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Original Article

Clinical outcomes in patients with retear after arthroscopic rotator cuff repair: A meta-analysis

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A B S T R A C T

Background: Rotator cuff retear is a major concern after arthroscopic rotator cuff repair (ARCR); however, the effects of retear remain unclear. Therefore, the purpose of this study was to assess the clinical outcomes of postoperative retear and intact tendons after ARCR.
Methods: We searched PubMed, Cochrane Library, Scopus, and PEDro databases for studies performed from January 2000 to June 2020. Clinical outcomes included the Constant score, American Shoulder and Elbow Surgeons (ASES) score, University of California Los Angeles shoulder (UCLA) score, pain score, range of motion, and muscle strength. Meta-analysis using random-effects models was performed on the pooled results to determine significance.
Results: The initial database search yielded 3141 records. After removal of duplicates, 26 of which met the inclusion criteria. Patients in the retear group had significantly lower Constant score [− 8.51 points (95% CI, − 10.29 to − 6.73); $P < 0.001$], ASES score [− 12.53 points (95% CI, − 16.27 to − 8.79); $P < 0.001$], UCLA score [− 3.77 points (95% CI, − 4.72 to − 2.82); $P < 0.001$], and significantly higher pain score [0.56 cm (95% CI, 0.10 to 1.01); $P = 0.02$] than the intact group. In addition, the retear group had significantly lower flexion [− 10.46° (95% CI, − 19.86 to − 1.07); $P = 0.03$], abduction [− 14.84° (95% CI, − 28.55 to − 1.14); $P = 0.03$], and external rotation [− 7.22° (95% CI, − 13.71 to − 0.74); $P = 0.03$] range of motion, and flexion [− 1.65 kg·f (95% CI, − 2.29 to − 1.01); $P < 0.001$], abduction [− 1.87 kg·f (95% CI, − 3.02 to − 0.72); $P = 0.001$], and external rotation [− 1.66 kg·f (95% CI, − 3.25 to − 0.07); $P = 0.04$] muscle strength.
Conclusion: Our results suggest that retear after ARCR leads to poor clinical outcomes after surgery.

1. Introduction

Arthroscopic rotator cuff repair (ARCR) mainly consists of single-row (SR) and double-row (DR) techniques. In the DR technique, the threads are sutured in the medial and lateral rows, with better biomechanical properties and a lower retear rate than SR fixation. Clinical outcomes after two-year follow-up showed no significant differences between the two repair techniques; however, the DR technique yielded superior clinical outcomes, especially for full-thickness tears larger than 3 cm [1].

The suture bridge (SB) technique, also called as the "trans-osseous-equivalent" technique, is an alternative technique. In the SB technique, the threads from the medial anchor are fixed with a lateral anchor, covering the torn tendon edge and fixing it to the original footprint; consequently, the pressurized contact area and mean pressure between the tendon and footprint were relatively improved compared with the conventional DR technique. In a comparison between DR and SB techniques with two-year follow-up, no apparent differences were found in patient satisfaction and clinical outcomes [2].

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Generally, ARCR produces acceptable clinical outcomes, while retear is a major concern after surgery. Several studies have indicated that the presence of a retear does not affect clinical function [3–5]. However, other studies have shown that retear results in inferior clinical outcomes [6–8]. In a systematic review of operative procedures for rotator cuff repair, the effect of postoperative retear on clinical outcomes has been partly addressed [9]; unfortunately, these reviews did not provide sufficient knowledge regarding retear effects. Therefore, the purpose of the present meta-analysis was to clarify the clinical outcomes in patients with or without retear after ARCR.

2. Material and methods

This study was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.

We systematically searched PubMed, Cochrane Library, Scopus, and PEDro databases for studies conducted between January 2000 and June 2020. The search strategy used a combination of Medical Subject Headings (MeSH) and keyword searches using the following search terms: arthroscopic, repair, rotator cuff, retear, re-tear, single-row, double-row, suture bridge, functional outcome, and clinical outcome. When applicable, the references of the selected articles were also reviewed to identify additional studies. The titles and abstracts of the resultant articles were preliminarily screened for inclusion, and full-text articles were further evaluated according to the predefined inclusion and exclusion criteria. References from eligible articles were also searched to ensure a comprehensive survey of the relevant literature. The inclusion criteria were as follows: (1) the interventions included SR repair, DR repair, and SB repair; (2) the presence or absence of a retear was documented using magnetic resonance imaging, ultrasound, and computed tomographic arthrography; and (3) functional outcomes at a minimum of 1-year follow-up. The exclusion criteria were as follows: (1) patients with isolated subscapularis tears and repairs, labral repairs of any kind, dislocations, and other diseases that affect the function of the shoulder; (2) interventions including conventional open or mini-open repair techniques; and (3) case reports.

In this study, rotator cuff retear after ARCR was defined as the diagnosis of postoperative retear in diagnostic imaging [10]. When the Sugaya classification system was used, types 1, 2, and 3 were categorized as the intact group and types 4 and 5 as the retear group. When the Charousset classification was used, stages 1 and 2 were categorized as the intact group and stage 3 as the retear group. The intact and retear ARCR groups were categorized according to these criteria.

The main outcomes were the Constant score, American Shoulder and Elbow Surgeons (ASES) score, University of California Los Angeles shoulder (UCLA) score, and pain score (visual analog scale [VAS]). These measures were chosen because they are the most abundant in the literature on shoulder outcomes. Other outcomes included the scores of range of motion (ROM) and muscle strength.

After selecting the final list of articles, we extracted the mean and standard deviation (SD) of clinical outcomes. Several studies had missing standard deviation, which is a necessary component of statistical calculations in a meta-analysis. Therefore, we contacted the corresponding authors for details on the clinical results. If the study author named in the report could not be contacted or did not respond, we calculated SDs from standard errors (SEs), 95% confidence intervals (CIs), or P values. If no measures of variation were reported and SDs could not be calculated, we planned to impute SDs from other trials in the same meta-analysis. If it was desirable to pool the two reported groups into one group, the mean and SD were synthesized from the reported values using standard methods as described in the Cochrane handbook [11]. We used I^2 and chi-squared statistics to measure the heterogeneity among the trials in each analysis. We interpreted the I^2 statistic as follows: 0%–40% may represent insignificant heterogeneity; 30%–60% may represent moderate heterogeneity; 50%–90% may represent substantial heterogeneity; and 75%–100% may represent considerable heterogeneity [11].

Meta-analyses were performed to combine the effect sizes between the two groups on the six selected clinical outcome variables (Constant score, ASES score, UCLA score, pain score, ROM, and muscle strength). Owing to clinical and/or methodological heterogeneity among published results, random-effects method was used to synthesize the effect estimates. We used the statistical software of The Cochrane Collaboration, Review Manager 5.4, to perform data analysis. An effect was considered significant if the P value < 0.05; the mean difference and 95% CI were reported. To assess the publication bias in ASES score and Constant score evaluated by more than 10 studies in our series [11], funnel plots and Egger's tests were performed.

3. Results

The search, which was conducted between January 2000 and June 2020, yielded 3141 records across the four databases. After duplicates were removed, 2264 records remained. We screened 145 full-text articles and identified 26 studies that were included in the review (Fig. 1).

A total of 1825 participants (565 patients treated with SR technique, 624 patients treated with the DR technique, and 636 patients treated with the SB technique) were included in the 26 studies. The average age of patients who participated in these trials was 60.2 years (52–70 years). The average follow-up duration ranged from 12 to 129 months (Tables 1 and 2).

The constant score was described in 17 studies [4–6,8,12–24], which included 1104 patients (828 intact and 276 retear patients). This analysis showed that the constant score of the retear group was significantly lower than that of the intact group, with a mean difference of −8.51 (95% CI, − 10.29 to − 6.73; P < 0.001) (Fig. 2A). The funnel plot and Egger's test (P = 0.147) showed no significant publication bias (Fig. 3A). A comparison by repair type showed that the Constant score in SR (mean difference, − 7.26; 95% CI, − 9.05 to − 5.46; P < 0.001), DR (mean difference, − 10.58; 95% CI, − 16.12 to − 5.04; P < 0.001), and SB (mean difference, − 8.34; 95% CI, − 10.91 to − 5.78; P < 0.001) of the retear group was significantly lower than that of the intact group (Table 3).

The ASES score was described in 12 studies [3,5–7,12,21,23,25–29], which included 775 patients (632 intact and 143 retear patients). This analysis showed that the ASES score of the retear group was significantly lower than that of the intact group, with a mean difference of − 12.53 (95% CI, − 16.27 to − 8.79; P < 0.001) (Fig. 2B). The funnel plot and Egger's test (P = 0.946) showed no significant publication bias (Fig. 3B). A comparison by repair type showed that the ASES score in SR (mean difference, − 14.50; 95% CI, − 18.90 to − 10.09; P < 0.001), DR (mean difference, − 15.53; 95% CI, − 21.17% to − 9.90; P < 0.001), and SB (mean difference, − 7.19; 95% CI, − 13.24 to − 1.14; P = 0.02) of the retear group was significantly lower than that of the intact group (Table 3).

The UCLA score was described in nine studies [4,5,7,8,19,23,25,27,29], which included 698 patients (541 intact and 157 retear patients). This analysis showed that the UCLA score of the retear group was significantly lower than that of the intact group, with a mean difference of −3.77 (95% CI, − 4.72 to − 2.82; P < 0.001) (Fig. 4A). A comparison by repair type showed that the UCLA score in SR (mean difference, − 4.54; 95% CI, − 7.54 to − 1.54; P < 0.001),

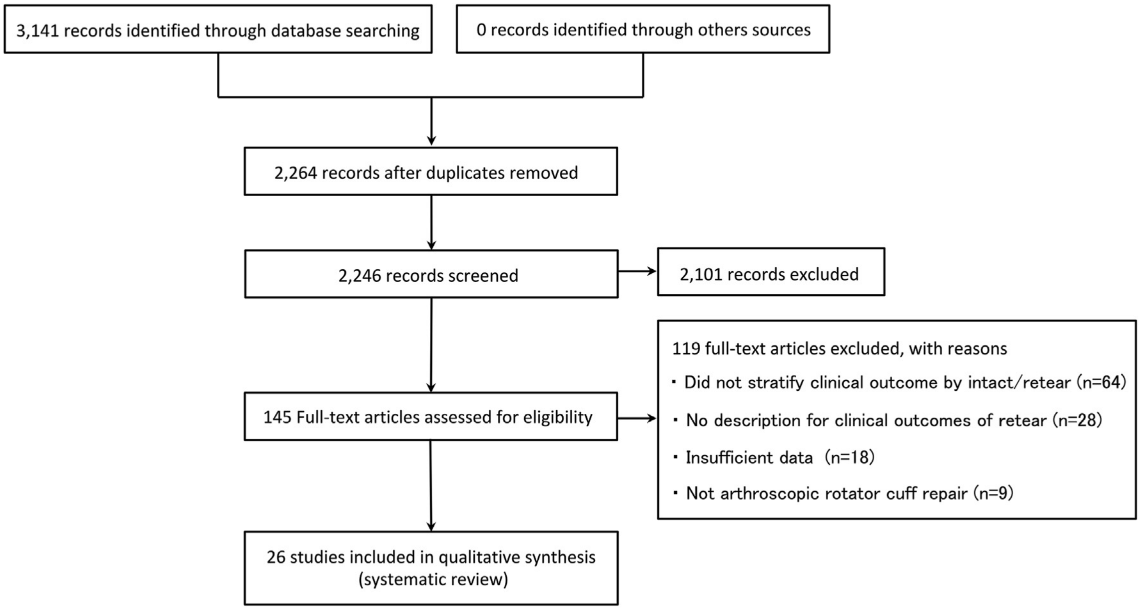

Fig. 1. Flowchart of the articles included in the systematic review.

Table 1
Characteristics of the included studies.

Author	Journal (Year)	Repair Method	Study Design	Sample Size	Mean Age, yr	Mean Follow-up, mo	Imaging Method
Bishop et al. [12]	JSES (2006)	SR	CS	40	64	12	MRI
Lichtenberg et al. [13]	KSSTA (2006)	SR	CS	53	60.9	26.4	MRI
Cole et al. [30]	JSES (2007)	SR	CS	49	57	24	MRI
Liem et al. [15]	Arthroscopy (2007)	SR	RCS	19	61.9	25.3	MRI
Liem et al. [16]	JBJS Am (2007)	SR	CS	53	60.9	26.4	MRI
Sugaya et al. [25]	JBJS Am (2007)	DR	CS	86	60.5	31	MRI
Lafosse et al. [14]	JBJS Am (2007)	DR	CS	105	52	36	CTA, MRI
Charousset et al. [17]	Arthroscopy (2008)	SR	CS	102	59.4	31	CTA
Charousset et al. [18]	Arthroscopy (2010)	SR	CS	81	70	41	CTA
El-Azab et al. [6]	KSSTA (2010)	DR	CS	20	58	14	MRI
Park et al. [3]	CORR (2010)	SB	CS	78	59.2	13.1	US
Sethi et al. [26]	JSES (2010)	SB	CS	40	61.4	16.1	MRI
Cho et al. [19]	AJSM (2011)	SB	CS	87	55.4	25.2	MRI
Toussaint et al. [20]	AJSM (2011)	DR	CS	154	N/A	15	CTA, MRI
Mihata et al. [7]	AJSM (2011)	SR	Cohort	65	61	45	MRI
	AJSM (2011)	DR	Cohort	130	63.2	35.6	MRI
Akpinar et al. [4]	AOTT (2011)	SR	CS	26	55.9	24	MRI, US
Choi et al. [5]	JSES (2012)	SB	CS	41	59	28	US
Hayashida et al. [27]	Arthroscopy (2012)	DR	CS	47	65	26	MRI
Kim et al. [8]	AJSM (2012)	SB	Case control	66	61.8	13.8	MRI, US
Park et al. [21]	Arthroscopy (2013)	SB	CS	36	62.4	37.6	MRI, US
Neyton et al. [22]	Arthroscopy (2013)	SB	CS	107	54.8	16.1	MRI
Carbonel et al. [23]	Adv Orthop (2013)	DR	Cohort	82	58	24	MRI
Iannotti et al. [31]	JBJS Am (2013)	SB	CS	113	58.6	12	MRI
Rimmke et al. [28]	PSM (2016)	SB	CS	42	59.7	13.5	US
Kim et al. [29]	AJSM (2017)	SR	Case control	73	64.1	24	MRI, MRA
Heuberer et al. [24]	AJSM (2017)	SR	CS	30	58.7	129	MRI

Adv Orthop, Advances in Orthopedics; AJSM, American Journal of Sports Medicine; AOTT, Acta Orthop Traumatol Turc; CORR, Clinical Orthopaedics and Related Research; CS, case series; CTA, computed tomography arthrogram; DR, double-row repair; JBJS Am, Journal of Bone and Joint Surgery, American Edition; JSES, Journal of Shoulder and Elbow Surgery; KSSTA, Knee Surgery, Sports Traumatology, Arthroscopy; MRA, magnetic resonance arthrogram; MRI, magnetic resonance imaging; PSM, Physician and Sportsmedicine; RCS, retrospective comparative study; SB, suture bridge repair; SR, single-row repair; US, ultrasound.

DR (mean difference, −4.12; 95% CI, −5.56 to −2.67; $P < 0.001$), and SB (mean difference, −3.09; 95% CI, −4.08 to −2.09; $P < 0.001$) of the retear group was significantly lower than that of the intact group (Table 3).

The pain score (VAS) was described in eight studies [3,6,12,19,21,28–30], which included 425 patients (301 intact and 124 retear patients). This analysis showed that the pain score (VAS) of the retear group was significantly higher than that of the intact group, with a mean difference of 0.56 (95% CI, 0.10 to 1.01; $P = 0.02$) (Fig. 4B). A comparison by repair type showed that the pain score in SR (mean difference, 0.62; 95% CI, −0.21 to 1.46; $P = 0.14$), and SB (mean difference, 0.55; 95% CI, −0.18 to 1.27; $P = 0.14$) in the retear groups was not significantly different from that of the intact group (Table 3).

Twelve studies [3,6,7,14,15,19–21,23,28–30] described the range of flexion, abduction, external rotation, and internal rotation. This

Table 2
Summary of patient Demographic Characteristics.

Characteristic	Single-Row Repair	Double-Row Repair	Suture-Bridge Repair
Repairs, n	565	624	636
Mean age, yr	61.8	59.5	58.8
Male patients, %	56	52.8	52.5
Dominant side, %	74.8	84.7	73.9
Mean follow-up, mo	38.4	25.9	19.9

analysis showed a significant difference in flexion (mean difference, – 10.46; 95% CI, – 19.86 to – 1.07; P = 0.03), abduction (mean difference, – 14.84; 95% CI, – 28.55 to – 1.14; P = 0.03) and external rotation (mean difference, – 7.22; 95% CI, – 13.71 to – 0.74; P = 0.03), but no significant differences in internal rotation (mean difference, – 9.40; 95% CI, – 25.79 to 6.98; P = 0.26) were detected (Fig. 5A–D).

Ten studies [4,6,12,14,19–21,28,30,31] described the muscle strength of flexion, abduction, and external rotation. The analysis showed a significant difference in flexion (mean difference, – 1.65; 95% CI, – 2.29 to – 1.01; P < 0.001), abduction (mean

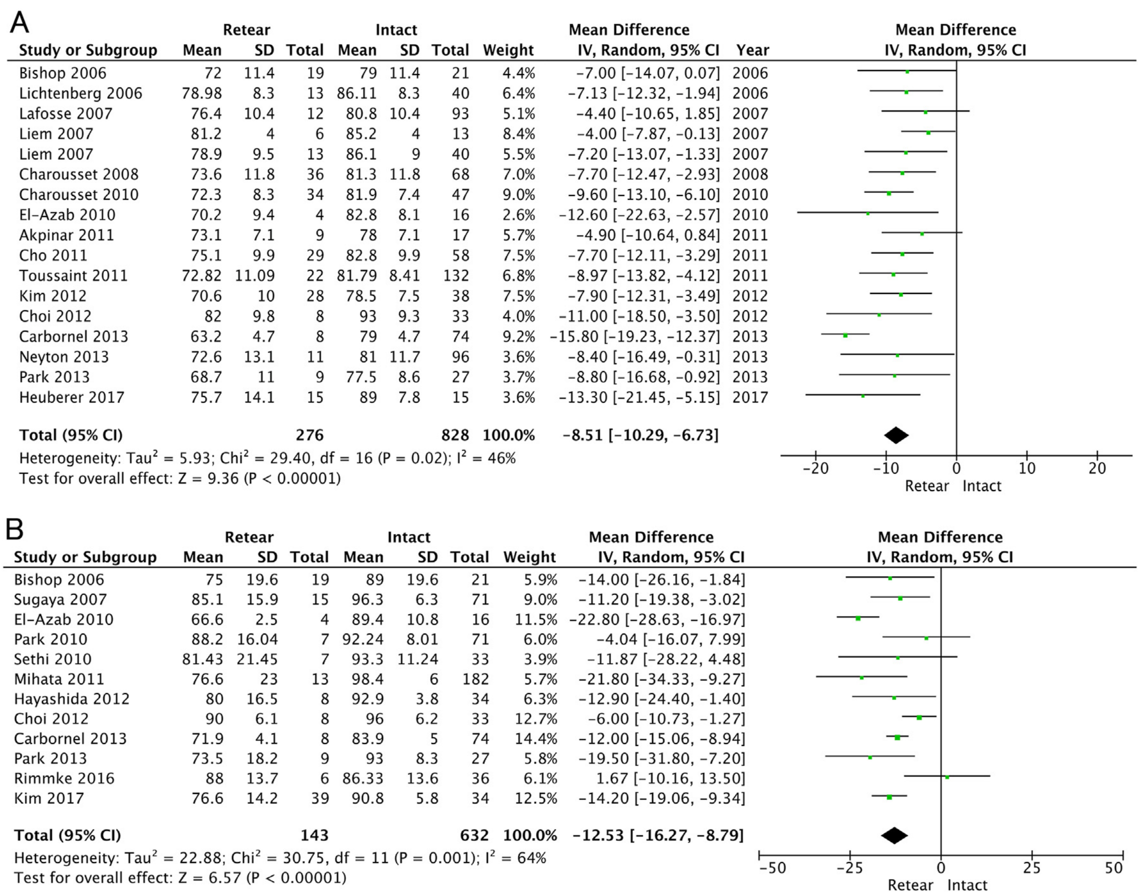

Fig. 2. Forest plots of Constant score and ASES score. (A) Mean difference and 95% CIs of Constant score. (B) Mean difference and 95% CIs of ASES score.

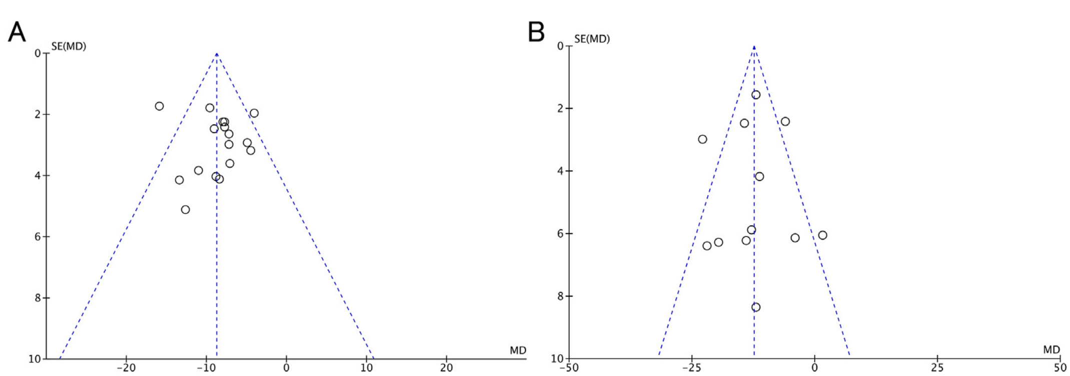

Fig. 3. Funnel plot of Constant score (A) and ASES score (B).

Table 3
Comparison of clinical results between retear and intact groups in single-row, double-row, and suture bridge repairs.

	Single-Row Repair			Double-Row Repair			Suture-Bridge Repair		
	n	Mean Difference (95%CI)	*P* Value	n	Mean Difference (95%CI)	*P* Value	n	Mean Difference (95%CI)	*P* Value
Constant score	406	−7.26 (−9.05 to −5.46)	<0.001	361	−10.58 (−16.12 to −5.04)	<0.001	337	−8.34 (−10.91 to −5.78)	<0.001
ASES	178	−14.50 (−18.90 to −10.09)	<0.001	360	−15.53 (−21.17 to −9.90)	<0.001	237	−7.19 (−13.24 to −1.14)	0.02
UCLA	164	−4.54 (−7.54 to −1.54)	<0.001	340	−4.12 (−5.56 to −2.67)	<0.001	194	−3.09 (−4.08 to −2.09)	<0.001
Pain (VAS)	162	0.62 (−0.21 to 1.46)	0.14	N/A	N/A	N/A	243	0.55 (−0.18 to 1.27)	0.14

ASES, American Shoulder and Elbow Surgeons; N/A, not available; UCLA, University of California, Los Angeles; VAS, Visual Analogue Scale.

difference, − 1.87; 95% CI, − 3.02 to − 0.72; P = 0.001), and external rotation (mean difference, − 1.66; 95% CI, − 3.25 to − 0.07; P = 0.04) (Fig. 6A–C).

4. Discussion

ARCR is a therapeutic procedure that improves function and provides pain relief when conservative treatment fails. However, retear remains a significant concern after surgery. Although repair techniques improve the postoperative retear rate, its effect on clinical outcomes after surgery remains unclear [9]. In 2017, a meta-analysis was performed in patients with retear after SR and DR techniques [10]. The present meta-analysis focused not only on SR and DR, but also on the SB technique, updating the clinical data. Consequently, our data showed that irrespective of the operative procedure, patients with postoperative retear had relatively low functional outcomes, including Constant score, UCLA score, ASES score, ROM (flexion/abduction/external rotation), strength (flexion/abduction/external rotation), and high pain score (VAS) compared to those with intact tendon after surgery.

Similarly, a previous systematic review showed a significantly lower Constant score, ASES score, and UCLA score in patients with retear [10]. Thus, our results are consistent with previous results on functional scores in patients with retear. When analyzed by repair type, a previous review reported a significantly lower Constant/UCLA scores in the SR retear group and a significantly lower Constant/ASES/UCLA scores in the DR retear group [10]. The ASES score in the SR group was not analyzed due to a lack of studies, and the functional score in the SB group was not evaluated. By updating and analyzing the target studies, we showed that the Constant/ASES/UCLA scores was significantly and consistently lower regardless of the repair type.

In a previous review, the pain score was not significantly different between the retear and intact groups, while our results showed that the retear group had significantly higher pain than the intact group [10]. In a previous study, pain level was analyzed by combining VAS (0–10 points) and modified pain score with the Constant score (original “1 to 15” was converted to “0 to 10” points), while the present study focused on analyzing VAS (0–10 points), which may have contributed to different results between the two studies. In a previous study, the pain score in the retear group was significantly higher in the DR group, but not in the SR group. In the present review, there were no significant differences between the retear and intact groups in each group; the analysis was not evaluated in the DR group due to the lack of information. Thus, the outcome difference between the total and each group may have been affected by the sample size included in the analysis. However, the pain scores of the retear group in SR and SB group tended to be

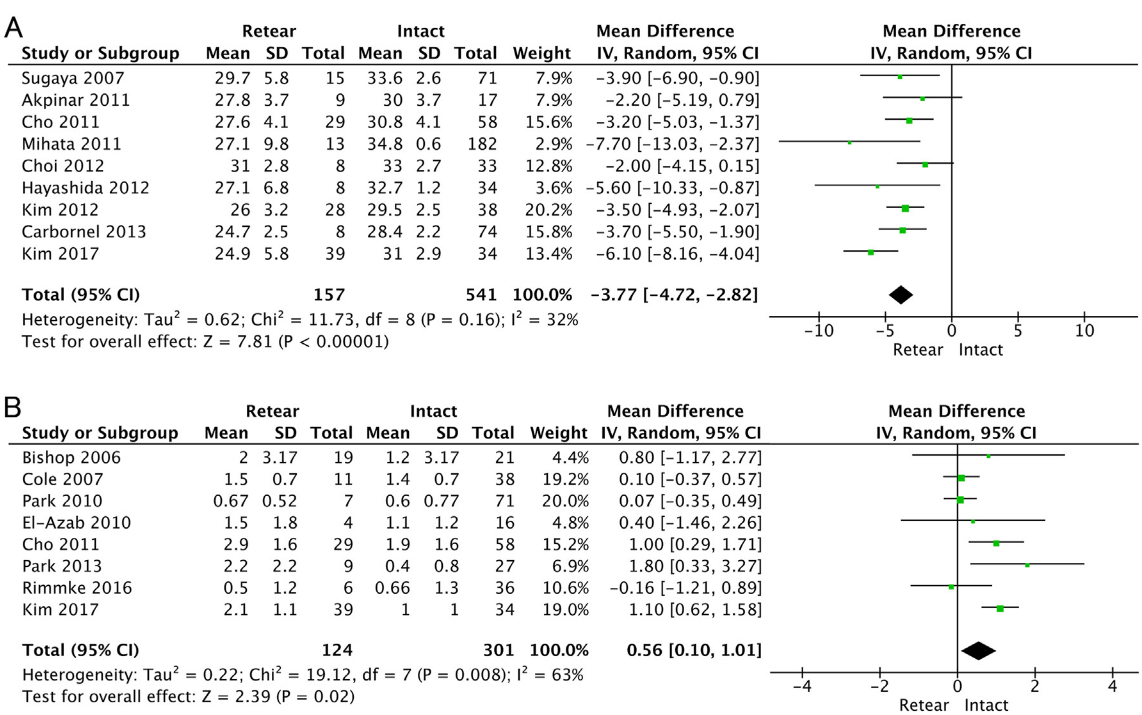

Fig. 4. Forest plots of UCLA score and Pain score (VAS). (A) Mean difference and 95% CIs of UCLA score. (B) Mean difference and 95% CIs of Pain score (VAS).

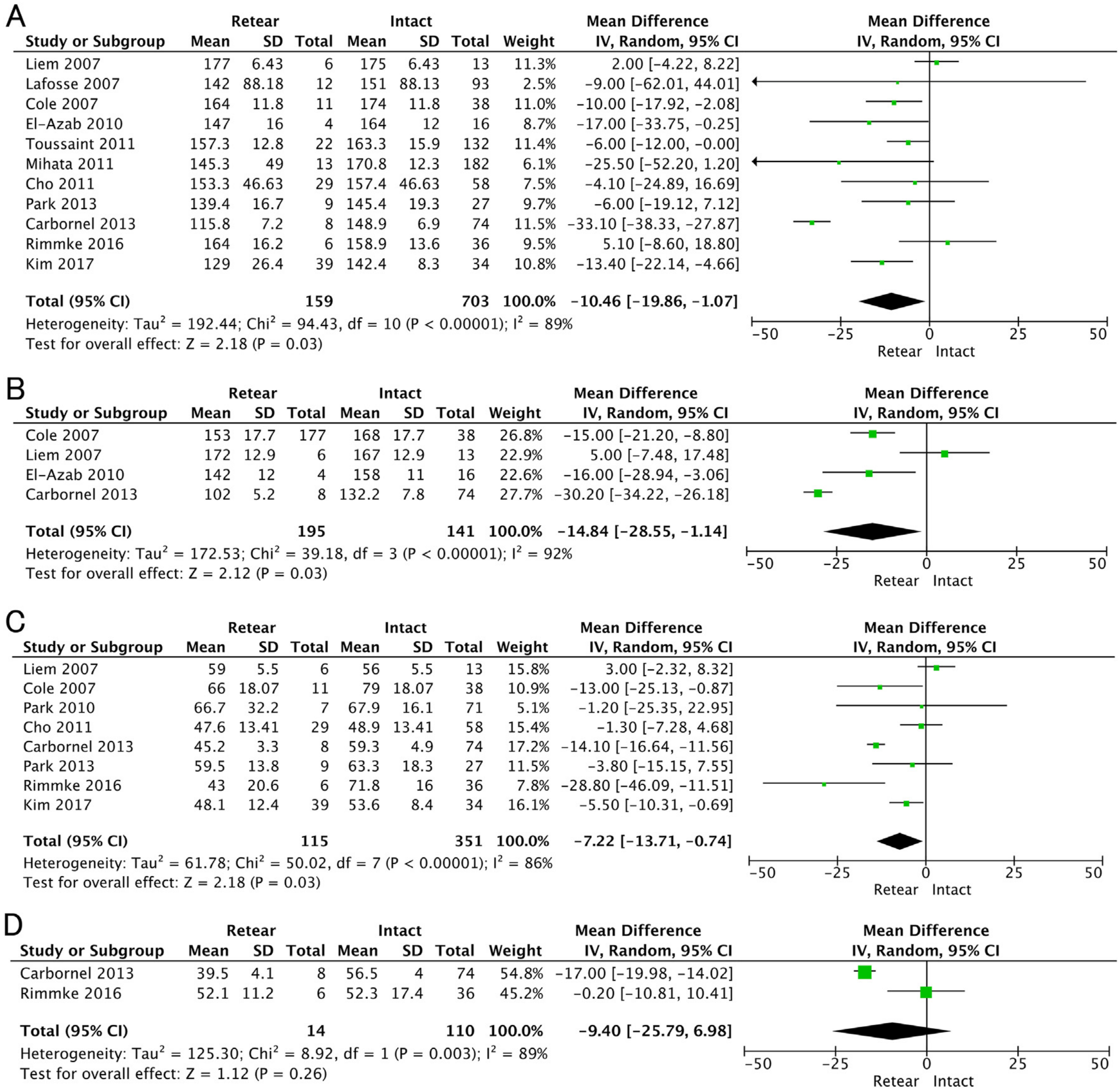

Fig. 5. Forest plots of ROM. (A) Mean difference and 95% CIs of flexion. (B) Mean difference and 95% CIs of abduction. (C) Mean difference and 95% CIs of external rotation. (D) Mean difference and 95% CIs of internal rotation.

relatively high compared to the intact group. There seems to be a negative effect of retear on postoperative pain, but further research is needed to clarify these issues.

Regarding muscle strength, abduction strength was significantly lower in the retear group than in the intact group [10]. The present study demonstrated that strength of abduction, flexion, and external rotation significantly decreased after retear. For range of motion, flexion, abduction and external rotation were significantly decreased after retear, although internal rotation did not. The sample size tested for internal rotation was significantly smaller than those of flexion, abduction and external rotation and may have affected the results. Therefore, these results suggest that retear affects muscle strength and range of motion.

Consistent with the systematic review by Yang et al. [10], the present review showed that the patients with retear in SR, DR, and SB group had significantly lower functional outcomes than those with intact tendon in these groups. On the other hand, in a systematic review by Rush et al., retear rate in the DR group was significantly lower than in the SR group, although there was no significant difference of functional outcomes between two groups [32]. Our previous study investigated clinical outcome of patients with large to massive rotator cuff tears who had retear after ARCR. As a result, the functional outcomes in these patients were significantly worsened when the retear propagated over the middle facet at the greater tuberosity [33]. Similar results were also observed in patients with retear after arthroscopic partial repair [34]. Study design and paper selection in our review were similar to those in review by Yang et al. [10], but not to those in review by Rush et al. [32]. Taken together, the number of patients with increased tear propagation in review by Rush et al. may have been different from those in reviews by Yang et al. and the present study, consequently leading to the different outcomes between these reviews.

Weak points of the present study were as follows. First, we analyzed lower-evidence-level studies (level 3 or 4) since we failed to find high-evidence-level studies (level 1 or 2). Second, the present study included a variety of repair types and tear sizes. Additional analysis on repair type was performed, but not on the tear size because of the lack of information. These factors may have

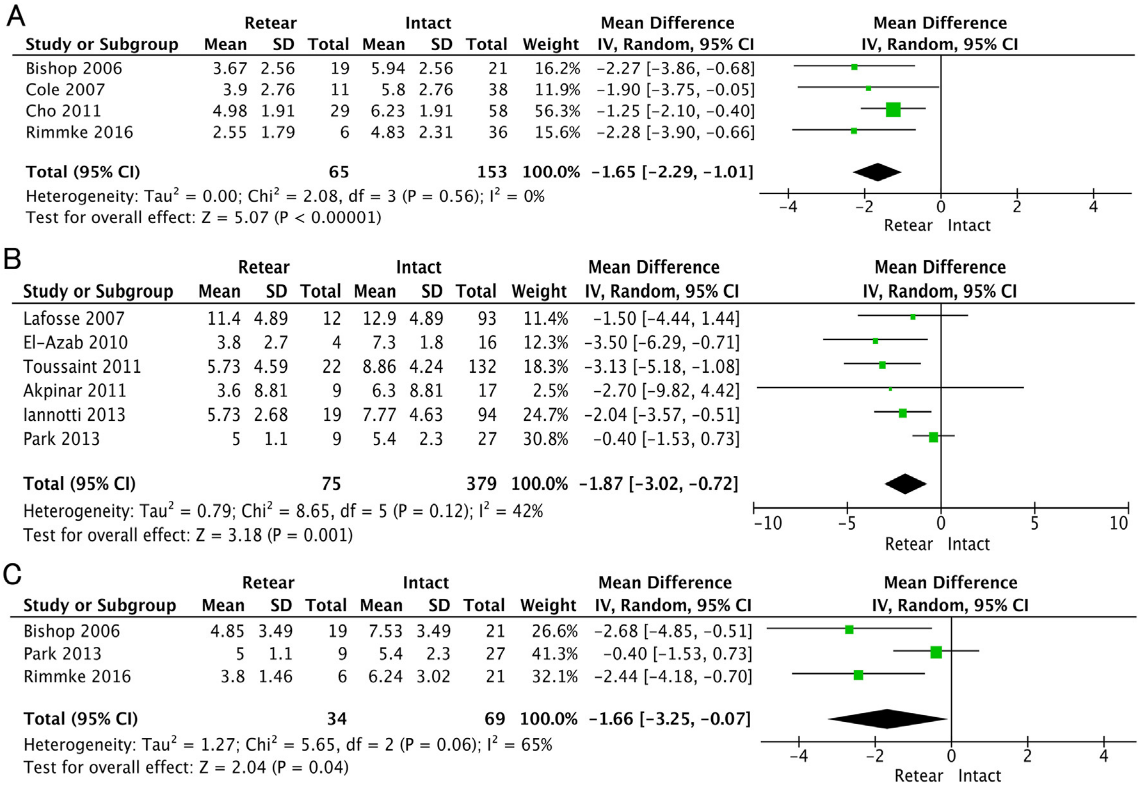

Fig. 6. Forest plots of muscle strength (kg·f). (A) Mean difference and 95% CIs of flexion. (B) Mean difference and 95% CIs of abduction. (C) Mean difference and 95% CIs of external rotation.

contributed to the observed heterogeneity in our analysis. A strong point of this study was the utilization of the "random effects method" to standardize the observed heterogeneity as much as possible, adjusting bias between the individual studies evaluated.

In conclusion, our data showed that postoperative retear had significantly decreased functional scores, ROM (flexion/abduction/external rotation), muscle strength (flexion/abduction/external rotation), and increased degree of pain. Therefore, these results suggest that retear after ARCR leads to poorer clinical outcomes after ARCR.

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Declaration of competing interest

The authors declare that they have no conflict of interest.

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