# Primary Arthroscopic Stabilization for a First-Time Anterior Dislocation of the Shoulder

## Long-Term Follow-up of a Randomized, Double-Blinded Trial

Liam Z. Yapp, BMSc(Hons), MBChB, MRCSEd, Jamie A. Nicholson, BSc(Hons), MBChB(Hons), MRCSEd, and C. Michael Robinson, BMedSci, BMBS, FRCS(Edin), FRCS(Tr&Orth)

*Investigation performed at the Royal Infirmary of Edinburgh, Edinburgh, United Kingdom*

**Background:** The aim of this study was to evaluate the long-term efficacy of arthroscopic Bankart repair (ABR).

**Methods:** Eighty-eight patients with an age of ≤35 years who had sustained a primary anterior glenohumeral dislocation were enrolled in a single-center, double-blinded clinical trial. Subjects were randomized to receive either an arthroscopic washout (AWO) or ABR. Participants were reassessed after a minimum of 10 years postoperatively. Data regarding recurrent instability, revision surgery, satisfaction, and function (Disabilities of the Arm, Shoulder and Hand [DASH] and Western Ontario Shoulder Instability Index [WOSI]) scores were collected.

**Results:** Sixty-five patients (74%; 32 in the AWO group and 33 in the ABR group) were included and had an average follow-up of 14.2 years (range,12 to 16 years). The rate of recurrent dislocation was significantly higher in the AWO group than the ABR group (47% and 12%, respectively; p = 0.002). Kaplan-Meier curves were plotted for event-free survival using recurrent instability and/or revision surgery as clinical end points. This analysis demonstrated a sustained significant difference between the groups at 10 years after surgery (58% for the AWO group versus 79% for the ABR group; log-rank test [Mantel-Cox]; p = 0.018). Long-term WOSI scores were significantly better in the ABR group. The presence of recurrent instability was associated with significantly poorer WOSI and DASH scores.

**Conclusions:** This study demonstrates a long-term benefit in overall shoulder stability and functional outcome in high-risk patients who have undergone ABR for first-time anterior dislocation.

**Level of Evidence:** Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

First-time anterior dislocation of the shoulder is common and has an incidence ranging between 21.9 and 26.9 per 100,000 population[1,2]. Although the majority of patients are managed nonoperatively, recurrent instability may lead to persistent functional disability and glenohumeral arthropathy in the long term[3-5].

Young age and male sex are frequently identified as risk factors for recurrent instability[6,7]. Primary surgical stabilization has been shown to reduce rates of recurrent instability and confer functional benefits compared with nonoperative management in high-risk cases[8-12]. Previous research has suggested arthroscopic washout (AWO), or joint lavage, alone had independent therapeutic effects for first-time anterior dislocation of the shoulder[13], avoiding the need for labral (Bankart) repair, which is more expensive, time-consuming to perform, and potentially associated with greater operative risk. Our institution undertook a randomized double-blinded trial comparing arthroscopic Bankart repair (ABR) with AWO following first-time anterior dislocation of the shoulder, demonstrating a marked treatment benefit favoring ABR in terms of reducing recurrent instability at 2 years[14]. However, there are limited long-term data regarding the operative success of ABR in these patients.

The aim of this study was to evaluate the long-term efficacy of primary ABR for first-time anterior dislocation of the shoulder. The null hypothesis was that the patients managed with ABR or AWO would demonstrate no difference in the

**Disclosure:** The authors indicated that no external funding was received for any aspect of this work. On the **Disclosure of Potential Conflicts of Interest** forms, *which are provided with the online version of the article*, one or more of the authors checked "yes" to indicate that the author had a relevant financial relationship in the biomedical arena outside the submitted work (http://links.lww.com/JBJS/F674).

A **data-sharing statement** is provided with the online version of the article (http://links.lww.com/JBJS/F676).

rate of recurrent instability or functional outcomes at ≥10 years postoperatively.

## Materials and Methods

### *Setting and Location of Data Collection*

We previously reported the 2-year results of this prospective, randomized, double-blinded trial[14]. Ethical permission for this long-term study was granted by the local Research and Ethics Committee (REC19/NS/0059) and was performed in a regional, university-affiliated teaching hospital. The study was registered with ClinicalTrials.gov (NCT04022629).

Eighty-eight patients were enrolled during the period September 2001 to January 2005. Patients were prospectively classified according to their predicted level of risk based on their age and sex (high-risk groups were male patients who were ≤27 years and female patients who were ≤16 years), as these were the only factors that independently predicted recurrent instability following nonoperative treatment of first-time anterior shoulder dislocation on multivariate analyses[6,14]. Once consent was obtained, subjects were allocated to treatment groups receiving AWO or ABR by computerized randomization using weighted minimization, on the basis of age and sex[14]. Weighted minimization is an adaptive treatment allocation in which the choice of treatment is the one that minimizes any imbalance between the 2 prognostic variables[15]. This technique has been shown to be a preferable method rather than simple stratification in studies with relatively small sample sizes[16].

Preoperative data relating to the rate of recurrent instability, functional outcome (Disabilities of the Arm, Shoulder and Hand [DASH] and Western Ontario Shoulder Instability Index [WOSI] scores), and satisfaction were prospectively recorded and compared at 6 months, 12 months, and 2 years postoperatively. Details regarding the operative techniques utilized, postoperative rehabilitation program, and management of recurrent instability have been reported[14]. Each trial participant was contacted for repeat assessment after a minimum of 10 years after the operation.

### *Inclusion Criteria*

The trial prospectively selected patients between the ages of 15 and 35 years who had radiographic evidence of a traumatic first-time anterior glenohumeral dislocation. The specific conditions of inclusion and the criteria for exclusion were previously reported[14] (see Appendix). All patients previously enrolled in the study were considered eligible for inclusion.

### *Exclusions*

Delayed presentation, a history of recurrent instability, or non-traumatic shoulder dislocation were specific criteria for exclusion (see Appendix)[14]. Patients were excluded from long-term follow-up if they were not able to be contacted, they declined to contribute, or they no longer retained the capacity to participate in the study.

### *Sample-Size Estimation*

A power calculation was performed using the results of a previous study in our unit in which all patients received standard nonoperative treatment for a primary traumatic anterior shoulder dislocation[6]. The trial was designed to detect so-called large treatment effects, defined as a 75% improvement in the outcome in a comparison of a new treatment with standard nonoperative management[6,14]. Sample size was estimated for the time point at which the development of recurrent instability following the first dislocation had reached a plateau (2 years[6]). This was performed using a "worst-case" scenario, in which it was assumed that all patients censored from follow-up at 2 years had developed recurrent instability. A minimum sample size of 30 patients recruited into each arm was calculated to detect large treatment effects on redislocation rates at 2 years, with type-I (alpha) error set at 0.05 and type-II (beta) error set at 0.1 (90% power)[14]. We did not perform a retrospective power analysis determining the minimum sample size required to identify such large treatment effects after a period of 10 years.

### *Blinding*

Patients and data reviewers were blinded to the treatment allocation during the course of this study. Treatment allocation was concealed unless the patient experienced recurrent instability requiring further investigation and treatment.

### *Data Collection*

Recurrent shoulder instability was defined as radiographically confirmed dislocation or symptomatic self-reported subluxation events. All patients who experienced recurrent instability underwent radiographic investigation and were offered further surgery on the basis of soft-tissue or osseous pathology, regardless of their initial treatment allocation.

The hospital's electronic TrakCare (InterSystems) system was used to obtain contact details of all participants. Data were collected via a mailed questionnaire or telephone interview. As all patients in our country have a unique patient identifier, we utilized the national Carestream Picture Archiving and Communication System (PACS; Kodak Carestream Health) network, which connects all hospitals within the country, to identify radiographic evidence of recurrent dislocations or further surgery throughout the duration of follow-up.

### *Patient-Reported Outcome Measure (PROM) Assessment*

The WOSI score is disease-specific, comprising 21 questions (modified total score with possible range from 0 to 210) with lower scores considered better. The DASH score is a region-specific assessment of disability, comprising 30 questions (transformed score with possible range from 0 to 100), where 0 is a perfect score[17]. Overall patient satisfaction was measured using a Likert 5-point scale.

### *Statistical Analysis*

Statistical analysis was performed using Statistical Package for Social Sciences software (version 24, SPSS; IBM). Data were tested for normal distribution before the appropriate parametric (Student t test) or nonparametric (Mann-Whitney U) test was used to assess continuous variables for differences between groups. Effect sizes were calculated as eta-squared ($\eta^2$)

for nonparametric data and transformed for interpretation according to Cohen d[18].

The chi-square test was used to assess categorical variables. Logistic regression was used to determine the influence of multiple patient variables on the risk of dislocation. Kaplan-Meier curves were plotted (with a 95% confidence interval [CI]) for event-free survival using recurrent instability and/or revision surgery as clinical end points. Development of recurrent instability was a time-dependent variable and was considered to be present when the shoulder first redislocated or when the patient first reported symptoms of subluxation. Patients who did not experience recurrent instability or revision surgery were censored from further analysis at the time they were lost to follow-up, died, or reached the cutoff point for the end of the study. Treatment effect was calculated using a Cox proportional hazards (PH) model with treatment group as the sole independent variable (hazard ratio [HR] with 95% CI). A p value of <0.05 was considered significant.

## Results

Of the 88 patients enrolled into the trial, 4 patients did not complete the 2-year study. During the long-term follow-up period, 3 patients had died (1 in the ABR group and 2 in the AWO group) (Fig. 1). Sixty-five patients (32 [74%] of 43 patients in the AWO group and 33 [73%] of 45 patients in the ABR group) were included in this long-term study, with an average total length of follow-up of 14.2 years (range, 12 to 16 years). This provided an overall response rate of 80% of available patients (74% of the original cohort). There were no significant differences between the 2 treatment groups with respect to age at the time of allocation, sex, or high-risk patients at the time of final follow-up (Table I).

Twenty-three (12 in the ABR group and 11 in the AWO group) of the eighty-eight patients who were initially randomized

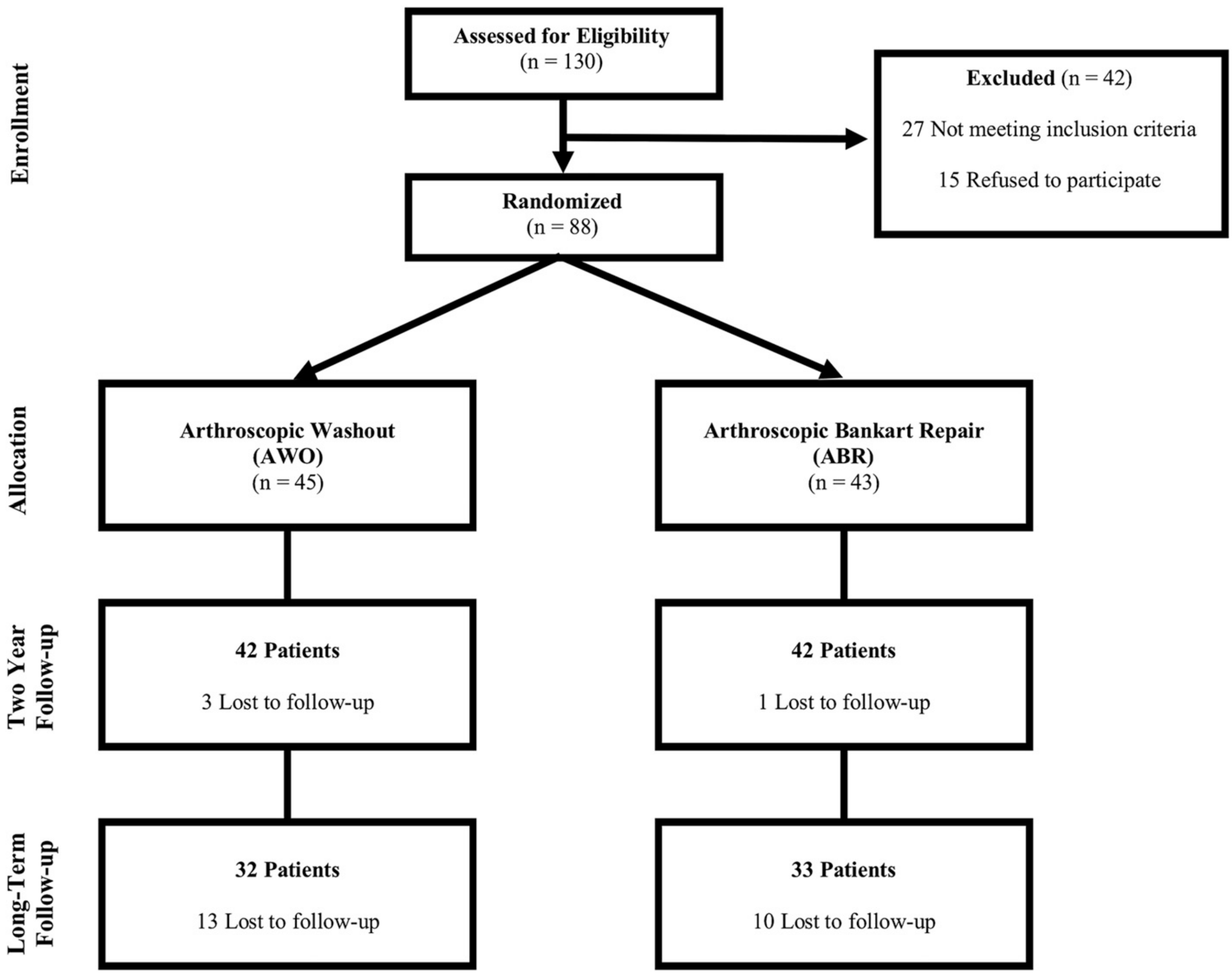


Fig. 1
Modified CONSORT (Consolidated Standards of Reporting Trials) flow diagram for study recruitment.

**TABLE I Patient Demographics at Time of Follow-up**

| Parameter | ABR* (N = 33) | AWO* (N = 32) | P Value |
|---|---|---|---|
| Age at time of operation† *(yr)* | 24.7 (23.0-26.5) | 23.8 (21.8-25.7) | 0.445 |
| Side *(no. of patients)* | | | 0.102 |
| Right | 18 | 11 | |
| Left | 15 | 21 | |
| Sex *(no. of patients)* | | | 1.00 |
| Male | 30 | 30 | |
| Female | 3 | 2 | |
| Injury mechanism *(no. of patients)* | | | 0.798 |
| Fall and/or assault | 11 | 3 | |
| Sports injury | 19 | 23 | |
| Other | 3 | 6 | |
| No. who played regular contact sports at time of op. | 23 | 25 | 0.276 |
| High risk‡ *(no. of patients)* | 20 (60%) | 22 (69%) | 0.492 |
| Dislocation *(no. of patients)* | 4 (12%) | 15 (47%) | 0.002§ |
| Further instability *(no. of patients)* | 7 (21%) | 23 (72%) | <0.001§ |
| Revision surgery *(no. of patients)* | 3 (9%) | 9 (28%) | 0.048§ |

*ABR = arthroscopic Bankart repair, and AWO = arthroscopic washout. †The values are given as the mean and the 95% confidence interval. ‡Male patients with an age of ≤ 27 years and female patients with an age of ≤16 years[5,10]. §Significant difference ($p < 0.05$).

did not complete long-term follow-up. Of the 81 living patients who completed 2-year follow-up, 16 (8 in the ABR group and 8 in the AWO group) were either untraceable or declined to participate in further assessment. No significant differences were detected in the demographics of each cohort lost to follow-up. A comparison of the 2-year outcomes of patients subsequently lost to follow-up at the long term versus those included in the final study demonstrated no significant difference in rates of recurrent dislocation (2 [6%] of 33 patients in long-term study versus 1 [8%] of 12 patients lost to follow-up in the ABR group [p = 1.0]; and 7 [22%] of 32 patients in long-term study versus 4 [36%] of 11 patients lost to follow-up in the AWO group; p = 0.43) or PROM scores.

### *Recurrent Dislocation and Symptomatic Instability*

At long-term follow-up, the rate of recurrent dislocation was significantly higher in the AWO group than the ABR group (15

**TABLE II Comparison of PROMs and Recurrent Instability in the ABR Group and AWO Group***

| Parameter | ABR (N = 33) | AWO (N = 32) | $SD_{Pooled}$ | 95% CI of Difference | P Value | $\eta^2$ | d |
|---|---|---|---|---|---|---|---|
| Stability | | | | | <0.001† | | |
| Stable | 26 (79%) | 9 (28%) | | | | | |
| Unstable | 7 (21%) | 23 (72%) | | | | | |
| Median WOSI‡ | | | | | | | |
| Total | 7.1 (1.4-22.8) | 13.5 (5.8-45.3) | 25.4 | 0.8-22.2 | 0.027† | 0.08 | 0.57 |
| Unstable | 34.5 (11.2-66.9) | 37.3 (9.8-52.0) | 29.1 | −48.5-29.2 | 0.740 | 0.03 | 0.33 |
| Stable | 3.0 (0.75-11.9) | 6.5 (3.7-9.6) | 21.2 | −7.4-3.0 | 0.231 | 0.03 | 0.33 |
| Median DASH‡ | | | | | | | |
| Total | 0 (0-2.3) | 2.3 (0-6.8) | 6.2 | 0.0-2.28 | 0.101 | 0.04 | 0.39 |
| Unstable | 6.8 (0.6-14.8) | 4.6 (0-9.1) | 8.3 | −11.4-18.2 | 0.642 | 0.02 | 0.25 |
| Stable | 0 (0-2.3) | 0 (0-3.4) | 4.7 | 0.0-2.27 | 0.848 | 0.01 | 0.20 |

*PROMs = patient-reported outcome measures, ABR = arthroscopic Bankart repair, AWO = arthroscopic washout, WOSI = Western Ontario Shoulder Instability Index score, DASH = Disabilities of Arm, Shoulder and Hand score, $SD_{Pooled}$ = pooled standard deviation, and CI = confidence interval. Effect sizes: $\eta^2$ = eta-squared, and d = Cohen d[18]. †Significant difference ($p < 0.05$). ‡The values are given as the median and the 25th to 75th percentiles (interquartile range).

**TABLE III High-Risk Compared with Low-Risk Patients***

| | ABR | AWO | $SD_{Pooled}$ | $\eta^2$ | d | 95% CI of Difference | P Value | NNT |
|---|---|---|---|---|---|---|---|---|
| High risk (n = 42) | N = 20 | N = 22 | | | | | | |
| Dislocation | 3 (15%) | 11 (50%) | | | | | 0.016† | 3.3 |
| Instability | 5 (25%) | 16 (73%) | | | | | 0.002† | 2.1 |
| Revision | 2 (10%) | 6 (27%) | | | | | 0.155 | 5.8 |
| DASH‡ | 1.1 (0-7.4) | 3.4 (0-9.7) | 6.7 | 0.03 | 0.37 | 0.0-4.5 | 0.223 | |
| WOSI‡ | 5.6 (0.6-25.8) | 25.0 (8.9-49.4) | 25.9 | 0.14 | 0.82 | 2.5-34.3 | 0.014† | |
| Low risk (n = 23) | N = 13 | N = 10 | | | | | | |
| Dislocation | 1 (8%) | 4 (40%) | | | | | 0.127 | 3.1 |
| Instability | 2 (15%) | 7 (70%) | | | | | 0.013† | 2.1 |
| Revision | 1 (8%) | 3 (30%) | | | | | 0.281 | 4.5 |
| DASH‡ | 0 (0-2.3) | 1.1 (0-5.1) | 4.9 | 0.03 | 0.33 | 0.0-2.3 | 0.446 | |
| WOSI‡ | 7.4 (2.2-15.2) | 5.3 (1.5-44.4) | 25.0 | 0.00 | 0.04 | −24.4-8.9 | 0.927 | |

*High-risk patients were male patients with an age of ≤ 27 years and female patients with an age of ≤16 years[5,10]. ABR = arthroscopic Bankart repair, AWO = arthroscopic washout, WOSI = Western Ontario Shoulder Instability score, DASH = Disabilities of Arm, Shoulder and Hand score, $SD_{Pooled}$ = pooled standard deviation, CI = confidence interval, and NNT = number needed to treat. Effect sizes: $\eta^2$ = eta-squared, and d = Cohen d[18]. †Significant difference ($p < 0.05$). ‡The values in the ABR and AWO columns are given as the median and the 25th to 75th percentiles (interquartile range).

patients [47%] versus 4 patients [12%]; p = 0.002). The relative risk (RR) for recurrent dislocation in the AWO group versus the ABR group was 2.14 (95% CI, 1.37 to 3.33).

The rate of recurrent instability, including patients without radiographic evidence of dislocation, was significantly higher in the AWO group than the ABR group (adjusted totals: 23 patients [72%], including 8 with subluxations and 15 with dislocations, in the AWO group versus 7 patients [21%], including 3 with subluxations and 4 with dislocations, in the ABR group [p < 0.001]). As a result, the RR for any reported shoulder instability following AWO compared with ABR was 2.33 (95% CI, 1.28 to 4.24). This provided a number needed to treat (NNT) of 2.9 for dislocation and 2.6 for instability, favoring ABR.

On logistic regression, only treatment allocation significantly affected the risk of dislocation. ABR significantly reduced the risk of dislocation (odds ratio [OR], 0.14; 95% CI, 0.04 to 0.53 [p = 0.004]) and instability (OR, 0.09; 95% CI, 0.03 to 0.31 [p < 0.001]). From the available data, no significant effect was identified related to high-risk groups, sex, or age at the time of dislocation.

### *Further Surgery*

Twelve patients (9 [28%] in the AWO group and 3 [9%] in the ABR group; p = 0.048) who had undergone further surgery had complete outcome data available for the long-term assessment. The AWO group underwent further surgery in the form of arthroscopic (9 patients) or open (3 patients) Bankart repair. The primary ABR failures had revision with an open Bankart repair in 2 patients and a Latarjet procedure in 1 patient. Three patients in the AWO group who had a revision ABR had ongoing instability and had revision with an open procedure (2 open Bankart repairs and 1 Latarjet procedure). Median time to revision surgery was 60.1 months (interquartile range [IQR] width, 56.6 months; range, 19.8 to 369.8 months). The RR for revision surgery following AWO versus ABR was 1.73 (95% CI, 1.10 to 2.71; NNT = 5.3).

### *PROMs*

At long-term follow-up, median WOSI scores were significantly better in the ABR group than the AWO group (7.1 and 13.5, respectively; 95% CI of the difference, 0.8 to 22.2; $\eta^2$ = 0.08,

**TABLE IV Life Table with Cumulative Survival***

| | ABR (N = 43) | | AWO (N = 45) | | Overall (N = 88) | | |
|---|---|---|---|---|---|---|---|
| Time | No. (%) | 95% CI Mean Survival *(%)* | No. (%) | 95% CI Mean Survival *(%)* | No. (%) | 95% CI Mean Survival *(%)* | P Value |
| 2 yr | 40 (93) | 85-99 | 33 (73) | 58-82 | 73 (83) | 73-89 | 0.013† |
| 5 yr | 36 (84) | 77-95 | 30 (67) | 50-73 | 66 (75) | 65-83 | 0.045† |
| 10 yr | 34 (79) | 72-91 | 26 (58) | 42-67 | 60 (68) | 58-78 | 0.018† |

*ABR = arthroscopic Bankart repair, AWO = arthroscopic washout, CI = confidence interval. †Significant difference ($p < 0.05$, Mantel-Cox log-rank test).

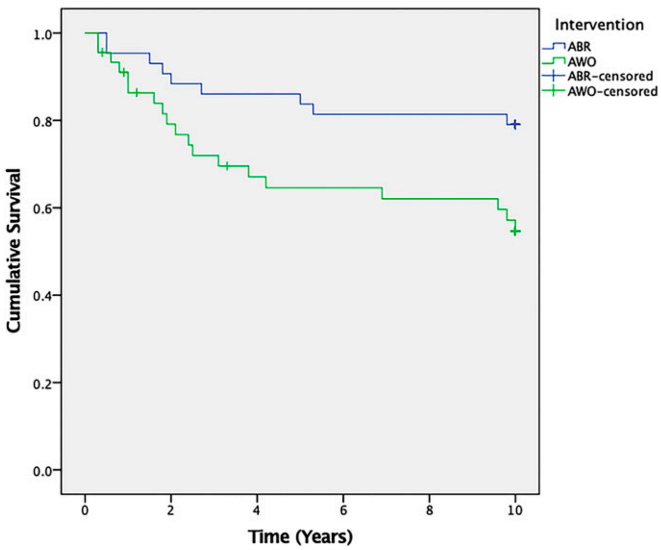


Fig. 2
Kaplan-Meier survival curve: AWO (arthroscopic washout) group versus ABR (arthroscopic Bankart repair) group.

d = 0.57, p = 0.027). Significant improvements from the preoperative baseline were detected at each time point for each group, but no significant difference was seen between 2 years and the final follow-up. No significant differences in the DASH score were detected between the groups at any time point (Table II).

Considering all patients regardless of the treatment allocation, recurrent instability was associated with significantly poorer median WOSI scores (7.3 for stable versus 44.0 for unstable shoulders; 95% CI, 8.6 to 42.0, $\eta^2 = 0.17$, d = 0.92, p = 0.001) and DASH scores (0.0 for stable versus 2.3 for unstable shoulders; 95% CI, 0.0 to 4.55, $\eta^2 = 0.06$, d = 0.48, p = 0.044). However, no significant difference was observed in the WOSI and DASH scores of patients who had a stable shoulder, irrespective of the initial treatment allocation.

High-risk patients treated with ABR had lower rates of recurrent dislocation and symptomatic instability and better WOSI scores than those treated with AWO (Table III). Linear regression of PROM scores did not show any influence of high versus low-risk group, sex, or age at dislocation.

Overall, 54 patients (83%) considered themselves satisfied or very satisfied with their overall treatment. No difference was observed between treatment allocations. Dissatisfaction was associated with recurrent instability (1 patient with a stable shoulder and 10 patients with an unstable shoulder; p < 0.001) and revision surgery (5 were satisfied and 7 were dissatisfied; p < 0.001). Forty-five patients (69%) continued to engage in regular sporting activity, with no difference noted between treatment arms.

### *Survivorship*

Kaplan-Meier survival analysis was plotted, demonstrating significant differences between treatment groups (Table IV, Fig. 2). Cox PH modeling favored ABR over AWO at 2 years (HR, 0.31; 95% CI, 0.1 to 0.96; p = 0.042), 5 years (HR, 0.41; 95% CI, 0.17 to 0.95; p = 0.041), and 10 years after surgery (HR, 0.40; 95% CI, 0.18 to 0.89; p = 0.024).

## Discussion

ABR was superior to AWO in the long-term prevention of recurrent anterior instability in young patients who had sustained a first-time anterior shoulder dislocation. The recurrence rate following ABR was 7% at 2 years and increased to 12% at a mean of 14.2 years, suggesting the benefits of ABR are preserved in the long term.

Improvements in instability-specific functional scores (WOSI) were also maintained in the long term following primary ABR, theoretically as a result of the lower rate of long-term recurrent instability in this group. However, there was no demonstrable benefit in terms of functional outcome in either group of patients if the shoulders were stable during this time period.

Few prospective studies have described the rate of recurrence following primary stabilization for first-time dislocation. Owens et al.[19] reported on a cohort of young athletes treated with ABR for first-time anterior shoulder dislocation with a mean follow-up of 11.7 years. Performing a labral repair using bioabsorbable tacks, those authors identified recurrent instability in 15 (38%) of the 39 patients (6 [15.4%] had dislocations and 9 [23.1%] had subluxations). This higher rate of recurrent instability could be explained by the differences in operative technique and the higher level of physical activity expected in a cohort of young athletes.

Kirkley et al.[8], in a prospective randomized trial comparing ABR with nonoperative treatment for first-time anterior shoulder dislocation, demonstrated a significant reduction in the rate of redislocation (47% in the nonoperative group versus 15.9% in the ABR group; p = 0.03) favoring early stabilization, at a mean follow-up of 32 months[8]. Jakobsen et al.[9] randomized patients to open repair or nonoperative management following a first-time anterior shoulder dislocation. Those authors reported recurrence rates of dislocation at 10 years of 9% for the operatively treated group compared with 62% for the nonoperatively treated group.

The treatment benefits of AWO are not clearly understood. It has been suggested that AWO assists healing of the labral detachment, encourages reduced activity levels, and increases compliance with postoperative physiotherapy[13]. AWO appeared to reduce the rate of recurrent instability compared with nonoperative management at 2 years[14]. However, our long-term findings refute this, and it seems more likely that AWO simply delays the onset of recurrent instability rather than preventing it entirely. Therefore, AWO could be argued to be a placebo procedure and thus our results highlight the true efficacy of ABR as a treatment for anterior shoulder dislocation.

The causes of recurrent instability continue to be extensively investigated. Zimmermann et al.[20] reported that instability persisted or recurred in 41.7% of patients treated with ABR at long-term follow-up (mean, 12 years), and one-third of revision procedures took place >5 years after the primary stabilization procedure. The presence of glenoid bone loss, hyperlaxity, and the number of suture anchors utilized in the repair have been previously identified as potential risk factors for failure of ABR[21]. In our study, the ABR group had predominantly low Beighton scores (93% had a Beighton score of <4), had few associated osseous lesions (91% had no osseous glenoid rim detachment), and had a procedure that utilized a mean of 4.2 anchors (range, 3 to 5 anchors)[14].

Lee et al.[22] reported that a time delay of >6 months between the index dislocation and the ABR, the presence of ≥2 dislocations preoperatively, and so-called off-track Hill-Sachs lesions were significantly associated with recurrent anterior instability following ABR (OR, 5.62, 8.77, and 4.31, respectively). The concept of the glenoid track, a method to objectively determine whether a Hill-Sachs lesion will engage with the anterior glenoid rim, was popularized after this trial began[23].

Park et al.[24] identified 2 distinct groups of dissatisfied patients who present following ABR for recurrent instability. Using multivariate analyses, they found that the width of the Hill-Sachs lesion could independently predict so-called subjective failure, supporting previous biomechanical studies demonstrating that glenohumeral instability worsens as the width of the Hill-Sachs lesion increases[25]. In the present study, it was not possible to retrospectively evaluate Hill-Sachs width, nor glenoid track, as computed tomographic scanning and magnetic resonance imaging were not considered part of our routine preoperative planning at that time.

In the present trial, 3 patients died and another 20 patients (23%) were considered lost to follow-up following initial randomization. Although the loss to follow-up could lead to reporting bias, no differences were noted with respect to the age, sex, or number of high-risk patients in each cohort of patients who did not complete follow-up. No differences were found in the rate of recurrent dislocation or PROM scores measured at 2 years between those included in this long-term study and those who were excluded after 2 years. Despite the loss to follow-up, each treatment arm remained adequate to fulfil the power calculation of the original trial[14], and accordingly, we believe that we were able to identify true differences in the rates of recurrent instability.

Finally, radiographic assessment of each patient after 10 years postoperatively was not routinely performed. Therefore, it was not possible to investigate whether recurrent instability was associated with increased risk of glenohumeral arthropathy following ABR. A 25-year follow-up study demonstrated that patients who underwent surgical stabilization for recurrent instability had lower levels of arthropathy than those who had not, concluding that surgical stabilization may slow down the evolution of arthropathy in these patients[5]. Research in the future should be undertaken to address the risk posed from this procedure; however, this assessment was not the primary aim of the present study.

This study demonstrates that ABR is associated with long-term prevention of recurrent anterior instability in young patients who had sustained a first-time anterior shoulder dislocation. Improvements in instability-specific functional scores were maintained in the long-term follow-up after ABR.

## Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJS/F675). ■

NOTE: The authors thank Mr. Tim White, Mr. Paul Jenkins, Mr. Andrew Ker, and Mrs. Elizabeth Will for their involvement with the previous study and prior data collection.

Liam Z. Yapp, BMSc(Hons), MBChB, MRCSEd[1]
Jamie A. Nicholson, BSc(Hons), MBChB(Hons), MRCSEd[1]
C. Michael Robinson, BMedSci, BMBS, FRCS(Edin), FRCS(Tr&Orth)[1]

[1]Royal Infirmary of Edinburgh, Edinburgh, United Kingdom

Email address for L.Z. Yapp: Liam.yapp@nhs.net

ORCID iD for L.Z. Yapp: 0000-0003-2180-8933
ORCID iD for J.A. Nicholson: 0000-0003-3640-8254
ORCID iD for C.M. Robinson: 0000-0001-6879-7026

## References

**1.** Shields DW, Jefferies JG, Brooksbank AJ, Millar N, Jenkins PJ. Epidemiology of glenohumeral dislocation and subsequent instability in an urban population. J Shoulder Elbow Surg. 2018 Feb;27(2):189-95. Epub 2017 Nov 10.

**2.** Zacchilli MA, Owens BD. Epidemiology of shoulder dislocations presenting to emergency departments in the United States. J Bone Joint Surg Am. 2010 Mar; 92(3):542-9.

**3.** Wasserstein DN, Sheth U, Colbenson K, Henry PDG, Chahal J, Dwyer T, Kuhn JE. The true recurrence rate and factors predicting recurrent instability after nonsurgical management of traumatic primary anterior shoulder dislocation: a systematic review. Arthroscopy. 2016 Dec;32(12):2616-25. Epub 2016 Jul 31.

**4.** Hovelius L, Olofsson A, Sandström B, Augustini BG, Krantz L, Fredin H, Tillander B, Skoglund U, Salomonsson B, Nowak J, Sennerby U. Nonoperative treatment of primary anterior shoulder dislocation in patients forty years of age and younger. A prospective twenty-five-year follow-up. J Bone Joint Surg Am. 2008 May;90(5): 945-52.

**5.** Hovelius L, Saeboe M. Neer Award 2008: arthropathy after primary anterior shoulder dislocation—223 shoulders prospectively followed up for twenty-five years. J Shoulder Elbow Surg. 2009 May-Jun;18(3):339-47. Epub 2009 Feb 28.

**6.** Robinson CM, Howes J, Murdoch H, Will E, Graham C. Functional outcome and risk of recurrent instability after primary traumatic anterior shoulder dislocation in young patients. J Bone Joint Surg Am. 2006 Nov;88(11):2326-36.

**7.** Roberts SB, Beattie N, McNiven ND, Robinson CM. The natural history of primary anterior dislocation of the glenohumeral joint in adolescence. Bone Joint J. 2015 Apr;97-B(4):520-6.

**8.** Kirkley A, Griffin S, Richards C, Miniaci A, Mohtadi N. Prospective randomized clinical trial comparing the effectiveness of immediate arthroscopic stabilization versus immobilization and rehabilitation in first traumatic anterior dislocations of the shoulder. Arthroscopy. 1999 Jul-Aug;15(5):507-14.

**9.** Jakobsen BW, Johannsen HV, Suder P, Søjbjerg JO. Primary repair versus conservative treatment of first-time traumatic anterior dislocation of the shoulder: a randomized study with 10-year follow-up. Arthroscopy. 2007 Feb;23(2):118-23.

**10.** Bottoni CR, Wilckens JH, DeBerardino TM, D'Alleyrand JC, Rooney RC, Harpstrite JK, Arciero RA. A prospective, randomized evaluation of arthroscopic stabilization versus nonoperative treatment in patients with acute, traumatic, first-time shoulder dislocations. Am J Sports Med. 2002 Jul-Aug;30(4):576-80.

**11.** Longo UG, Loppini M, Rizzello G, Ciuffreda M, Maffulli N, Denaro V. Management of primary acute anterior shoulder dislocation: systematic review and quantitative synthesis of the literature. Arthroscopy. 2014 Apr;30(4):506-22.

**12.** Handoll HHG, Almaiyah MA, Rangan A. Surgical versus non-surgical treatment for acute anterior shoulder dislocation. Cochrane Database Syst Rev. 2004;1:CD004325.

**13.** Wintzell G, Haglund-Akerlind Y, Nowak J, Larsson S. Arthroscopic lavage compared with nonoperative treatment for traumatic primary anterior shoulder dislocation: a 2-year follow-up of a prospective randomized study. J Shoulder Elbow Surg. 1999 Sep-Oct;8(5):399-402.

**14.** Robinson CM, Jenkins PJ, White TO, Ker A, Will E. Primary arthroscopic stabilization for a first-time anterior dislocation of the shoulder. A randomized, double-blind trial. J Bone Joint Surg Am. 2008 Apr;90(4):708-21.

**15.** Bridgman S, Engebretsen L, Dainty K, Kirkley A, Maffulli N; ISAKOS Scientific Committee. Practical aspects of randomization and blinding in randomized clinical trials. Arthroscopy. 2003 Nov;19(9):1000-6.

**16.** Scott NW, McPherson GC, Ramsay CR, Campbell MK. The method of minimization for allocation to clinical trials. A review. Control Clin Trials. 2002 Dec;23(6):662-74.

**17.** Rouleau DM, Faber K, MacDermid JC. Systematic review of patient-administered shoulder functional scores on instability. J Shoulder Elbow Surg. 2010 Dec;19(8):1121-8.

**18.** Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates; 1988.

**19.** Owens BD, DeBerardino TM, Nelson BJ, Thurman J, Cameron KL, Taylor DC, Uhorchak JM, Arciero RA. Long-term follow-up of acute arthroscopic Bankart repair for initial anterior shoulder dislocations in young athletes. Am J Sports Med. 2009 Apr;37(4):669-73. Epub 2009 Feb 13.

**20.** Zimmermann SM, Scheyerer MJ, Farshad M, Catanzaro S, Rahm S, Gerber C. Long-term restoration of anterior shoulder stability: a retrospective analysis of arthroscopic Bankart repair versus open Latarjet procedure. J Bone Joint Surg Am. 2016 Dec 7;98(23):1954-61.

**21.** Boileau P, Villalba M, Héry JY, Balg F, Ahrens P, Neyton L. Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. J Bone Joint Surg Am. 2006 Aug;88(8):1755-63.

**22.** Lee SH, Lim KH, Kim JW. Risk factors for recurrence of anterior-inferior instability of the shoulder after arthroscopic Bankart repair in patients younger than 30 years. Arthroscopy. 2018 Sep;34(9):2530-6.

**23.** Di Giacomo G, Itoi E, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: from "engaging/non-engaging" lesion to "on-track/off-track" lesion. Arthroscopy. 2014 Jan;30(1):90-8.

**24.** Park I, Kang JS, Jo YG, Shin SJ. Factors related to patient dissatisfaction versus objective failure after arthroscopic shoulder stabilization for instability. J Bone Joint Surg Am. 2019 Jun 19;101(12):1070-6.

**25.** Arciero RA, Parrino A, Bernhardson AS, Diaz-Doran V, Obopilwe E, Cote MP, Golijanin P, Mazzocca AD, Provencher MT. The effect of a combined glenoid and Hill-Sachs defect on glenohumeral stability: a biomechanical cadaveric study using 3-dimensional modeling of 142 patients. Am J Sports Med. 2015 Jun;43(6):1422-9. Epub 2015 Mar 20.