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Arthroscopic Repair versus Non-operative Treatment of First-time Traumatic Anterior Shoulder Dislocations: A Numbers-needed-to-treat Analysis for Prevention of Recurrent Dislocations

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Background: Arthroscopic surgical repair is a better intervention than non-operative (conservative) treatment for patients with shoulder dislocations. This systematic review determined the numbers-needed-to-treat (NNT) and relative risk reduction (RRR) associated with arthroscopic surgical repair versus non-operative treatment in reducing recurrence rates among patients with first-time traumatic anterior shoulder dislocations.

Methods: We searched Google Scholar, MEDLINE, SPORTDiscus, and CINAHL from inception in 2015. All articles had to compare arthroscopic surgical repair and non-operative treatment and be written in English. We used the total number of subjects and the number of recurrent dislocations within each treatment to calculate the NNT and RRR for each study and the pooled data.

Results: Six articles were selected and all clearly demonstrated that the arthroscopic surgical repair was more effective than non-operative treatment in reducing the recurrence episodes. The pooled NNT was 1.76 (95% confidence interval [CI]=NNT to benefit 1.50–2.13) and the pooled RRR was 86.0% (95% CI=77.0%–92.0%) among individuals who underwent arthroscopic repair. The average follow-up time was 56 months.

Conclusions: A Strength of Recommendation Taxonomy level of evidence of 1 with a grade A recommendation supports the use of arthroscopic surgical repair over non-operative treatment in prevention of first-time traumatic anterior shoulder dislocations. We suggest that sports medicine practitioners consider the patients' age, occupation, and physical activity level when making a clinical decision.
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Key Words: Glenohumeral; Conservative; Instability; Redislocation

Introduction

Traumatic anterior shoulder dislocations are common due to the vast three-dimensional mobility of the shoulder joint. Recurrent episodes, after the first-time dislocation, are more problematic because of functional deficiency, emotional disturbance, and medical expenses. A recent study reported that the recurrence rate one year after the initial dislocation was 39%.[1)] Treatment options include primary arthroscopic surgical capsulolabral repair or non-operative (conservative) treatment. Many systematic reviews[2-4)] reported that arthroscopic surgical repair is superior to non-operative treatment in terms of recurrent episodes of shoulder dislocations, especially in young patients participating in intense physical activity (e.g., contact sports).[3)] Since the effectiveness of arthroscopic repair has been well documented, the next logical step would be to determine the degrees of effectiveness when compared with non-operative treatment.

Summarizing treatment effects from randomized clinical trials (RCTs), in terms of the numbers-needed-to-treat (NNT) and relative risk reduction (RRR), is helpful to physicians and clinicians in

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making a decision.[5] Simply, the NNT is an inverse of the absolute risk reduction (ARR),[6] indicating the number of interventions in order to receive clinical benefit or risk.[7] The ideal NNT would be 1. This means that for every patient who received a specific intervention, one recurrent event would be prevented.[8] For example, from a recent NNT analysis, 89 individuals would need to participate in neuromuscular training to prevent one anterior cruciate ligament (ACL) injury.[9] RRR estimates the percentage of risk that an intervention reduces risk compared to the control (no intervention),[10] which is simply calculated by subtracting relative risk (RR) from one. RR is a ratio between the probability of an event in the intervention and the probability of an event in the control.[5] Therefore, a RR close to one indicates no difference in treatment efficacy between the intervention and the control. In the same systematic review mentioned above,[9] the RRR was 70%. This indicates that neuromuscular training would reduce the risk of ACL injury by70% relative to the control (no training).

Several practical advantages of the NNT and RRR include the following:[11] (1) sports medicine practitioners understand the potential risk of injury involved with a specific intervention, (2) the information can be used in making a clinical decision in terms of medical cost and time effectiveness, (3) clinical interventions are reinforced by scientific evidence, resulting in improving value for patients. The number of patients required to undergo arthroscopic surgical repair in order to prevent recurrent events and the magnitude of efficacy is unclear. Hence, we were interested in systematically reviewing the literature to report the efficacy of arthroscopic surgical repair in preventing recurrent episodes in patients with first-time traumatic anterior shoulder dislocations. We evaluated the methods of previous RCTs and calculated NNT and RRR. The pooled results of this study would increase the strength of current evidence and be helpful in development of guidelines for clinical decision making.

Methods

Literature Search and Included Studies

We searched Google Scholar, PubMed, SPORTDiscus, and CINAHL from inception of March 2015 using combinations of the terms 'shoulder, glenohumeral, rotator cuff, scapular stabilizers, external rotators, rehabilitation, strengthening, surgery repair, reconstruction, instability, dislocation, subluxation, arthroscopy, trauma, and acute'. Citations were also cross-referenced for identification of studies not found using the original search terms. We further limited the search by applying additional selection criteria: (1) full manuscripts written in English, (2) acute first-time traumatic anterior dislocations only, (3) an arthroscopic capsulolabral repair had to be compared with a non-operative treatment, and (4) an outcome measure of dislocation recurrence rates within the arthroscopic surgical repair and non-operative treatments had to be included.

After applying selection criteria, a total of 1,554 articles were initially identified but 1,543 studies were excluded based on the exclusion criteria. More specifically, these articles included a comparison between different surgical techniques (e.g., open vs. arthroscopic), patients with shoulder dislocations rather than anterior direction (e.g., posterior instability), patients with multiple dislocations (e.g., not first-time), different outcome measures (e.g., cost effectiveness), only recorded outcome measures from the surgical treatment (e.g., absence of the control). Among the remaining 11 relevant studies,[12-22] five articles[18-22] were further excluded. One study,[18] which was a longer-term follow-up to the same patients used in another study,[16] and was included in the pooled data, was excluded. We chose to pool the results of the shorter follow-up study[16] because several patients could not be included at the longer-term follow-up.[18] We further excluded four studies[19-22] because patients in those studies underwent arthroscopic lavage[21,22] and debridement.[20] One article was excluded because only an abstract was published.[19] Therefore, six studies[12-17] were finally pooled. The average follow-up time was 56 months.

Quality Assessment

Selected studies were evaluated by two co-authors using the Physiotherapy Evidence Database (PEDro) scale,[23] a 10-item scale designed for rating methodological quality of randomized controlled trials, with a fair to good reliability (intraclass correlation coefficient, 0.68; 95% confidence interval [CI], 0.57–0.76).[24] The articles within this systematic review were independently rated, and a consensus score was determined for each article, after collaboration. Scores ranged between 5 and 7, with an average of 5.8 out of 10 (Table 1).

Data Extraction

Calculation of the NNT, RRR, and the 95% CIs required extraction of the following data from the 11 studies: (1) number of patients with recurrent glenohumeral dislocations following arthroscopic surgical or non-operative treatment, (2) number of patients without recurrent glenohumeral dislocations following arthroscopic surgical or non-operative treatment, and (3) the total number of patients within each treatment (arthroscopic surgical and non-operative). The number of patients in each study and the number of recurrences per treatment were added to obtain a pooled estimate of effectiveness.

Statistical Analyses

To quantify homogeneity level, heterogeneity test (I^2) was performed (24 cells: recurrence rates for each treatment across six studies).

$I^2=[(Q-df)/Q]\times100\%$, where Q is chi-squared value and df is degrees of freedom.[25]

NNT was calculated as the inverse of the ARR, which was

Table 1. Summary of PEDro Scores and Interventions

Reference	Study design	PEDro score	Population	Follow-up time (mo)	Arthroscopic repair	Non-operative treatment
Arciero et al.[12]	Prospective randomized	5	Military personnel, 18–24 years old	15–45 (average: 32)	Arthroscopic Bankart repair (10 days post injury) 4 weeks immobilization Rehabilitation (same as non-operative treatment)	4 weeks immobilization Rotator cuff and scapular strengthening exercises Return to activity 4 months
Bottoni et al.[13]	Prospective randomized	6	Military personnel, 18–26 years old	24–56 (average: 36)	Arthroscopic Bankart repair (10 days post injury) 4 weeks immobilization Rehabilitation (same as non-operative treatment)	4 weeks immobilization 5–8 weeks passive and active ROM 9–12 weeks resistance exercise Return to activity 4 months
DeBerardino et al.[14]	Prospective non-randomized	5	Military personnel, 17–23 years old	24–60 (average: 37)	Arthroscopic Bankart repair (10 days post injury) 4 weeks immobilization Rehabilitation (same as non-operative treatment)	3 weeks immobilization followed by strengthening focused on internal rotation and abduction Return to activity 3 months
Jakobsen et al.[15]	Prospective randomized	6	Emergency room patients, 15–39 years old	24 and 240	Arthroscopic Bankart repair 1 week immobilization Rehabilitation (same as non-operative treatment)	1 week immobilization 3 weeks post-OP internal rotation and abduction ROM & 8 weeks post-OP external rotation ROM 12 weeks post-OP swimming and light sports Return to activity 6 months
Kirkley et al.[16]	Prospective randomized	7	Emergency room and orthopedic office, <30 years old	20–53 (average:32)	Arthroscopic Bankart repair (4 weeks post injury) 3 weeks immobilization post-surgery Rehabilitation (same as non-operative treatment)	0–3 weeks immobilization 4–6 weeks active ROM and scapular retractions 7–8 weeks active ROM and isometric exercises 9–12 weeks isotonics and scapular strengthening Return to activity 4 months
Larrain et al.[17]	Prospective non-randomized	6	Competitive athletes, 17–27 years old	28–120 (average: 68)	Arthroscopic Bankart repair 3–4 weeks immobilization Rehabilitation (same as non-operative treatment)	2–4 weeks immobilization 4–8 weeks single-plane shoulder movements 8–12 weeks multi-plane shoulder movements 12–16 strengthening Return to activity 4 months

PEDro: Physiotherapy Evidence Database, ROM: range of motion, OP: operation.

calculated by taking the non-operative recurrence risk minus the arthroscopic surgical recurrence risk. The surgical recurrence risk was calculated by taking the total number of recurrent dislocations in the arthroscopic surgical treatment and dividing those by total number of patients in the arthroscopic surgical treatment.[9,26] The non-operative recurrence risk was calculated by taking the total number of recurrent dislocations in the non-operative treatment and dividing them by the total number of patients in the non-operative treatment.[9,26] The NNT was then calculated by taking the inverse of the ARR. NNT to benefit was indicative of a preventative effect in the arthroscopic surgical treatment compared to the non-operative treatment. NNT CIs were calculated on a 95% interval, those that crossed infinity were considered to be NNT to harm and were representative of the surgical treatment increasing the risk of recurrent dislocation compared to the non-operative treatment.[10]

ARR=Non-operative recurrence risk-Arthroscopic surgical recurrence risk

Recurrence risk=Total # of recurrent dislocations/Total # of patients (within the same treatment)

NNT=1/ARR

RRR estimates the percentage of risk that an intervention reduces risk compared to the control (no intervention).[10] To calculate the RRR, the RR had to be calculated first, by dividing the surgical recurrence risk by the non-operative recurrence risk. The RRR was then calculated by subtracting the RR from one and multiplying by 100 so that the RRR could be expressed as a percentage. The RRR is indicative of the ability of the arthroscopic treatment to reduce the risk of recurrent dislocation when compared to the non-operative treatment. Positive RRRs indicated reduced risk with arthroscopic treatment and negative values indicated increased risk associated with the arthroscopic treatment in comparison with the non-operative treatment; 95% CI and the point estimates for the NNT, ARR, and RRR were calculated using a statistical software program (Confidence Interval Analysis ver. 2.1; University of Southampton, Southampton, UK).

RR=Non-operative recurrence risk/Arthroscopic surgical recurrence risk

RRR=(1-RR)×100

Results

The result of the heterogeneity test was 66%, indicating that the level of patient heterogeneity in the pooled data was moderate.

The results for the NNT, ARR, and RRR calculations are summarized in Table 2. Forest plots for NNT and RRR are shown in Fig. 1 and 2, respectively. Across all six studies,[12-17] the arthroscopic surgical treatment showed a decreased rate of recurrent shoulder dislocations or subluxations when compared to the non-operative treatment.

Calculated pooled result of NNT was a positive number of 1.76 (95% CI=1.50 to 2.13), indicating that two arthroscopic surgical repairs would need to be performed in order to prevent one recurrent episode. The pooled RRR was 86.0% (95% CI=77.0% to 92.0%) indicating that the risk of a recurrent shoulder dislocation in a patient treated with arthroscopic surgical repair would be 87% lower compared to a patient treated non-operatively.

Discussion

The purpose of this review was to evaluate the effectiveness of arthroscopic surgical treatment (Bankart repair) when compared to non-operative treatment at reducing recurrent anterior shoulder dislocation in patients with first-time traumatic anterior shoulder dislocations. Our search and calculations clearly demonstrated that reduction of recurrence rates in all studies was much higher in the arthroscopic surgical treatment than the non-operative treatment. The results of this systematic review reinforce the previous studies reporting[2-4,27] that arthroscopic Ban-

Table 2. Injury rates, Numbers-needed-to-treat Analysis, ARR, and RRR

Reference	Recurrence rate* (non-operative)	Recurrence rate* (arthroscopic)	NNTB (95% CI)	ARR (95% CI)	RRR (95% CI)
Arciero et al.[12]	12/15 (80.0)	3/21 (14.3)	1.52 (1.10–2.47)	0.66 (0.25–0.41)	0.82 (0.48–0.94)
Bottoni et al.[13]	9/12 (75.0)	1/9 (11.1)	1.57 (1.04–3.13)	0.64 (0.32–0.96)	0.85 (0.03–0.98)
DeBerardino et al.[14]	4/6 (66.7)	6/49 (12.2)	1.84 (1.07–6.41)	0.54 (0.16–0.93)	0.82 (0.53–0.93)
Jakobsen et al.[15]	21/39 (53.8)	1/37 (2.7)	1.96 (1.48–2.89)	0.51 (0.35–0.68)	0.95 (0.65–0.99)
Kirkley et al.[16]	9/19 (47.4)	3/19 (15.8)	3.17 (1.68–26.47)	0.32 (0.04–0.59)	0.67 (-0.4–0.90)
Larrain et al.[17]	17/18 (94.4)	1/28 (3.6)	1.10 (0.97–1.28)	0.91 (0.78–1.03)	0.96 (0.74–0.99)
Pooled results	72/109 (66.1)	15/163 (9.2)	1.76 (1.50–2.13)	0.57 (0.47–0.67)	0.86 (0.77–0.92)

ARR: absolute risk reduction, RRR: relative risk reduction, NNTB: numbers-needed-to-treat to benefit, CI: confidence interval.
*Total # of recurrent dislocations/total # of patients (%).

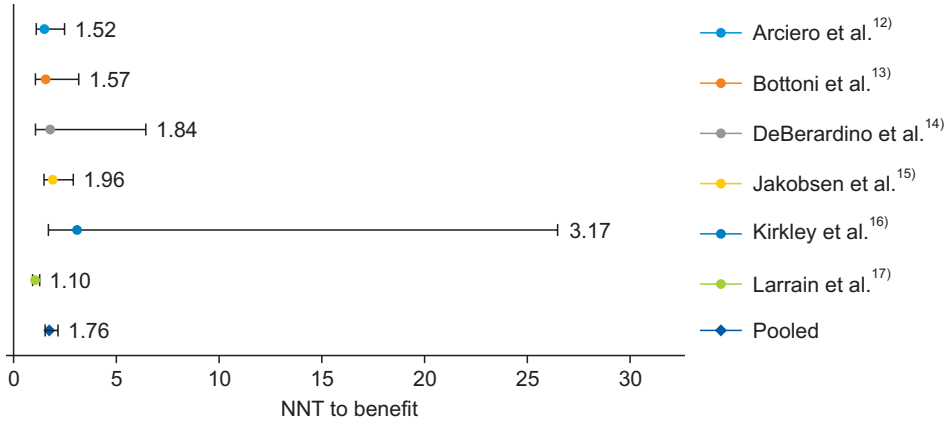

Fig. 1. Numbers-needed-to-treat (NNT) of recurrence rate in a comparison of arthroscopic repair and non-operative treatment. Error bars (95% confidence intervals) do not cross the midline (zero) indicate that the corresponding average number is statistically significant (p<0.05).

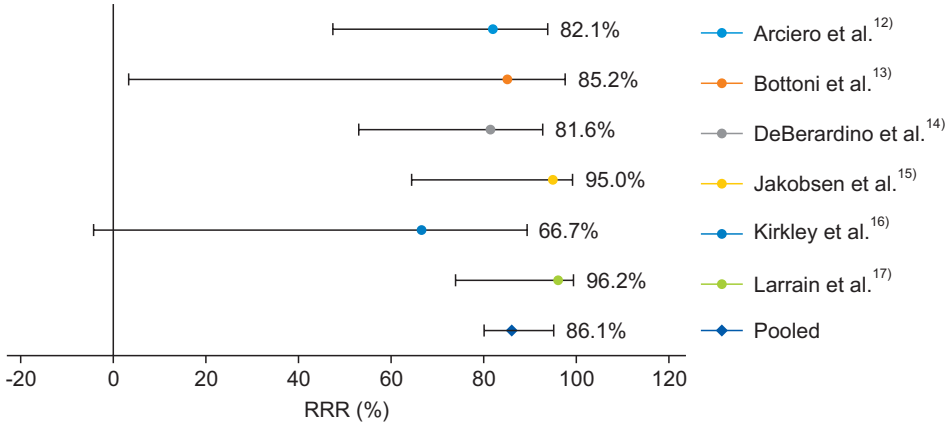

Fig. 2. Relative risk reduction (RRR) of recurrent rate in a comparison of arthroscopic repair and non-operative treatment. Error bars (95% confidence intervals) do not cross the midline (zero) indicate that the corresponding average number is statistically significant (p<0.05).

kart repair is a more effective treatment for reducing the number of recurrent dislocations in patients with first-time traumatic anterior shoulder dislocations, when compared to non-operative treatment. One[16)] of the studies in this systematic review had RRRs that crossed zero, meaning that there is uncertainty as to the true effectiveness of the intervention. In this study,[16)] number of positive (recurrent episodes; n=9) and negative outcomes (n=10) in the arthroscopic repair were similar in the non-operative treatment (n=19). These numbers were produced in much smaller ARR (0.32) and RRR (0.67), compared to other studies (Table 2) which yielded wider 95% confidence bands, which resulted in 95% confidence bands touching the zero line. Despite this study, the pooled results provide strong evidence (level 1 with grade A based on the Strength of Recommendation Taxonomy grading scale).[28)] The results of individual studies in this systematic review were consistent (level 1) and the outcome measurement was recurrent dislocation (good quality patient-oriented evidence: grade A).[28)]

The studies selected in this systematic review used Bankart repair for the arthroscopic surgery. Open surgical techniques are also currently being used in treatment of first-time traumatic anterior shoulder dislocations. Many studies[29-32)] have compared open surgical procedures with arthroscopic procedures for treatment of the same population as this review. However, these studies yielded different results. A recent systematic review[29)] pooled 19 studies, and concluded that arthroscopic surgery was associated with significantly higher risk of recurrent instability compared to the open surgical procedure. Two studies[30,32)] were prospective RCTs. One of them[30)] demonstrated that both techniques yielded similar postoperative results, but recommended arthroscopic procedure because it can be performed safely. Another study[32)] reported that no significance was found, but the authors mentioned that open is a more reliable method for collision athletes. One study[31)] retrospectively reviewed outcomes of both procedures and found no significant difference between the two types of surgical procedures. In our systematic review, we reviewed studies that included the arthroscopic procedure compared to non-operative treatment. This systematic review did not include any study with open surgical technique. Therefore, the results and analysis in this study can only be applicable to the arthroscopic Bankart repair, not the general surgical intervention.

According to traumatic or atraumatic classifications,[33)] we reviewed and analyzed studies that evaluated patients with first-time traumatic anterior shoulder dislocations. Therefore, we do not know the effects of the two different interventions on mul-

tidirectional (e.g., inferior and/or posterior) or chronic shoulder instability. In addition, the pooled results cannot be generalized for other acute shoulder pathologies such as rotator-cuff or SLAP (superior labrum anterior to posterior) tear. There were also differences in the subject population across the pooled results from six studies. Three studies[12-14] included military cadets, two studies[15,16] sampled from emergency rooms, and one study[17] included competitive athletes. Level of homogeneity of the patient population in the pooled studies (66%) may weaken our results. Because clinical and methodological variation always exists, any systematic review has some degree of heterogeneity. For example, 25% of meta-analyses have I^2 values higher than 50%.[25] Therefore, the interpretation of heterogeneity test is arguable.[34] In addition, since we focused more on a select specific population (patients with first-time traumatic anterior shoulder dislocations) rather than activity levels or age ranges, the effect of patient heterogeneity on the pooled results is minimal. Therefore, we believe that the selected population in this review adds to and strengthens current evidence as expected.

Throughout the six studies, averaged follow-up times to evaluate the functional outcomes varied (Table 1). All six studies followed more than 24 months: Arciero et al.[12] and Kirkley et al.[16] followed 32 months, Bottoni et al.[13] followed 36 months, DeBerardino et al.[14] followed 37 months, and Larrain et al.[17] followed 68 months. One study[15] reported different follow up times, one at 2 years and one at 10 years. Even though most of the patients were evaluated after 24 months, the long-term effects of arthroscopic surgical treatment have not been thoroughly investigated, and remain a limitation. Although the same rehabilitation programs were applied to both treatments in each article, immobilization periods and rehabilitation program with progression timeframes during rehabilitation were slightly different among the six studies (Table 1). One study[15] only reported a week of immobilization while other studies reported three to four weeks. Regarding rehabilitation protocols and progression timeframes, most studies[13,15-17] followed a 4-week progression of initial range of motion (ROM) exercises after immobilization followed by shoulder and scapular strengthening exercises (Table 1). Two studies[12,14] did not specify ROM exercises and progression timelines in their rehabilitation programs. Time for returning to activity also varied among the six studies. In four studies[12,13,16,17] patients returned after 4 months, and after 3 months[14] and 6 months[15] in the other studies.

Note that variations of the aforementioned factors in rehabilitation programs may affect the clinical and functional outcomes. Documented rehabilitation programs may allow sports medicine practitioners to construct rehabilitation protocols when working with the same pathology. In order to prevent recurrent episodes of shoulder dislocation, we suggest application of rehabilitation protocols that include immobilization, neuromuscular and ROM exercises, strengthening exercises, and functional exercises with a 4-week progression.[35] We also suggest paying more attention to neuromuscular and strengthening exercises at the glenohumeral and scapulothoracic joints since dynamic stability of the shoulder joint is from the capsuloligamentous and musculotendinous stabilizers.

Conclusions

The pooled NNT (1.76; 95% CI=1.50 to 2.13) and RRR (86.0%; 95% CI=77.0% to 92.0%) reinforce the current scientific and empirical evidence that arthroscopic surgical treatment has substantially lower recurrence rates than non-operative treatment in patients suffering a first-time traumatic anterior shoulder dislocation. Sports medicine practitioners should consider patients' age, occupation, and physical activity level when making a clinical decision for patients following first-time traumatic anterior shoulder dislocations.

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