other open stabilization procedures with an average loss of 8–15°, this technique seems to favour good postoperative range of motion [4, 9, 18, 26, 37]. It can be hypothesized that this is because of a horizontal healing and scaring pattern of the capsule and subscapularis tendon, which results in less compromise of the capsule/tendon length than an additional vertical incision. A careful dissection between the subscapularis tendon and the capsule during exposure has been considered helpful in preventing postoperative scarring between the two structures and thus preventing loss of motion [9]. Maintaining the external rotation is supposed to be

Table 2 Mean peak torques in N m of the isokinetic testing in six degrees of freedom and their *SD*

		Mean peak torque (N m) ± SD	$p <$
Flexion			
60 °/s	Contralateral	53.6 ± 18.3	0.027
	Injured	48.0 ± 15.4	
120 °/s	Contralateral	48.0 ± 16.2	0.035
	Injured	43.6 ± 14.4	
180 °/s	Contralateral	45.7 ±17.4	0.104
	Injured	42.2 ± 16.1	
Abduction			
60 °/s	Contralateral	49.0 ± 15.9	0.001
	Injured	43.6 ± 13.7	
120°/s	Contralateral	47.2 ± 14.7	0.004
	Injured	42.3 ± 13.1	
180 °/s	Contralateral	42.0 ± 14.5	0.029
	Injured	37.8 ± 15.8	
External rotation			
60 °/s	Contralateral	29.7 ± 10.7	0.002
	Injured	25.9 ± 9.1	
120 °/s	Contralateral	27.4 ± 10.4	0.001
	Injured	23.6 ± 8.7	
180 °/s	Contralateral	24.9 ± 9.9	0.011
	Injured	22.2 ± 8.4	
Extension			
60 °/s	Contralateral	69.4 ± 32.3	0.338
	Injured	65.4 ± 28.8	
120 °/s	Contralateral	60.9 ± 33.0	0.259
	Injured	57.9 ± 29.3	
180 °/s	Contralateral	61.7 ± 30.5	0.163
	Injured	53.7 ± 29.6	
Adduction			
60 °/s	Contralateral	65.8 ± 29.5	0.125
	Injured	58.7 ± 26.3	
120 °/s	Contralateral	61.0 ± 28.4	0.125
	Injured	56.1 ± 25.1	
180 °/s	Contralateral	58.5 ± 28.4	0.023
	Injured	50.0 ± 26.7	
Internal rotation			
60 °/s	Contralateral	42.6 ± 17.4	0.393
	Injured	40.3 ± 16.5	
120 °/s	Contralateral	39.8 ± 16.1	0.131
	Injured	38.0 ± 13.8	
180 °/s	Contralateral	37.9 ± 15.9	0.520
	Injured	35.3 ± 10.3	

even more crucial for a subjective excellent outcome than is the restoration of stability [9].

The overall results of the clinical outcome scores presented in this study seem to be comparable to those of other studies investigating arthroscopic or open stabilization procedures for recurrent shoulder instability [4, 7, 9, 15, 23, 28]. However, there is currently a lack of consensus on how to evaluate the results of surgical shoulder stabilization [10, 36]. Soldatis et al. [31] reported that it is inappropriate to expect a ''normal'' or ''symptom-free'' shoulder after injury or surgery. Using five different scoring systems among 190 healthy athletes, reference values for ''normal'' shoulder function were calculated. Surprisingly, major symptom categories for pain, instability, strength, and function revealed diminished values even in uninjured shoulders. This information can be used as a reference to compare results of surgery to a ''normal'' baseline. Recently, much work has been done to compare different shoulder-specific scoring systems [36].

In our study, the Constant–Murley Survey as the most sensitive in reporting functional symptoms was 14.6% below the possible maximum. Overall differences to the possible maximum value available for the ASES and UCLA as the most sensitive scores in reporting pain were 12 and 9.7%, respectively. The ROWE score that was specifically designed to differentiate successful results from unsuccessful results after Bankart repair averaged an impairment of 15.2% and therefore appears to be the most sensitive to changes in this patient group. Overall, these systems cannot be directly compared by category because not all systems use the same categories for scoring. None of the abovementioned systems is ideal for scoring shoulder function in athletes [31]. Nevertheless, the rate of recurrence to preinjury levels of sports activity seems to become more important in shoulder outcome analysis [11, 15, 17, 23, 26, 37].

Quality of life and sports activity

The three-step follow-up used in our study revealed a significant impairment of both MCS and PCS values following injury, measured during the time of recurrent shoulder instability. Two years after surgical stabilization, PCS values remained significantly lower compared to the preinjury condition, reflecting an impairment of quality of life. According to other orthopaedic conditions, Katz et al. [16] mention that quality of life data should be ascertained routinely in orthopaedic outcome studies. Quality of life data also provide a benchmark against which treatment effectiveness can be determined [20].

Beaton and Richards [2] found that the shoulder-specific questionnaires performed differently than the general health surveys, and they recommended the use of both a generic health-status measure and a disease-specific measure. According to Matsen et al. [21], health status questionnaires can document and call attention to important aspects of the patient's condition that might not otherwise be detected. Questionnaires such as SF-36 and SF-12 have been proven to be a capable tool even for orthopaedic conditions [6]. The application of this methodology before and after treatment is extremely compelling as it documents

effectiveness of surgical procedures. The patient self-assessment SF-12 scores for the two summary measures PCS and MCS strongly correlate with those of the more complex 36-item short form [34].

A score especially designed for the athlete's shoulder was published by Tibone and Bradley in 1993 [32]. It was used in this study to quantify recurrence to the preinjury level of sports activity. The preinjury value is supposed to be 100. Applied to our patient group, it decreased to a mean of 58 for the time of recurrent instability and averaged 80.0 two years after surgery, indicating that preinjury levels are not reached despite surgical intervention. These data correlate well with a number of studies assessing recurrence to prior sports activity levels [1, 4, 6, 9, 11, 15, 17, 23, 24, 26, 28, 37]. Unfortunately, none of these studies refers to the above-mentioned scoring system, the only one as far as we know to quantify shoulder-specific sports activity. This makes a comparison of sports activity impossible. All authors used more or less arbitrary descriptions of sports activity. Allain et al. [1] distinguish four types of sports with respect to the potential risk of injury of the shoulder (type I non-impact sports, type II high impact sports, type III overhead sports with hitting movements, and type IV sports with overhead hitting movements and sudden stops). Eighty percent of their 49 patients were able to return to the same sport at the same level. Similarly, Kralinger et al. [11, 17] divided the various sports activities into three main types: type I no shoulder strain, type II moderate shoulder strain, and type III strong shoulder strain. Only 65.5% of 180 patients returned to full athletic activity. Gill et al. [9] analysed the level and frequency of participation in sports before and after the operation in 56 patients, without referring to sport-specific shoulder strain. All but one patient returned to their preoperative level of activity (98%), whereas one patient was unable to return because of shoulder pain with overhead activity. In a comparative study on 63 patients by Cole et al. [4], 11% of the arthroscopic group patients were not able to return to sports, whereas all open-repair group patients were able to return to sports. Over 50% in each group had mild-to-severe limitations when performing sports postoperatively. However, these authors do not report about maintaining or not the same level and frequency of participation in sports. Fifty-two of 58 American football players who underwent open stabilization for recurrent instability returned to full participation for at least 1 year in a study presented by Pagnani and Dome [26]. However, only 50% of these patients participated for 3 or more years. Nothing is said about the reasons for ceasing sports participation. After a combined Bankart procedure and coracoid transfer in contact athletes with traumatic anterior shoulder instability, 88% of 73 patients could successfully participate at the preinjury level. Again, nothing is mentioned about possible limitations during participation [37].

Radiographic evaluation

At time of follow-up, grade I degenerative changes were present in six patients. Hovelius et al. [12] reports a prevalence of osteoarthritic changes after surgical stabilization of about 20% ten years following surgery. Severe loss of external rotation, resulting after excessive tightening of the anterior capsule, has been accused to be one reason for secondary degenerative joint disease. Long-term studies must prove whether maintaining of good ROM is important for preventing glenohumeral arthropathy.

EMG–isokinetic testing

The tendency towards decreased activity of the dynamic shoulder stabilizers has been observed in previous studies [22]. It has been further demonstrated that the serratus anterior activity is decreased in patients with anterior glenohumeral instability, whereas the biceps brachii muscle plays an active compensatory role with increased activity in the unstable shoulder. The abnormalities in rotator cuff muscle activity are part of the complexity of anterior joint instability, thus revealing a disturbance of the interrelationship of the articular, capsulo-ligamentous, and dynamic stabilizers of the glenohumeral joint. Ovesen and colleagues demonstrated that both the supraspinatus and infraspinatus/teres minor are important in passively stabilizing the shoulder posteriorly [25]. In addition, rotator cuff muscles enhance anteroposterior stability by actively moving the joint into a position that tightens the capsular–ligamentous complex and therefore increase compression of articular surfaces. On the basis of this information, the importance of strengthening and conditioning these muscles is evident.

Our isokinetic testing protocol revealed a significant weakening for abduction and external rotation when compared to the normal shoulder. These data are consistent with other studies for anterior and posterior instability [13, 24, 35]. Previous studies have shown that age and sex correlate well with isometric strength measures, whereas there is no general side-to-side difference (dominant/non-dominant shoulder) except for some of the movements [14]. It is unclear what factors contribute to this weakness for the above-mentioned motion planes. It can be assumed that the

precise centering of the humeral head in the unstable shoulder is lost due to disturbance of the inter-relationship of the articular, capsulo–ligamentous, and dynamic stabilizers. This may result in a more off-centre joint reaction force and lower peak torques. However, some subjects do not show any decrease of muscle strength [24]. Further analyses have to show if there is any determinant that allows for coping with shoulder instability. Physical therapy programs have a basis for focusing on abduction and external rotation exercises after anterior reconstruction surgery.

Functional changes after reconstruction of recurrent shoulder instability are complex and not yet fully understood. Many patients cannot return to their previous level of sports activity and experience a reduction of life quality. Further in vitro and in vivo studies are needed to better understand biomechanics in unstable shoulders. There is evidence that strengthening and conditioning of the rotator cuff muscles may improve postoperative results. However, recurrent shoulder instability remains a disabling condition in competitive athletes.

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