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Original Research

Arthroscopic anatomic glenoid reconstruction has a lower rate of recurrent instability compared to arthroscopic Bankart repair while otherwise maintaining a similar complication and safety profile

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ABSTRACT

Objectives: The primary purpose of this study was to determine the frequency and type of complications, including subluxation, infection, hardware complication, graft/glenoid fracture, chondrolysis, neurovascular deficits and stiffness following an Arthroscopic Bankart Repair (ABR) or an Arthroscopic Anatomic Glenoid Reconstruction (AAGR) using a distal tibia allograft for recurrent anterior shoulder instability. Secondary purposes were to determine the frank dislocation rate and the associations of post-operative complications with demographic patient factors.

Methods: Demographic and clinical data were reviewed using means ± standard deviations or frequencies in patients with recurrent anterior shoulder instability who underwent either an ABR or an AAGR. Post-operative patient records were analysed to identify any post-operative complications. The numerical variables of the two groups were compared using the independent t-test or Mann–Whitney *U* test. Categorical variables and complications were tested using the chi-square test, Fisher's exact test, or the two-sided Monte Carlo test with a significance level of 0.05.

Results: We included 174 patients in this cohort, with 61.5% of patients receiving ABR and 38.5% receiving AAGR. Most of our patients were male (70.1%) with an average age of 23.41 ± 8.26 years in the ABR group and 29.37 ± 13.54 years in the AAGR group ($p = 0.001$). The two groups were similar with respect to their post-operative complication rates when excluding frank dislocation (ABR: 11%, AAGR: 12%). The AAGR group had statistically significantly higher rates of hardware removal compared to the ABR group ($p = 0.004$). The ABR group had 25 post-operative frank dislocations, with none reported in the AAGR cohort ($p < 0.001$). The total complication rate for each procedure was found to be 35% for ABR and 12% for AAGR.

Conclusion: AAGR has a comparable safety profile to the ABR when assessing post-operative complications such as subluxation, infection, graft/glenoid fracture, chondrolysis, neurovascular deficits and stiffness. AAGR is superior to ABR with respect to rates of recurrent instability and should be considered as a first-line treatment in certain patients with specific risk factors such as younger age, competitive contact sports participation, and higher number of instability events pre-operatively.

Level of evidence: Level III.

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What are the new findings?

- Arthroscopic anatomic glenoid reconstruction (AAGR) had a lower rate of recurrent instability compared to an arthroscopic Bankart repair (ABR)
- AAGR has similar complication and safety profiles to that of the ABR
- AAGR had fewer overall complications and less risk of neurological injury compared to those reported in the literature for a Latarjet procedure

Introduction

Glenohumeral joint instability is a relatively common orthopaedic condition, with approximately 2% of the general population experiencing a shoulder dislocation in their lifetime and up to 70% of patients who dislocate once experiencing a subsequent recurrence [1–4]. Over 95% of shoulder dislocations are anterior with the majority occurring in young active males [1,2,3]. These patients classically present with a torn anteroinferior labrum, which has been coined the Bankart lesion, after being described by Dr. Arthur Bankart in 1923 in the British Medical Journal [5]. In that article, Dr. Bankart also detailed an open repair, which subsequently became the gold standard due to its long-term success and low re-dislocation rates of less than 5% [6].

In the early 1990s, the arthroscopic Bankart repair (ABR) using suture anchors emerged as a minimally invasive surgical alternative to an open repair and quickly gained popularity, becoming the surgical treatment of choice for patients with glenohumeral joint instability [7,8]. Its quick adoption was likely secondary to its lower reported complication rate, preservation of the subscapularis, better cosmesis, easier recovery and ability for concomitant intra-articular pathologies to be addressed simultaneously compared to the open Bankart repair [6,9]. Although an arthroscopic Bankart repair is currently the most common surgical stabilisation technique performed for recurrent glenohumeral joint instability, it is not without risk, limitations and controversy [9–11]. The literature continues to report a post-surgical re-dislocation rate of up to 35%, with a mean of approximately 15%, despite the advancements in arthroscopic tools, anchors and techniques [6,10,12,13,14]. This unacceptable recurrence rate is especially problematic in patients with significant bone loss of either the glenoid, humeral head (Hill-Sachs lesion) or both [13]. As a result, alternate surgical options that address the bony defect are often employed, such as the Latarjet procedure, which was first described in 1954, and the newly minted Arthroscopic Anatomic Glenoid Reconstruction (AAGR) developed in 2015 [5,15].

The Latarjet procedure can be performed as an open or arthroscopic repair and involves an osteotomy and then the transfer of the coracoid to the anteroinferior glenoid [11,16]. Compared to the Bristow procedure, where just the tip of the coracoid is transferred, the Latarjet procedure transfers the majority of the coracoid, thereby producing a larger bone block [17]. Additionally, the Latarjet procedure has the advantages of allowing a capsulolabral repair, preserving the inferior subscapularis and having the sling effect from the conjoint tendon [17,18]. Each of these anatomic components contributes to the efficacy of the Latarjet procedure in decreasing post-surgical recurrence rates in patients with significant glenoid bone loss (>25%). Burkhart and De Beer report only a 4.9% recurrence rate in this high-risk population post-Latarjet procedure compared to their previously reported 67% recurrence rate in this same population post arthroscopic Bankart repair [17]. While the recurrence rate post-Latarjet procedure is quite impressive, the complication rate is unfortunately quite high, reported as 25% by Shah, with 6% of patients developing a post-operative infection and 10% a neurological complication [15].

As an alternative to the Latarjet procedure, the minimally invasive AAGR was developed by Wong and Urquhart in 2015 and used a distal tibia allograft (DTA), which augments the glenoid with a bone block while also allowing for an arthroscopic repair of the Bankart lesion and preservation of the subscapularis tendon, thereby, addressing bony and soft tissue instability simultaneously [5]. Short-term outcomes from this procedure at a minimum of 1-year and 2-year follow-up were promising, with no reported recurrent instability and an encouraging safety profile with no significant complications [19,20]. As a relatively new procedure, this is the first study that we are aware of that compares the AAGR complication rate to that of the arthroscopic Bankart repair.

The primary purpose of this study was to determine the frequency and type of complications, including subluxation, infection, hardware complication, graft/glenoid fracture, chondrolysis, neurovascular deficits and stiffness following an ABR or an AAGR using a DTA for recurrent anterior shoulder instability. Our secondary purpose was to determine the frank dislocation rate and the associations of post-operative complications with demographic patient factors such as age at the time of surgery, sex, operative side or number of dislocation years. We hypothesised that AAGR would have a similar safety profile to ABR with a lower post-operative recurrence rate.

Methods

Patients with recurrent anterior shoulder instability who underwent either an ABR between 1999 and 2018 or an AAGR using a DTA between 2013 and 2017 were identified by using a retrospective cohort study design. Fellowship-trained orthopaedic surgeons from the same institution, specialised in sports medicine, performed all of the surgeries. To participate in this study, patients required a diagnosis of recurrent anterior shoulder instability, have undergone either an ABR or AAGR and have had a minimum of 2 years of follow-up.

Demographic information, including the patient's age at the time of surgery, sex, surgical side, mechanism of injury and number of dislocation years, was collected pre-operatively. The data of the patient's sports level of involvement (competitive or recreational) and type (contact or non-contact) was also collected, but this data was unfortunately not comprehensive for all patients in the cohort.

Post-operative patient records were analysed to identify any post-operative complications including frank dislocation, recurring subluxation or subjective instability, infection, hardware complications, graft or glenoid fractures, chondrolysis, neurovascular deficit or shoulder stiffness. For determining graft or hardware complications in the AAGR group, radiographs and CT scans were obtained at six months post-operatively. All patients received two-mm axial CT scans in the supine position and sagittal, coronal and 3D reconstructions were also done. The arthroscopic Bankart repairs were all performed in standard fashion using single loaded anchors on the glenoid face with inferior to superior capsular shift of the capsule labral complex [4,21]. Following an examination under anaesthesia, a diagnostic arthroscopy was performed from a posterior viewing portal. An injury to the anteroinferior labrum (the Bankart lesion) was confirmed and then repaired by liberating the labral tissue, preparing the glenoid to optimise healing potential, and repairing the labrum to the glenoid using suture anchors. The AAGR procedures were all performed by the same surgeon who developed the procedure and previously published the technique, which is identical to the Bankart repair with one additional step: to add the bone block secured with two cannulated screws through the Halifax portal [5].

As is standard at our centre, all patients were instructed to participate in post-operative physiotherapy based on the guidelines from the American Society of Shoulder and Elbow Surgeons. However, due to the retrospective nature of this study, no specific rehab data were collected [22]. This study was granted ethical approval by the Nova Scotia Health Authority Research Ethics Board (blinded for the review purpose).

Statistical considerations

Demographics and complications of the two groups were described with means ± standard deviations or frequencies (count and percentage).

Numerical variables of two groups, including age at surgery and number of dislocation years, were compared using the two-sided two-sample independent t-test or Mann–Whitney *U* test depending on the results of the normality test and Levene's test. Effect sizes were calculated as an addition to the significant P-values using the following equations for the t-test and Mann–Whitney *U* test, respectively: $d = t \times \sqrt{((n_1+n_2)/(n_1 \times n_2))}$ and $r = Z/\sqrt{N}$. Cohen's d denotes effects that are weak if less than 0.2, between 0.2 and 0.8 are considered moderate, and larger than 0.8 is considered strong [23]. Mann–Whitney *U* test effect size r is interpreted as weak if less than 0.3, between 0.3 and 0.5 are considered moderate, and larger than 0.5 are considered strong. Categorical variables of two groups, including sex, operation side, and complications, were compared using the chi-square test. If the assumptions of the chi-square test were not met, a 2-sided Monte Carlo test with a 99% confidence interval or Fisher's exact test would be performed depending on the size of the contingency table. Based on the size of contingency tables, Phi and Cramer's V coefficients were used as measures of associations between complications and factors including sex, operative side, surgery type, mechanism of dislocation, and the number of dislocations in both groups. Phi in chi-statistics or Cramer's V denotes effects that are weak if less than 0.2, between 0.2 and 0.4 are considered moderate, and strong is greater than 0.4 [23]. The statistical significance level was set at a P-value of 0.05. SPSS (IBM, Version 26) was used for statistical analysis.

Results

After identifying patients who met our inclusion criteria and excluding those with posterior or multi-directional instability, or concomitant rotator cuff pathologies, 174 patients were eligible for inclusion in this study. Of the 174 patients in this cohort, 107 (61.5%) underwent an ABR, while 67 (38.5%) had an AAGR. The majority of the patients in the cohort were male (70.1%). The patient's age at the time of surgery ranged from 13 to 79 years, with those in the ABR group being statistically significantly younger (23.41 ± 8.26) than those undergoing an AAGR (29.37 ± 13.54) ($p = 0.001$, effective size $r = 0.249$). The mechanism of dislocation was most often traumatic or sports-related (70.1%), and 67% of patients reported at least five pre-operative dislocations. Complete demographic data are presented in Table 1.

By removing frank dislocation as a complication from the analysis, the complication rate for the ABR group was 11.2% (12/107) and a similar 11.9% (8/67) for the AAGR group ($p = 0.884$), with no statistically significant difference between the complication occurrence time points between the two groups (Table 2). There were 20 surgical complications in the total cohort, with 12 in the ABR group (60%) and eight in the AAGR group (40%). Of the 12 complications in the ABR group, four were subluxations compared to the AAGR group, which had only one subluxation ($p = 0.650$). The majority of the complications in the AAGR group (5/8) were related to hardware prominence.

The ABR group had 25 frank dislocations; however, there was no frank dislocation in the AAGR group ($p < 0.001$). An analysis of the relationships between frank dislocations and the different demographic factors showed that statistically significant relationships were revealed between frank dislocations and age at surgery, with younger patients more likely to experience a frank dislocation post-operatively ($p < 0.001$, 99% CI: 0.000, <0.001, Cramer's V: 0.353). However, following subgroup analysis, this association was only found to be true in the ABR group ($p = 0.001$) and not the AAGR group (Table 3). Most patients (20/25, 80%) in the ABR group who experienced a frank dislocation post-operatively were less than 20 years of age, with the remaining 5/25 (20%) being between the ages of 21 and 30. In addition, the traumatic patients had less possibility of having post-operative infection than non-traumatic patients ($p = 0.038$, 99% CI: 0.033, 0.043, Cramer's V: 0.570).

There was also a significant association between age at surgery and complications in the AAGR group (Table 3). The majority of the AAGR patients who had complications were older than 30 years of age (7/8, 87.5%). Out of five AAGR patients with hardware complications, four

Table 1
Demographic Data for the ABR and AAGR Cohorts with P-values generated from chi-square test and 2-sided Monte Carlo test with 99% confidence interval for categorical variables and those generated from Mann–Whitney *U* test for continuous variables based on the normality test results.

	Mean ± SD or N (%)		P-value	P-value (Monte Carlo, 99% CI)
	ABR (N = 107)	AAGR (N = 67)		
Age at surgery (yr)	23.41 ± 8.26	29.37 ± 13.54	0.001**	–
Sex				
Male	75 (70.1%)	47 (70.1%)	0.994*	–
Female	32 (29.9%)	20 (29.9%)		
Side				
Right	43 (40.2%)	32 (47.8%)	0.241*	–
Left	64 (59.8%)	35 (52.2%)		
Dislocation years	2.9 ± 3.5	4.7 ± 5.6	0.271**	–
<1	0	2 (4.7%)	0.002*	0.001 (<0.001, 0.002)
1-5	41 (89.1%)	29 (67.4%)		
>5	5 (10.9%)	12 (27.9%)		
Surgery type				
Primary	92 (98.9%)	43 (64.2%)	<0.001*	–
Revision	1 (1.1%)	24 (35.8%)		
Mechanism of Dislocation				
Sports/Trauma	58 (74.4%)	38 (64.4%)	0.451*	0.484 (0.471, 0.497)
ADL	3 (3.8%)	3 (5%)		
Other	17 (21.8%)	18 (30.5%)		
Number of Dislocations				
1	7 (9.6%)	4 (7.8%)	0.139*	0.139 (0.130, 0.148)
2-5	13 (17.8%)	17 (33.3%)		
>5	53 (72.6%)	30 (58.8%)		
Age at Surgery				
≤20	48 (44.9%)	20 (29.9%)	0.002*	<0.001 (<0.001, 0.002)
21-30	42 (39.2%)	25 (37.3%)		
31-40	11 (10.3%)	11 (16.4%)		
41-50	6 (5.6%)	3 (4.5%)		
≥51	0 (0%)	8 (11.9%)		

Note: ABR = arthroscopic Bankart repair, AAGR = Arthroscopic Anatomic Glenoid Reconstruction, yr = year, SD = standard deviation, ADL = activities of daily living, CI = confidence interval. *These P-values were computed based on chi-Square. **These P-values were computed using the Mann–Whitney *U* test.

Table 2

Comparison of the number of complications and the time points of the complication occurrence between the ABR and AAGR groups. P-values were computed based on Fisher's exact test and Mann–Whitney *U* test, respectively.

	Number of the Complications, N (%)			Time of Complication Occurrence, years		
	ABR (N = 107)	AAGR (N = 67)	P-values*	ABR (N = 107)	AAGR (N = 67)	P-values**
Total complications (without recurrence)	12 (11.2%)	8 (11.9%)	1.000	0.4 ± 0.4	1.5 ± 0.9	0.004
Subluxations	4 (3.7%)	1 (1.5%)	0.650	0.5 ± 0.3	1.4	0.400
Infection	1 (0.9%)	0 (0%)	1.000	0.02	–	–
Hardware	0 (0%)	5 (7.5%)	0.008	–	1.8 ± 1.0	–
Graft/glenoid fractures	0 (0%)	0 (0%)	–	–	–	–
Chondrolysis	1 (0.9%)	0 (0%)	1.000	0.4	–	–
Neurovascular deficits	1 (0.9%)	0 (0%)	1.000	0.003	–	–
Stiffness	5 (4.7%)	2 (3.0%)	0.708	0.5 ± 0.6	0.9 ± 1.0	0.571
Frank dislocations	25 (23.4%)	0 (0%)	<0.001	3.3 ± 2.5	–	–

Note: "-" means no statistics were computed because the values of the variable were a constant; ABR = arthroscopic Bankart repair, AAGR = Arthroscopic Anatomic Glenoid Reconstruction, SD = standard deviation. P-values with "*" were computed using Fisher's exact test, and those with "**" were computed using the Mann–Whitney *U* test.

Table 3

Summary of the sub-analysis in Bankart and AAGR groups regarding the significant associations between complications and demographic variables. P-values were calculated using a two-sided Monte Carlo simulation with a 99% confidence interval, and Phi and Cramer's V were used to measure the strength of the associations depending on the size of contingency tables.

Complications	Demographic variables[a] with significant P-values and coefficients					
	Bankart			AAGR		
	Significant variables	P-values[b]	Phi/Cramer's V	Significant variables	P-values[b]	Phi/Cramer's V
Total complications	n.s.[c]			Age at Surgery	0.003 (0.002, 0.004)	0.509[d]
Frank dislocation	Age at Surgery	0.001 (<0.001, 0.002)	0.401[d]	–		
Subluxations	n.s.[c]			n.s.[c]		
Infection	Mechanism of dislocation	0.038 (0.033, 0.043)	0.570[d]	–		
Hardware	–			Age at Surgery	0.046 (0.041, 0.051)	0.366[d]
Graft/glenoid fracture	–			–		
Chondrolysis	n.s.[c]			–		
Neurovascular deficits	n.s.[c]			–		
Stiffness	n.s.[c]			Age at Surgery	0.039 (0.034, 0.043)	0.433[d]

[a] Demographic variables included in the tests were sex, operative side, dislocation years, surgery types, mechanism of dislocations, number of dislocations, and age at surgery.

[b] P-values were computed using a two-sided Monte Carlo simulation with a 99% confidence interval.

[c] n.s. = not significant.

[d] Cramer's V was used to measure the strength of the associations because there was more than a 2 × 2 contingency. "-" means no statistics were computed.

(80%) were older than 30 years of age (p = 0.046; 99% CI: 0.041, 0.051; Cramer's V: 0.366). Both AAGR patients with stiffness were older than 30 years of age (p = 0.039; 99% CI: 0.034, 0.043; Cramer's V: 0.433). There were no other significant associations found between demographic factors, including sex, dislocation years, mechanism of dislocations, surgery type (primary or revision), number of dislocations, and the complications listed in Table 3 (p > 0.05).

Discussion

This study revealed a complication rate of 11.2% in the ABR group and 11.9% in the AAGR group. This rate jumps to 31.8% in the ABR group when the complication of frank dislocations is factored into the analysis. The majority of complications in the ABR group were related to the recurrence of instability, while no patients in the AAGR group experienced a post-operative dislocation, and the most common complication seen was hardware prominence.

With 25 patients in our ABR cohort reporting frank dislocation and four others reporting subluxations, the total recurrence rate was 27% (29/107), which is consistent with the rates presented in the literature [14,24,25]. A study by Mohtadi et al. comparing an open to arthroscopic Bankart repair in the treatment of anterior shoulder instability found that the recurrence rate in the arthroscopic group was also 23% compared to 11% in the open group [25]. Moreover, a study analysing the long-term outcomes of arthroscopic shoulder stabilisation found that 35% of patients experienced at least one redislocation within 8–10 years post-operatively [14]. Both of these studies found that the presence of bone loss, and specifically a Hill-Sachs lesion, increased the likelihood of a future instability event. Aboalota et al. discovered an 18% recurrence rate at a minimum of 13 years of follow-up, while a review article by Defroda reported a large recurrence range from 3.4% to 33.3% with a mean of 13.1% when combining 12 studies [6,10]. A recent article from 2020 evaluating the mid to long-term results with a mean follow-up of 8.3 years found an overall recurrence rate of 22%, with over half of the recurrences occurring by 2 years post-operative and 86% of cases in patients less than 30 years of age [24]. As a result, these authors suggest that alternative surgical techniques be employed in this patient population.

With only one patient in our AAGR group reporting post-operative shoulder instability by way of subluxation, the recurrence rate in this cohort was remarkably low at 1.5% (1/67), especially when compared to the published and our recurrence rate for an arthroscopic Bankart repair. When compared to other surgical procedures designed specifically to address bone loss, such as the Latarjet procedure, our recurrence rate was also similar [15,17,18,20]. In his cohort of 102 patients who had undergone a modified Latarjet reconstruction, Burkhart et al. reported four dislocations and one subluxation post-operatively for a total recurrence rate of 4.9% [17], compared to Shah et al. who found a recurrence rate of 8% (4/45) [15]. The two-year clinicoradiographic outcomes for the 73 patients who underwent an AAGR using DTA were recently published and demonstrated excellent results with no post-operative dislocations and a 100% graft union rate [20]. Analogous to our findings, Boileau et al. revealed that 69 out of their 70 patients treated with an arthroscopic Bristow-Latarjet with Bankart repair had a stable shoulder [18].

In addition to our AAGR group having a lower or similar recurrence rate to other published papers where an open or arthroscopic Latarjet technique was employed, a noteworthy advantage of the AAGR is its overall lower complication rate when considering all types of complications. With no infections or neurological injuries reported, the complications seen in the AAGR group were relatively benign and related to hardware prominence (5/8), stiffness (2/8) and subluxation (1/8). In comparison, Shah et al., who assessed the short-term complications of the Latarjet procedure, reported a 25% total complications rate with 3 (6%) superficial infections and 5 (10%) neurological injuries [15]. Thus, the AAGR may be a good alternative to the Latarjet procedure with a similar or lower recurrence rate, fewer overall complications and less risk of neurological injury. From a practical perspective, the AAGR offers all of the advantages of a standard open Latarjet while being less invasive with less complication risk. When compared to an arthroscopic Latarjet, the AAGR using DTA has been shown to have a quicker learning curve and be faster to perform, making it an appealing option for surgeons and patients alike [26].

The data presented in this study were collected from two surgeons at a single site, such that the surgical technique employed, recovery protocol recommended, and follow-up conducted were consistent across the cohort. However, being a retrospective study, there was no randomisation of surgical treatment. Follow-up was challenging due to the transient propensity of this young population. However, our hospital system uses a province-wide Picture Archiving and Communication system (PACS), and any further imaging studies of the patient's shoulder would be captured in our review, and likely most complications requiring surgical intervention would be documented. In addition, the surgeon who developed the AAGR technique, and thus, had familiarity and considerable skill with the procedure, performed all of the AAGRs in this study, which may have contributed to the low complication rate and may limit generalisability.

Conclusion

AAGR using DTA has demonstrated excellent clinical outcomes with low recurrence rates and a reassuring safety profile, making it a phenomenal surgical option for patients with shoulder instability with or without significant bone loss. While irrevocably a great option in revision cases, an AAGR can also be considered as a first-line procedure in certain patients with specific risk factors such as younger age, competitive contact sports participation, and more pre-operative instability events. While still a relatively new procedure, further clinicoradiographic data is required to determine the long-term outcomes. AAGR can provide stability to the shoulders like the Latarjet procedure, but with the safety profile of the ABR with an average of 3.37 years post-operatively.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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