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ORIGINAL RESEARCH ARTICLE

Long-term effectiveness of conservative management for lateral epicondylitis: a meta-analysis

Qiaojie Chen[a], Pingping Shen[b], Bo Zhang[a], Yang Chen[a], Chunli Zheng[c]

[a]Department of Orthopedics, Ningbo No.2 Hospital, Ningbo, China; [b]Department of Gastroenterology, Ningbo Yinzhou No.2 Hospital, Ningbo, China; [c]Department of TCM Rehabilitation, Ningbo No.2 Hospital, Ningbo, China

ABSTRACT

Objective: To investigate the long-term (>12 months) effectiveness of conservative management for lateral epicondylitis.
Data Sources: PubMed and Embase databases were searched for relevant studies from inception to March 2023.
Study Selection and Data Extraction: Only English-written randomized controlled trial (RCT) with data download as well as follow up ≥12 months were acceptable. Raw data were extracted into a predefined worksheet, and quality analysis was conducted based on the Cochrane risk-of-bias tool version 2 (RoB2).
Data Synthesis: The standardized mean difference (SMD) with 95% confidence interval (CI) were calculated.
Results: Extracorporeal shock wave therapy (ESWT) could significantly relive pain for lateral epicondylitis patients in the long term (SMD: –0.19, 95% CI [–0.36, –0.02]); however, there was no significant difference between ESWT and control groups in long-term function outcome (SMD: 0.24, 95% CI [–0.02, –0.49]). No significant difference could be observed between (1) exercise and control groups in pain (SMD: –0.21, 95% CI [–0.60, 0.18]) or function (SMD: 0.06, 95% CI [–0.11, 0.23]), (2) corticosteroids and placebo groups in pain (SMD: 0.70, 95% CI [–0.43, 1.82]) or function (SMD: –0.02, 95% CI [–0.36, 0.31]), and (3) platelet-rich plasma (PRP) in pain (SMD: –0.30, 95% CI [–0.85, 0.25]) and function (SMD: –0.08, 95% CI [–0.78, 0.62]).
Conclusion: The present conventional conservative management for lateral epicondylitis, with the exception of ESWT, a lack adequate evidence supporting their long-term effectiveness.

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KEY WORDS
lateral epicondylitis; tennis elbow; conservative management; therapy; interventions; treatment.

Introduction

Lateral epicondylitis, a prevalent elbow injury, presents with pain and tenderness localized to the lateral epicondyle alongside grip weakness and hindrance of forearm rotation [1]. It affects 1% of the adult population globally, with highest incidence observed between ages 35 and 55. The disorder is colloquially referred to as 'tennis elbow' because it displays a higher incidence rate of 40–50% among tennis players over the course of their lifetime [2].

Lateral epicondylitis was first labeled as 'tendinitis'; however, histopathological studies have revealed no discernable signs of acute or chronic inflammation in surgical pathology specimens collected from primary lateral epicondylitis patients. Current theories attribute lateral epicondylitis to 'tendinosis' resulting from repetitive microtrauma to the origin of both the extensor carpi radialis brevis (ECRB) and the extensor digitorum communis (EDC) [3, 4].

Conservative management typically involves therapies that do not require invasive procedures or the removal of tissue. Conservative interventions such as extracorporeal shock wave therapy (ESWT), exercise-based physiotherapy, and corticosteroid injections have emerged as first-line treatment options for lateral epicondylitis, providing symptomatic relief and improving function in the short term (<12 months) compared with placebo or no intervention [5–7]. However, there is limited evidence regarding the long-term (≥12 months) effectiveness of these non-surgical therapies beyond the timeframe. Moreover, 80% cases of lateral epicondylitis resolve spontaneously within 6–12 months, whereas a substantial proportion of patients remain symptomatic and experience functional limitations beyond this timeframe [8]. This suggests that short-term symptom relief may not necessarily translate to sustained improvements in pain, function, and quality of life. In essence, the extent to which conservative interventions contribute to the long-term resolution of symptoms remains unclear.

Therefore, our study aims to conduct a meta-analysis of existing literature to evaluate the long-term efficacy of conservative interventions for lateral epicondylitis. By synthesizing data from high-quality randomized controlled trials (RCTs), we aim to provide clinicians and patients with a comprehensive understanding of conservative management for lateral epicondylitis, enabling them to make informed decisions about their care.

Methodology

Search strategy

A systematic literature search was conducted in March 2023, including PubMed and Embase databases. The explicit search strategies were presented in Table 1. The references included in these candidate

CONTACT Qiaojie Chen francisqiaojie@163.com Department of Orthopedics, Ningbo No.2 Hospital, Ningbo, China, No. 41 Xibei Rd, Haishu District, Ningbo 315000, China. Tel: 86-13516889636.

Table 1. Search Strategy for PubMed and Embase.

PubMed	
#1	'conservative management' [Mesh] OR conservative management *[tiab] OR therapy*[tiab] OR intervention*[tiab] OR treatment *[tiab]
#2	'Tennis Elbow' [Mesh] OR lateral epicondylitis*[tiab] OR tennis elbow*[tiab] OR elbow injury*[tiab] OR 'elbow tendinopathy*[tiab]
#4	#1 AND #2
Embase	
#1	'conservative management'/exp OR 'conservative management*':ab,ti OR 'therapy*':ab,ti OR 'intervention*':ab,ti OR 'treatment*':ab,ti
#2	'tennis elbow'/exp OR ‚tennis elbow*':ab,ti OR ‚lateral epicondylitis*':ab,ti OR ‚elbow injur*':ab,ti OR ‚elbow tendinopathy*':ab,ti OR ‚elbow joint*':ab,ti
#4	#1 AND #2

studies were also manually searched to supplement access to relevant literature.

Inclusion and exclusion criteria

Two authors/reviewers (Q.C. & P.S.) independently performed the screening and assessed the eligibility of candidate studies. Any discrepancies were resolved by a consensus discussion, with inclusion of a third party (C.Z.) if necessary. We included RCTs that compared conservative management versus no active treatment or placebo control for treating lateral epicondylitis patients. The studies written in non-English languages or those that do not provide data download should also be excluded. A minimum follow-up period of 12 months was required. Only conservative treatments with at least three RCTs that fulfill the criteria described here were taken into consideration within the further meta-analysis.

Risk of bias assessment

Risk of bias assessment was performed by the Cochrane risk-of-bias tool version 2 (RoB2) and visualized by R package 'robvis' [9, 10]. RoB2 was specially designed for RCTs studies, and each domain in RoB2 was rigorously evaluated for its susceptibility to bias, resulting in categorization as low risk, some concerns, or high risk. The domains are as follows:

- Bias arising from the randomization process
- Bias due to deviations from intended interventions
- Bias due to missing outcome data
- Bias in measurement of the outcome
- Bias in selection of the reported result

Types of outcome measures

- Pain: Visual analogue scale (**VAS**), Likert scale, Nirschl Phase Rating Scale (**NPRS**), Roles Maudsley score (**RMS**)
- Function: Grip Strength (**GS**), Pain-free Grip Strength **(PFGS)**, Disabilities of the Arm, Shoulder, and Hand (**DASH**), Pain-Free Function Questionnaire (**PFFQ**), Roles Maudsley score (**RMS**)

Data analysis

Data for patient-reported pain and function was used R package 'meta' for statistical analysis [11]. The standardized mean difference (SMD) with 95% confidence interval (CI) was used as the effect analysis statistic for the measures. The magnitude of heterogeneity was also determined

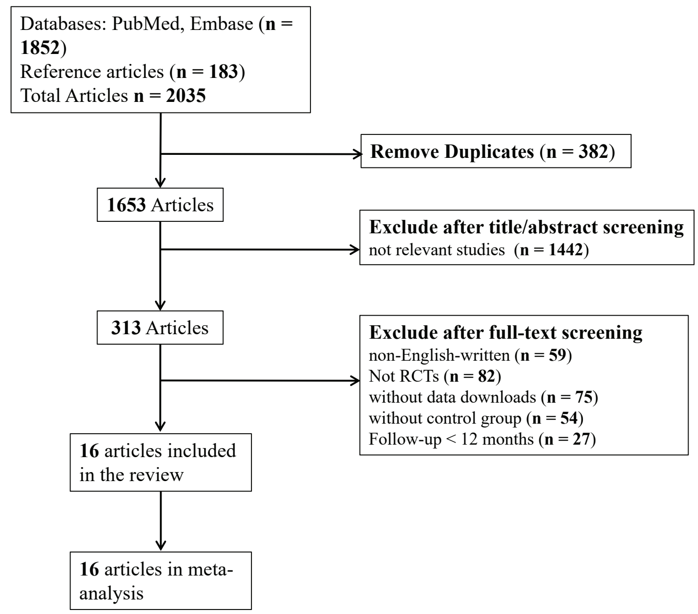

Figure 1. Flow diagram of search strategy and articles selection.

by combining I^2 quantification and Q statistic. If the I^2 value exceeded 50% or the Q-statistic *p*-value was less than 0.05, indicating significant heterogeneity among the included studies, the random effects model was considered to be more appropriate. Otherwise, the common effect model (also known as fixed effect model) was preferred.

Results

Search results

A total of 2035 papers were obtained for the initial review. After full-text assessment, 16 studies reached our retention criteria for further meta-analysis (Figure 1). Characteristics of all included studies were listed in Table 2.

Assessment of risk of bias

The result of 'risk of bias' assessment for 16 studies were presented in Figure 2. Most studies were evaluated as low or moderated risk of bias, and two studies were assessed to be high risk of bias in at least one domain.

It is worth noting that, the assessment of function outcome in some RCTs was in the form of patients' own ratings or questionnaires (DASH, PFFQ), leading to lower quality than other studies, so we have filled in the 'Bias in measurement of the outcome' domain of these studies as 'some concerns'.

Extracorporeal shock wave therapy

A total of five studies explored the long-term effectiveness of ESWT for lateral epicondylitis [7, 12–15]. All five RCTs provided VAS as pain outcome measure, and three RCTs provided GS as function outcome measure. ESWT could significantly relive pain for lateral epicondylitis patients in the long term (Figure 3a, SMD: −0.19, 95% CI [−0.36, −0.02], *p*-value = 0.03); however, there was no significant difference between ESWT and control groups in long-term function outcome (Figure 3b, SMD: 0.24, 95% CI [−0.02, −0.49], *p*-value = 0.07).

Table 2. Characteristics of 16 candidate studies.

Study	Year	Country	Follow-up (m)	Outcome	Treatment	Samples
Haake	2002	Germany	28	VAS	ESWT	105/101
Pettrone	2005	USA	12	VAS, GS	ESWT	56/58
Rompe	1996	Germany	12	VAS, GS	ESWT	38/40
Speed	2002	UK	16	VAS	ESWT	38/33
Staples	2008	Australia	16	VAS, GS	ESWT	36/32
Bisset	2006	Australia	12	VAS, PFFQ	Exercise	66/67
					CI	65/67
Luginbühl	2008	Switzerland	12	NPRS, PFGS	Exercise	10/10
McQueen	2020	USA	12	VAS, DASH	Exercise	21/38
Olaussen	2015	Norway	12	VAS, PFFQ	Exercise	58/60
Smidt	2002	Netherlands	12	Likert Scale, PFFQ	Exercise	64/59
					CI	62/59
Strujis	2004	Netherlands	12	Likert Scale, PFFQ	Exercise	51/61
Hay	1999	UK	12	Likert Scale, PFFQ	CI	52/56
Lindenhovius	2008	USA	12	VAS, DASH	CI	31/33
Linnanmäki	2020	Finland	12	VAS, DASH	PRP	40/39
Montalvan	2015	France	12	RMS	PRP	25/25
Peerbooms	2010	Netherlands	12	VAS, DASH	PRP	49/51

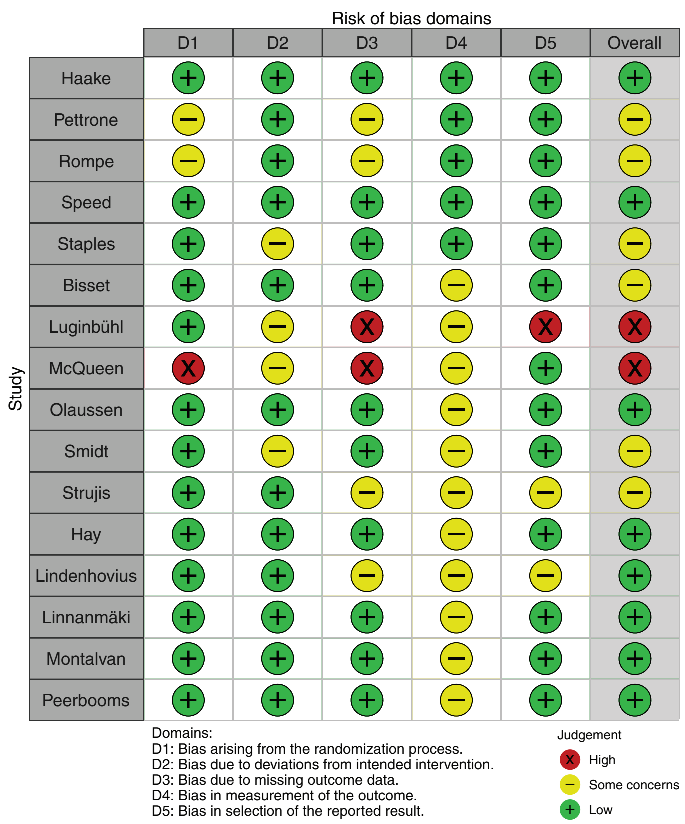

Figure 2. Risk of bias assessment of the selected 16 studies.

Exercise

A total of six studies explored the long-term effectiveness of exercise-based physiotherapy for lateral epicondylitis patients [16–21]. Three RCTs provided VAS, two RCTs provided Likert scale, and one RCT provided NPRS as pain outcome measure. We standardized these three indicators (VAS, Likert scale, NPRS) by converting them into a single indicator with values ranging from 0 to 10, considering their similar characteristics and higher values indicating greater pain intensity. Four RCTs provided PFFQ, one RCT provided DASH, and one RCT provided PFGS as function outcome measure. PFGS differs from the other two indicators in that higher values indicate better function recovery. Therefore, we had to exclude PFGS, resulting in only five RCTs included in the meta-analysis for function outcome.

Since I^2 = 80% and Q-statistic *p*-value < 0.001, we conducted random effect model for exercise-based physiotherapy pain outcome meta-analysis. There was no significant difference between exercise and control groups in long-term pain (Figure 3c, SMD: −0.21, 95% CI [−0.60, 0.18], *p*-value = 0.29) or function outcome (Figure 3d, SMD: 0.06, 95% CI [−0.11, 0.23], *p*-value = 0.49).

Corticosteroids injection (CI)

A total of four studies explored the long-term effectiveness of corticosteroids injection for lateral epicondylitis patients [5, 16, 20, 22]. Two RCTs provided VAS and two RCT provided Likert scale as pain outcome measure. Three RCTs provided PFFQ, one RCT provided DASH as function outcome measure. We adopted the same standardized approach as mentioned here.

Both pain (I^2 = 96% and Q-statistic *p*-value < 0.001) and function (I^2 = 67% and Q-statistic *p*-value = 0.03) outcome meta-analysis should be performed by random effect model. No significant difference could be observed between corticosteroids injection and placebo groups in long-term pain (Figure 4a, SMD: 0.70, 95% CI [−0.43, 1.82], *p*-value = 0.23) or function outcome (Figure 4b, SMD: −0.02, 95% CI [−0.36, 0.31], *p*-value = 0.90).

Platelet-rich plasma

A total of three studies explored the long-term effectiveness of platelet-rich plasma (PRP) therapy for lateral epicondylitis patients [23–25]. Two RCTs provided VAS and one RCT provided RMS as pain outcome measure. Two RCTs provided DASH and one RCT provided RMS as function outcome measure. We adopted the same standardized approach as mentioned here.

Both pain (I^2 = 67% and Q-statistic *p*-value = 0.03) and function (I^2 = 78% and Q-statistic *p*-value = 0.01) outcome meta-analysis should be performed by random effect model. No significant difference could be observed between PRP and placebo groups in long-term pain (Figure 4c, SMD: −0.30, 95% CI [−0.85, 0.25], *p*-value = 0.28) or function outcome (Figure 4d, SMD: −0.08, 95% CI [−0.78, 0.62], *p*-value = 0.81).

Discussion

ESWT, exercise, CI and PRP are widely used conservative management for lateral epicondylitis patients. Although a significant number

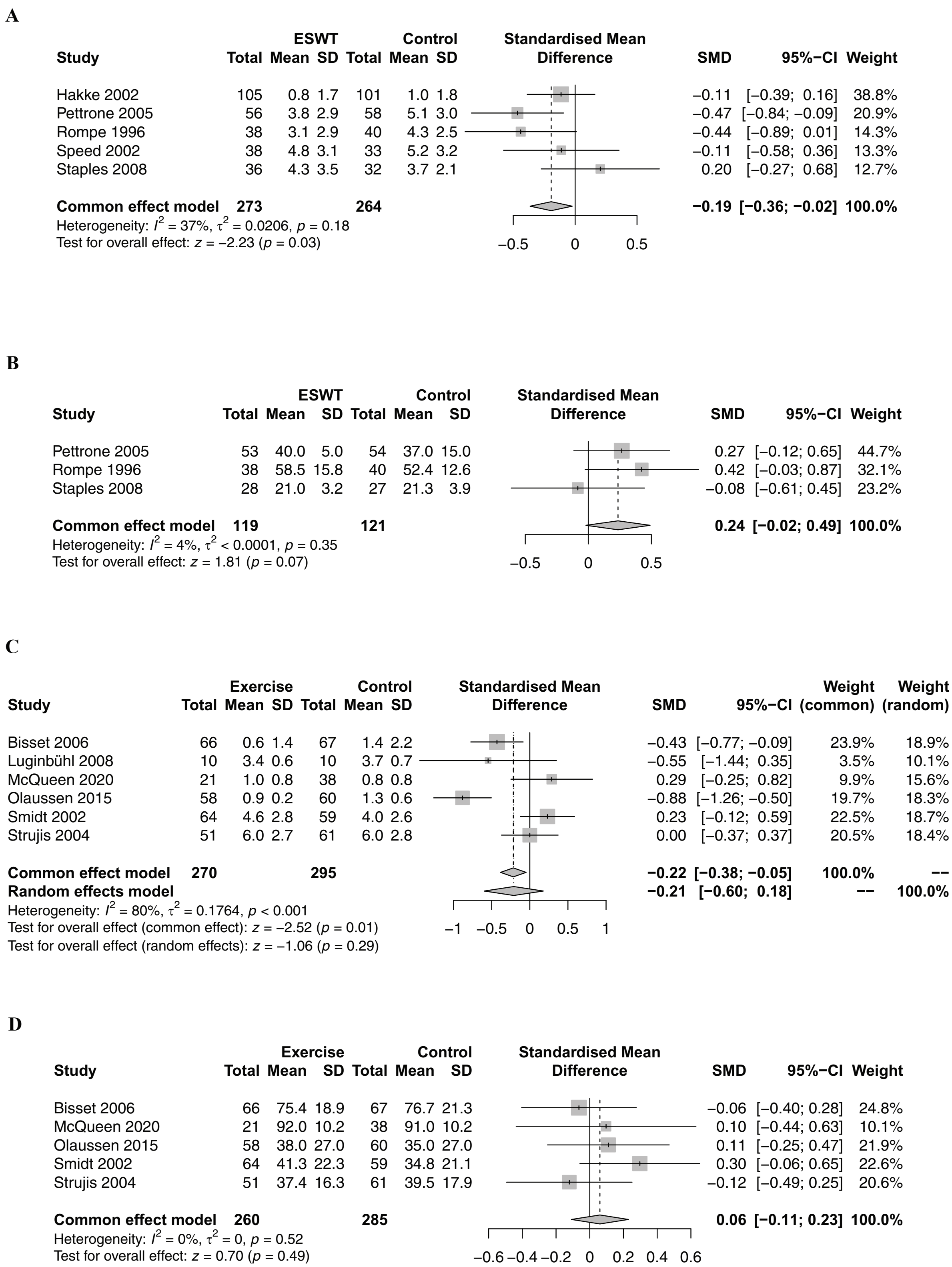

Figure 3. Forest plot for long-term effectiveness between (a) ESWT and control groups in pain outcome. (b) ESWT and control groups in function outcome. (c) exercise and control groups in pain outcome. (d) exercise and control groups in function outcome.

of researchers have investigated the efficacy of these conservative therapies and compared their advantages, their studies have only focused on short-term outcomes (<12 months) and neglected their long-term effectiveness [26–28].

Our meta-analysis including 16 RCTs measured the long-term efficacy of four conservative therapies – ESWT, exercise, CI and PRP – on lateral epicondylitis in terms of both pain and function outcome. In comparison to the control group, ESWT demonstrated a significant

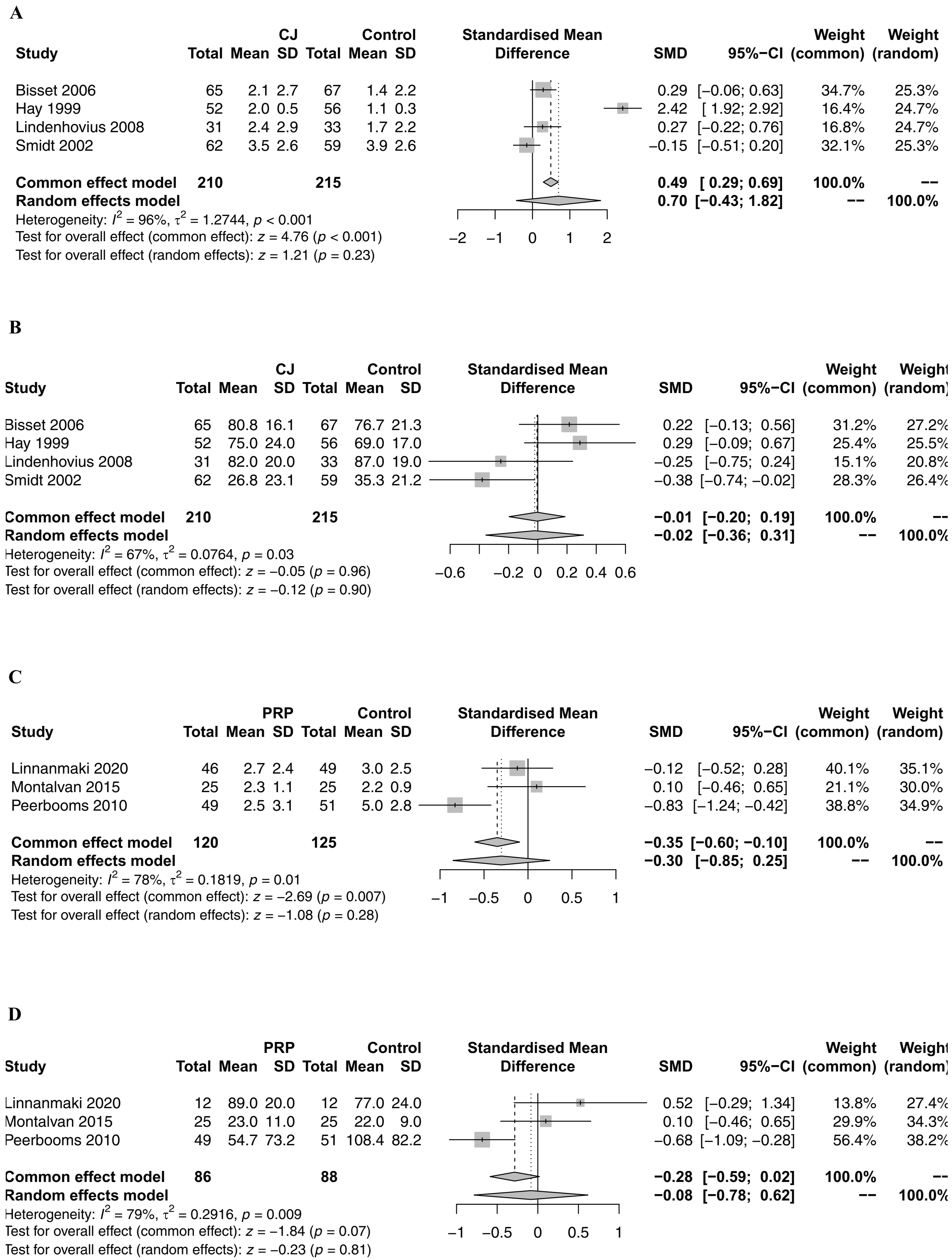

Figure 4. Forestplot for long-term effectiveness between (a) corticosteroids injection and control groups in pain outcome. (b) corticosteroids injection and control groups in function outcome. (c) PRP and control groups in pain outcome. (d) PRP and control groups in function outcome.

reduction in pain; however, it did not exhibit any significant enhancement in function outcome (grip strength). Our findings partially align with Yao's study. Yao demonstrated a significant positive impact of ESWT on both pain relief and function recovery. However, it is worth observing that their study have included more RCTs with a follow-up period of <12 months compared with our analysis, which only focused on RCTs with a follow-up duration ≥12 months [29].

Exercise-based physiotherapy failed to show any significant improvements in either pain relief or functional recovery. The finding contradicts the results of Kim's study, which indicates that physiotherapy can provide long-term benefits for individuals with tennis elbow. However, Kim's study lacks rigor in distinguishing between the different types of physiotherapy, as exercise is only one form of physiotherapy [30].

The long-term efficacy of two injectable therapies (corticosteroid injection, PRP) was not established in terms of pain and function. The administration of corticosteroid injections for treating lateral epicondylitis could be linked to the erroneous belief that it was a form of 'tendinitis'. However, surgical pathological evidence indicates that the underlying cause of lateral epicondylitis is repetitive microtrauma other than inflammation, which may explain why corticosteroid injections are ineffective in producing long-lasting outcomes [3, 4]. Historically, PRP is not considered to be superior to other conservative treatments. More recent studies have revealed that PRP could demonstrate notable long-term effectiveness in patients with genetic variants of PDGFB, which may help to elucidate the reasons behind such outcomes [31].

Based on our meta-analysis results, it appears that the currently available conventional non-surgical treatments for lateral epicondylitis, except for ESWT, lack sufficient evidence of long-term efficacy. Considering that most tennis elbow symptoms tend to resolve within 12 months without intervention, we recommend that medical practitioners and patients prioritize ESWT, and adopt a more cautious approach toward other conservative management.

Our study also has some limitations. The meta-analysis has a limited sample size due to the scarcity of studies with follow-up periods ≥12 months. Additionally, all the original data used in our analysis were derived from studies conducted in Western countries, and there is a paucity of data available from other regions. As mentioned in the 'risk of bias' section, a considerable number of studies utilized patients' self-reported ratings or questionnaires (e.g., DASH, PFFQ) to measure functional outcomes. The approach could potentially affect the quality of data in these studies and even influence the final conclusion.

Conclusion

The present conventional conservative management for lateral epicondylitis, with the exception of ESWT, lack adequate evidence supporting their long-term effectiveness. Both healthcare providers and patients should adopt a more cautious approach toward the implementation of conservative treatment for lateral epicondylitis.

Conflicts of interest

All authors declare that they have no conflicts of interest.

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