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Comparative Outcomes of Early vs. Delayed Treatment for Rotator Cuff Injuries - A Meta-Analysis Study

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ABSTRACT

Background: This meta-analysis evaluates clinical and structural outcomes of early versus delayed rotator cuff repair. Rotator cuff injuries commonly impair shoulder function, causing pain and disability. The study compares functional recovery, pain relief, and re-tear rates to determine optimal surgical timing, aiming to guide decision-making for improved patient outcomes and tendon healing.
Objective: To compare clinical outcomes between Early vs. Delayed Treatment for Rotator Cuff Injuries
Methods: A systematic search of PubMed, Embase, Google Scholar, and Cochrane Library (2010–2025) identified comparative studies on early versus delayed rotator cuff treatment in athletes. Inclusion criteria required direct comparison and at least one functional outcome. Data extraction and quality assessment used Review Manager 5.4 and the Cochrane Risk of Bias tool.
Results: Four studies met the inclusion criteria, comprising three cohort studies and one randomized controlled trial, totaling 190 patients. Pooled analysis showed no significant differences in Constant Score, Oxford Shoulder Score, OA AC joint changes, or retear rates. However, UCLA Scores significantly favored early treatment, suggesting potential functional benefits with earlier intervention.
Conclusion: Early rotator cuff repair may improve shoulder function and reduce retears, though Constant and Oxford scores show no differences. Further high-quality randomized trials are required to confirm optimal surgical timing.

Keywords: Rotator cuff repair, Early treatment, delayed treatment, Functional outcomes

INTRODUCTION

Rotator cuff injuries are among the most common causes of shoulder pain and dysfunction, frequently affecting individuals engaged in repetitive overhead activities or experiencing age-related tendon degeneration. These injuries can significantly impair shoulder function, leading to decreased range of motion, weakness, and diminished quality of life.(1) Management of rotator cuff tears often involves surgical repair, especially in cases of full-thickness tears or persistent symptoms despite conservative treatment. However, the optimal timing of surgical

intervention—whether early after diagnosis or delayed following a trial of non-operative management—remains a subject of ongoing debate.(2)

Early surgical repair has been associated with potential advantages, including reduced tendon retraction, prevention of muscle atrophy, and improved healing potential due to better tendon quality.(3) In contrast, delayed surgery allows for a period of rehabilitation and symptom resolution, potentially avoiding unnecessary procedures in patients who respond to conservative measures. However, postponing surgery may result in larger tear size, fatty infiltration, and less favorable postoperative outcomes. Given these contrasting perspectives, a comprehensive evaluation of the timing of surgical intervention is essential for optimizing patient outcomes.(4)

Previous studies have reported conflicting findings regarding functional recovery, pain relief, and re-tear rates between early and delayed rotator cuff repair.(5) Meta-analyses and systematic reviews provide an opportunity to synthesize current evidence and guide clinical decision-making based on pooled outcomes. Therefore, this meta-analysis aims to compare the clinical and structural outcomes of early versus delayed treatment for rotator cuff injuries, with the goal of identifying the optimal timing for surgical intervention to achieve the best functional and anatomical results.

MATERIALS AND METHODS

A comprehensive literature search was performed across four major electronic databases PubMed, Embase, Google Scholar, and the Cochrane Library to identify relevant studies published between January 2010 and June 2025. The primary objective of this meta-analysis was to evaluate and compare the clinical outcomes of early versus delayed treatment for rotator cuff injuries specifically in the athletic population. The search aimed to collect comparative clinical studies assessing functional recovery, complication profiles, and long-term shoulder function following different timing strategies for surgical or non-surgical management.

A structured search strategy was designed using the following Boolean keyword string:

((“rotator cuff tear” OR “rotator cuff injury”) AND (“early repair” OR “early treatment”) AND (“delayed repair” OR “delayed treatment”)

Inclusion criteria were as follows:

1. Original peer-reviewed clinical research articles.
2. Studies directly comparing early and delayed treatment for rotator cuff injuries in athletes.
3. Studies reporting at least one functional outcome measure (e.g., Constant score, ASES score, strength recovery, or return-to-sport rate).
4. Full-text availability in English.

Exclusion criteria included:

1. Studies involving non-comparative interventions or populations other than athletes.
2. Research focusing exclusively on degenerative or chronic non-traumatic tears unrelated to sports activity.
3. Case reports, review articles, letters, conference abstracts, technical notes, or animal studies.
4. Articles not published in English.

All identified titles and abstracts were screened for relevance based on the inclusion and exclusion criteria. Full-text articles of potentially eligible studies were retrieved for detailed evaluation. In cases where multiple publications originated from the same study cohort, the most comprehensive or most recent report was included to avoid duplication.

This systematic approach ensured that the meta-analysis synthesized high-quality comparative evidence to determine whether early intervention for rotator cuff injuries in athletes leads to superior outcomes compared to delayed treatment.

Methodological Quality Assessment

For the methodological quality assessment, the Review Manager Software Version 5.4 was used. Two authors independently performed the assessment. The Cochrane Risk of Bias (RoB) tool evaluates the selected studies based on five specific domains: selection bias (random sequence generation and allocation concealment), performance bias, detection bias, attrition bias, and reporting bias, shown in figure 2.

PICO Criteria

Population (P): Individuals diagnosed with rotator cuff injuries requiring treatment.

Intervention (I): Early treatment, defined as surgical repair or structured rehabilitation initiated within the acute/subacute period after injury (e.g., ≤3 months).

Comparison (C): Delayed treatment, defined as surgical repair or rehabilitation initiated after a prolonged interval from injury (e.g., >3 months).

Outcome (O): Functional outcomes (Constant score, UCLA score), strength recovery, patient-reported outcome measures, and complication or re-tear rates.

RESULTS

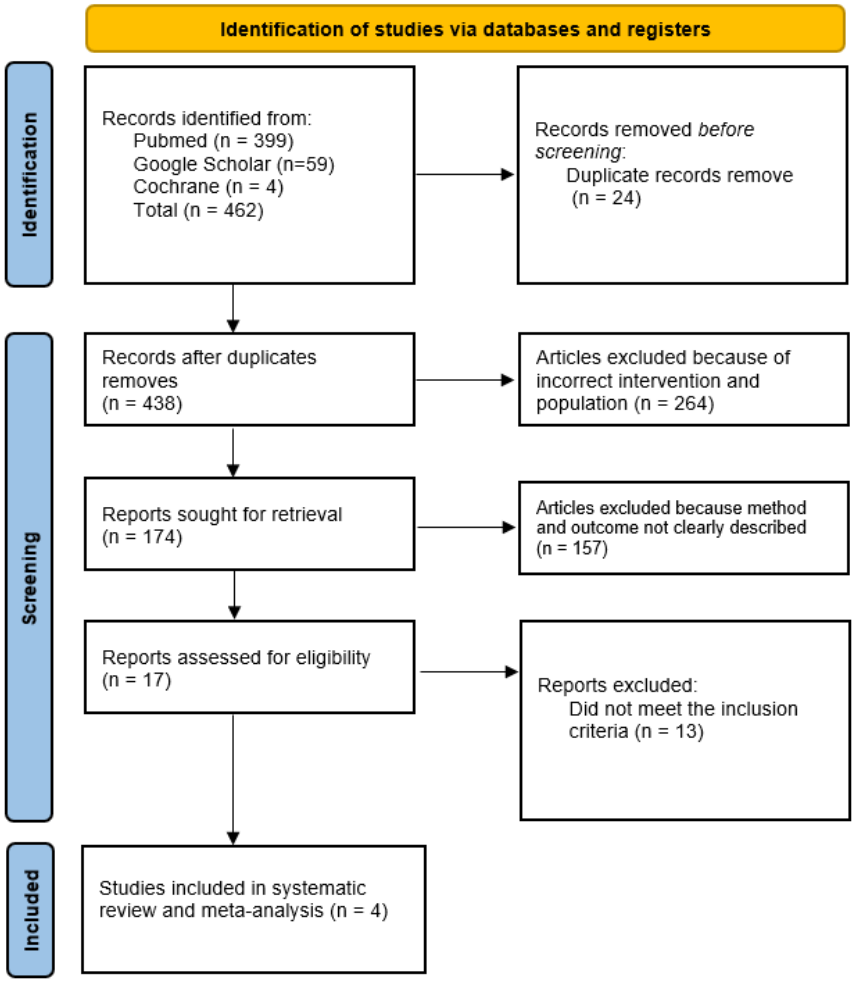

Figure 1. PRISMA Flow Chart

An initial search across three major databases—PubMed (n = 399), Google Scholar (n = 59), and the Cochrane Library (n = 4)—identified a total of 462 records. After removing 24 duplicate entries, 438 articles remained for screening. During the title and abstract screening, 264 articles were excluded due to incorrect intervention or target population, leaving 174 articles for full-text assessment. Of these, 157 were excluded because the methods and outcomes were not clearly described.

Seventeen articles underwent eligibility assessment, of which 13 did not meet the inclusion criteria. Ultimately, 4 studies fulfilled all criteria and were included in the final systematic review and meta-analysis. Shown in Figure 1.

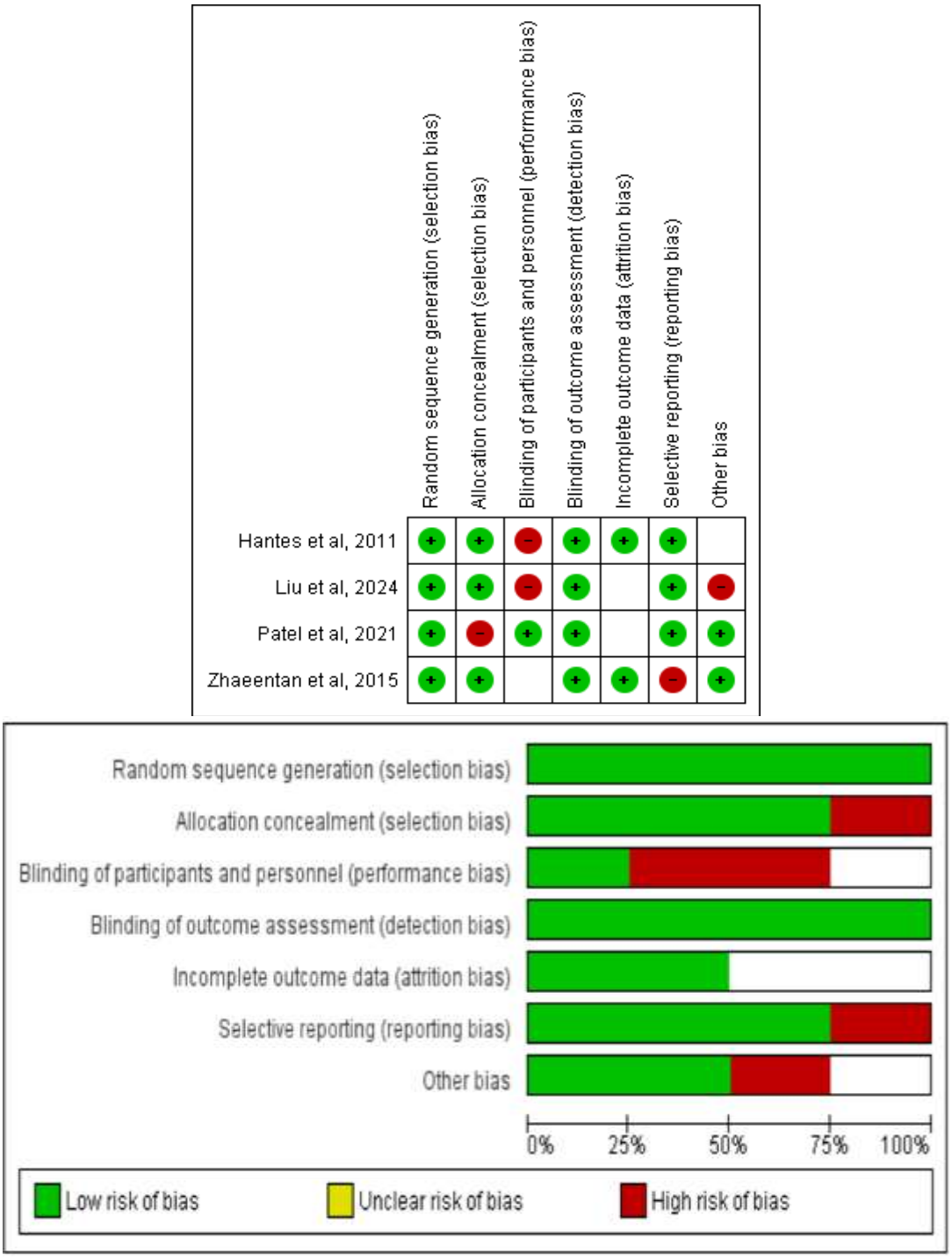

Figure 2. Risk of Bias Assessment

Table 1. Demographic Data of Included Study

No	Authors	Types of Study	Sample Size	Mean Age		Sex		Outcomes Recorded
				Early	Delayed	M	F	
1	Zhaeentan et al, 2015(6)	Cohort Prospective	75 Early=39 Delayed=36	59 (34–70)	59 (42–72)	58	17	- Constant Score - Oxford Shoulder Score - OA AC Joint - Retear
2	Patel et al, 2021(7)	Cohort Prospective	40 Early=20 Delayed=20	65(53–77)	65(53–77)	29	11	- Constant Score - Oxford Shoulder Score - Retear
3	Hantes et al, 2011(8)	RCT	35 Early=15 Delayed=20	54.2(28–68)	56.1(33–70)	21	14	- Constant Score - UCLA Score
4	Liu et al, 2024(9)	Cohort Retrospective	40 Early=22 Delayed=18	59.64±6.84	59.28 ± 4.99	20	20	- Constant Score - OA AC Joint - Retear - UCLA Score

Table 2. Clinical Outcomes of Included Study

No	Reference	Constant Score	OS Score	OA AC joint	Retear	UCLA Score
1	Zhaeentan et al, 2015(6)	Early: 68 (22) Delayed: 69 (22) *P* = n.a	Early: 41 (8) Delayed: 41 (8) *P* = n.a	Early: 32 Delayed: 28 *P* = n.a	Early: 6 Delayed: 8 *P* = n.a	-
2	Patel et al, 2021(7)	Early: 73 (18.25) Delayed: 73.5 (10.75) *P* > 0.05	Early: 43 (8.75) Delayed: 45 (4.25) *P* > 0.05	-	Early: 1 Delayed: 0 *P* = n.a	-
3	Hantes et al, 2011(8)	Early: 83 (8.75) Delayed: 76 (11.25) *P* = 0.0027	-	-	-	Early: 32 (1.25) Delayed: 27 (2.5) *P* =0.180
4	Liu et al, 2024(9)	Early: 81.73 ± 4.62 Delayed: 77.28 ± 4.71 *P* =0.005	-	Early: 2 Delayed: 3 *P* =0.642	Early: 1 Delayed: 6 *P* =0.033	Early: 31.14 ± 1.52 Delayed: 28.56 ± 2.25 *P* =0.001

Four studies were included in the meta-analysis, comprising three cohort studies (two prospective and one retrospective) and one randomized controlled trial (RCT). The study by Zhaeentan et al. (2015) was a prospective cohort study with a total of 75 patients, divided into early (n = 39) and delayed (n = 36) treatment groups. The mean age was 59 years in both groups, with a range of 34–70 years for the early group and 42–72 years for the delayed group. The study involved 58 males and 17 females, and outcomes measured included Constant Score, Oxford Shoulder Score, osteoarthritis of the acromioclavicular (AC) joint, and retear rate. Patel et al. (2021) conducted a prospective cohort study with 40 patients equally distributed between early (n = 20) and delayed (n = 20) treatment groups. The mean age was 65 years in both groups (range 53–77 years), with 29 males and 11 females. The outcomes assessed were Constant Score, Oxford Shoulder Score, and retear rate.

Hantes et al. (2011) performed a randomized controlled trial involving 35 patients, with 15 in the early group and 20 in the delayed group. The mean ages were 54.2 years (range 28–68) and 56.1 years (range 33–70) for the early and delayed groups, respectively. The study included 21 males and 14 females, with outcomes measured using the Constant Score and UCLA Score. Liu et al. (2024) carried out a retrospective cohort study with 40 patients, comprising 22 in the early group and 18 in the delayed group. The mean ages were 59.64 ± 6.84 years for the early group and 59.28 ± 4.99 years for the delayed group. The study population consisted of 20 males and 20 females. The outcomes evaluated included Constant Score, osteoarthritis of the AC joint, retear rate, and UCLA Score. Shown in Table 1.

The table summarizes the functional outcomes and complications of early versus delayed treatment for rotator cuff injuries. Zhaeentan et al. (2015) reported similar Constant Scores (early: 68 ± 22, delayed: 69 ± 22) and Oxford Shoulder Scores (early: 41 ± 8, delayed: 41 ± 8) between groups. Osteoarthritis of the AC joint occurred in 32 patients in the early group and 28 in the delayed group, while retears were observed in 6 early and 8 delayed cases. No p-values were provided. Patel et al. (2021) found comparable Constant Scores (early: 73 ± 18.25, delayed: 0.8 ± 10.75) and Oxford Shoulder Scores (early: 43 ± 8.75, delayed: 45 ± 4.25) with no significant differences (P > 0.05). Retears were rare, with 1 case in the early group and none in the delayed group.

Hantes et al. (2011) showed a significantly higher Constant Score in the early group (83 ± 8.75) compared to the delayed group (76 ± 11.25; P = 0.0027). The UCLA Score was also higher in the early group (32 ± 1.25) than in the delayed group (27 ± 2.5; P = 0.180). Liu et al. (2024) reported that the early group had significantly better Constant Scores (81.73 ± 4.62 vs. 77.28 ± 4.71; P = 0.005) and UCLA Scores (31.14 ± 1.52 vs. 28.56 ± 2.25; P = 0.001). Retears were less frequent in the early group (1 case) compared to the delayed group (6 cases; P = 0.033), while osteoarthritis of the AC joint was slightly more common in the delayed group (3 cases) than the early group (2 cases; P = 0.642).

Overall, studies by Hantes et al. and Liu et al. demonstrated significantly better functional outcomes with early treatment, while the other studies reported no significant differences. Shown in Table 2.

Constant Score

The pooled standardized mean difference (SMD) was 0.34 with a 95% confidence interval (CI) of −0.14 to 0.83, indicating no statistically significant difference between the early and delayed groups (Z = 1.39, P = 0.16). Among the included studies, Hantes et al. (2011) reported an SMD of 0.67 [−0.02, 1.36], Liu et al. (2024) reported 0.94 [0.28, 1.60], Patel et al. (2021) reported −0.03 [−0.65, 0.59], and Zhaeentan et al. (2015) reported −0.04 [−0.50, 0.41]. Heterogeneity was moderate (I^2 = 62%), suggesting variability among the studies. Overall, these findings suggest that there is

no significant difference in outcomes between early and delayed treatment. Illustrated in figure 3.

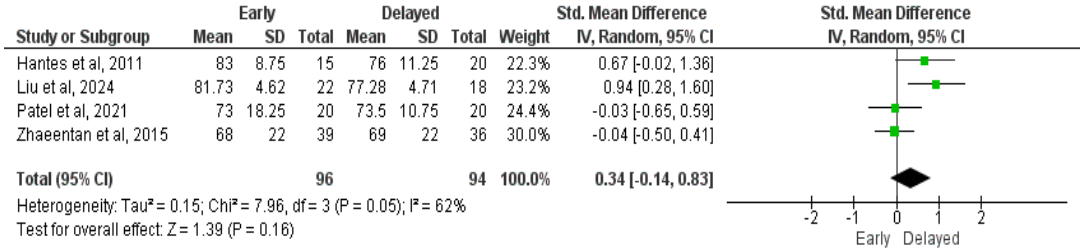

Figure 3. Analysis of Constant Score between two groups

Oxford Shoulder Score

The pooled standardized mean difference (SMD) was −0.10 with a 95% confidence interval (CI) of −0.46 to 0.27, indicating no statistically significant difference between the early and delayed groups (Z = 0.53, P = 0.60). Patel et al. (2021) reported an SMD of −0.28 [−0.91, 0.34], while Zhaeentan et al. (2015) reported an SMD of 0.00 [−0.45, 0.45]. Heterogeneity was very low (I^2 = 0%), suggesting minimal variability between the studies. Overall, these findings indicate that early and delayed treatments provide comparable outcomes without clear superiority of either approach. Illustrated in figure 4.

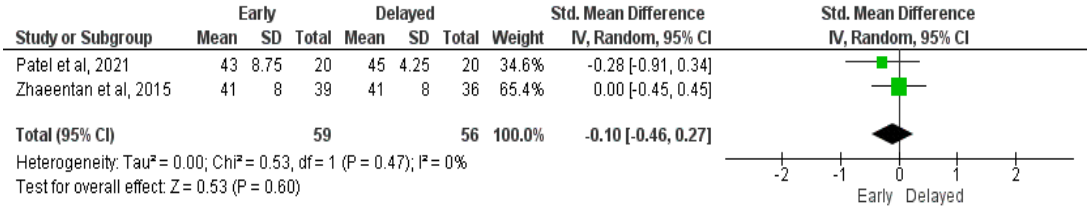

Figure 4. Analysis of Oxford Shoulder Score between two groups

OA AC Joint

The pooled odds ratio (OR) was 1.02 with a 95% confidence interval (CI) of 0.38 to 2.70, showing no statistically significant difference in event occurrence between the early and delayed groups (Z = 0.03, P = 0.97). Liu et al. (2024) reported an OR of 0.50 [0.07, 3.38], whereas Zhaeentan et al. (2015) reported an OR of 1.31 [0.42, 4.06]. Heterogeneity was very low (I^2 = 0%), indicating minimal variability between studies. Overall, these findings suggest that early and delayed treatments have comparable event rates without clear superiority of either approach. Illustrated in figure 5.

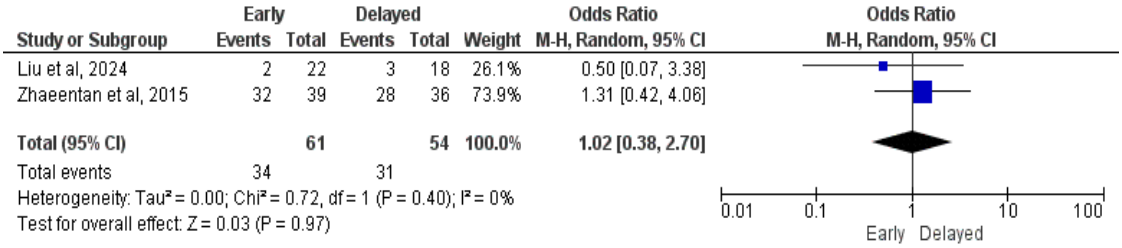

Figure 5. Analysis of OA AC Joint between two groups

Retear

The pooled odds ratio (OR) was 0.47 with a 95% confidence interval (CI) of 0.19 to 1.17, indicating no statistically significant difference in event occurrence between the early and delayed groups (Z = 1.62, P = 0.11). Liu et al. (2024) reported an OR of 0.10 [0.01, 0.89], Patel et al. (2021) reported

3.15 [0.12, 82.16], and Zhaeentan et al. (2015) reported 0.64 [0.20, 2.05]. Heterogeneity was moderate (I^2 = 43%), suggesting some variability between studies. Overall, these findings indicate that early treatment may show a trend toward fewer events, but the difference was not statistically significant. Illustrated in figure 6.

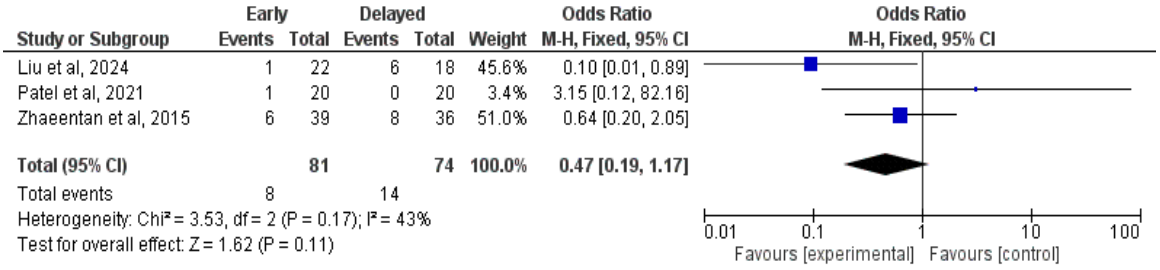

Figure 6. Analysis of Retear Event between two groups

UCLA Score

The pooled standardized mean difference (SMD) was −1.82 with a 95% confidence interval (CI) of −2.82 to −0.82, indicating a statistically significant difference favoring early treatment (Z = 3.56, P = 0.0004). Hantes et al. (2011) reported an SMD of −2.37 [−3.26, −1.48], and Liu et al. (2024) reported an SMD of −1.34 [−2.04, −0.65]. Heterogeneity was moderate to high (I^2 = 68%), suggesting some variability between studies. Overall, these findings demonstrate that early treatment was associated with significantly better outcomes compared to delayed treatment. Illustrated in figure 7.

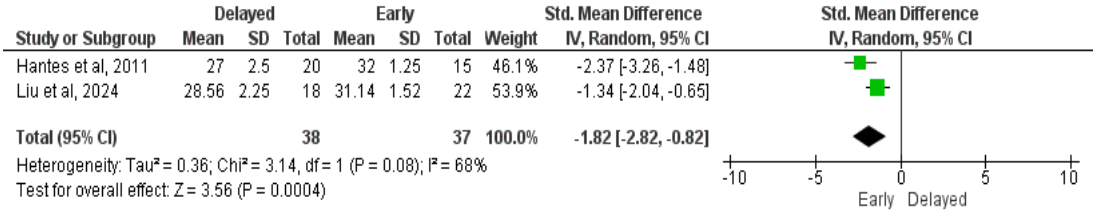

Figure 7. Analysis of UCLA Score between two groups

DISCUSSION

The findings from this meta-analysis provide valuable insights into the overall efficacy of early intervention for rotator cuff injuries. The Constant Score, a widely accepted measure of shoulder function, did not reveal a statistically significant difference between early and delayed treatment groups (SMD = 0.34, 95% CI: −0.14 to 0.83, P = 0.16). This divergence, coupled with moderate heterogeneity (I^2 = 62%), suggests that patient-specific factors and study designs might contribute to the variation in results. Similarly, the Oxford Shoulder Score, another validated measure of shoulder-specific function, showed no significant difference between early and delayed treatments (SMD = −0.10, 95% CI: −0.46 to 0.27, P = 0.60), supported by low heterogeneity (I^2 = 0%) and consistent findings across studies, suggesting that patient-perceived improvements in function and pain may be similar regardless of intervention timing. Regarding postoperative complications, the analysis of acromioclavicular (AC) joint osteoarthritis showed no significant difference in event rates (OR = 1.02, 95% CI: 0.38–2.70, P = 0.97) and minimal heterogeneity (I^2 = 0%), indicating that surgical timing does not appear to influence the development of this condition. Retear rate, a potentially more critical clinical outcome, trended lower in the early treatment groups but did not reach statistical significance (OR = 0.47, 95% CI: 0.19–1.17, P = 0.11). Moderate

heterogeneity (I^2 = 43%) further suggests that surgical technique, patient compliance, and follow-up length may impact this variability. Notably, the UCLA Score, which assesses broader aspects of shoulder function including pain and satisfaction, showed a significant pooled benefit in favor of early treatment (SMD = −1.82, 95% CI: −2.82 to −0.82, P = 0.0004). Although heterogeneity was moderate to high (I^2 = 68%), the consistent advantage observed in these studies reinforces the clinical relevance of early intervention.

A large-scale study by Sugaya et al. (2025) evaluated real-world data from a Japanese claims database and demonstrated that delayed rotator cuff repair (RCR) was associated with prolonged rehabilitation, increased healthcare costs, and lower short-term functional recovery compared to early repair. The authors emphasized that early surgical treatment reduced long-term morbidity and improved overall clinical and economic outcomes.(10) Similarly, Greif et al. (2024) found that delays in surgical management of full-thickness rotator cuff tears, particularly those confirmed via ultrasound or MRI, led to greater tendon retraction and fatty degeneration—factors known to impair postoperative recovery and increase retear risk. Their findings strongly support prompt surgical intervention to preserve muscle integrity and improve patient outcomes.(11)

Contrastingly, a number of studies report no significant benefit to early treatment and argue for the efficacy of delayed or even conservative management in select patients. Martinez-Catalan et al. (2025) examined the outcomes of delayed arthroscopic repair in patients with massive traumatic rotator cuff tears and found that even with delayed intervention, patients experienced satisfactory functional outcomes and quality of life. The study concluded that delayed repair remains a valid approach in well-selected patients and should not be automatically disqualified in favor of early surgery.(12) Lathiere et al. (2025) conducted a health economic review and found no consistent cost-effectiveness advantage of early surgery over non-operative treatment for non-traumatic musculoskeletal shoulder disorders, including rotator cuff-related pain. This calls into question the generalizability of early surgery benefits, particularly in non-acute cases.(13)

Overall, while early treatment appears to provide superior outcomes in comprehensive measures like the UCLA Score, differences in Constant Score, Oxford Score, retear rate, and AC joint osteoarthritis were largely non-significant, implying that delayed treatment may still be a viable option for many patients. These results underscore the need to consider patient-specific factors, surgical methods, and rehabilitation protocols when determining treatment timing, and they highlight the importance of future randomized controlled trials with standardized outcomes and long-term follow-up to guide definitive clinical recommendations.

Clinical Implications

The overall results indicate that early repair of rotator cuff injuries may lead to improved functional outcomes, particularly in UCLA Scores, and potentially lower retear rates. However, the lack of significant differences in Constant and Oxford Shoulder Scores suggests that some functional measures may not be sensitive enough to detect benefits of early intervention. The variability in study designs, sample sizes, and surgical techniques contributes to heterogeneity, underscoring the need for larger randomized controlled trials with standardized outcome reporting.

From a clinical standpoint, early surgical repair may be advantageous in selected patients—especially younger individuals or those with acute traumatic tears—given the trend toward improved function and lower retear risk. For older patients or those with degenerative tears, delayed repair may still provide comparable functional outcomes,

particularly when preoperative rehabilitation is optimized.

LIMITATIONS

The primary limitations of this review include the small number of available studies, heterogeneous study designs, and limited reporting of p-values and standardized outcome measures. Furthermore, most studies were cohort-based, with only one randomized trial included. The moderate heterogeneity observed in Constant and UCLA Scores highlights differences in surgical technique, timing of intervention, and rehabilitation protocols.

CONCLUSION

This meta-analysis suggests that early treatment of rotator cuff injuries may offer advantages in overall shoulder function, as evidenced by higher UCLA Scores, and may reduce the risk of retears. However, Constant and Oxford Shoulder Scores showed no significant differences between early and delayed treatment. While the evidence leans toward favoring early repair, further high-quality randomized controlled trials are necessary to confirm these findings and establish optimal timing for surgical intervention.

Declaration by Authors

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