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Review

Effectiveness of Additional or Standalone Corticosteroid Injections Compared to Physical Therapist Interventions in Rotator Cuff Tendinopathy: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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ABSTRACT

Importance. Rotator cuff tendinopathy represents the most prevalent cause of shoulder pain, the third most common musculoskeletal disorder after low back pain and knee pain.

Objective. The objective of this study was to determine the effectiveness of corticosteroid injection(s), alone or in combination with anesthetic injection or any other physical therapist interventions, compared to physical therapist interventions alone in adults with rotator cuff tendinopathy.

Design. This study was a systematic review and meta-analysis of randomized controlled trials. PubMed, EMBASE, Cumulative Index to Nursing and Allied Health Literature, Cochrane Central Register of Controlled Trials, Scopus, Web of Science, and Physiotherapy Evidence Database were searched from inception to March 2023. Meta-analysis using a random-effects model was performed. Risk of bias and certainty of the evidence for the primary outcomes were assessed using the Cochrane risk-of-bias tool and the Grading of Recommendations, Assessment, Development and Evaluation approach, respectively. The protocol was registered in the International Prospective Register of Systematic Reviews (CRD42021240882).

Participants. Participants were adults with rotator cuff tendinopathy.

Interventions. Corticosteroid injection(s), alone or in combination with anesthetic injection or with any other physical therapist interventions, was compared to physical therapist interventions alone.

Main Outcomes. Pain, function, quality of life, patient-rated overall improvement, and adverse events were the main outcomes.

Results. Fifteen randomized controlled trials (1785 participants) met the inclusion criteria. At short term, corticosteroid injection coupled with physical therapist interventions and compared to the same interventions alone might have resulted in some small to moderate improvements in pain and function. Conversely, corticosteroid injection alone seemed not to be more effective than physical therapist interventions in improving pain and function in most of the studies included. At mid- and long-term follow-up assessments corticosteroid injection seemed not to be more effective than any physical therapist interventions.

Conclusions. This study highlights the potential effectiveness of corticosteroid injection(s) in rotator cuff tendinopathy for pain and function at short term at best, especially in combination with physical therapist interventions. However, the evidence is of moderate to mostly very low certainty. Additional high-quality research considering core outcomes, therefore, is needed.

Relevance. Corticosteroid injection(s) seems not to be superior to physical therapist interventions, other than resulting in some transient improvements at short term if provided together with other physical therapist interventions, in adults with rotator cuff tendinopathy. Furthermore, considering the potential adverse events associated with the injections, physical therapist interventions may be an important stand-alone treatment option.

Key words: Injections; Physical Therapy Modalities; Rehabilitation; Rotator Cuff; Shoulder; Shoulder Impingement Syndrome; Tendinopathy.

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INTRODUCTION

Shoulder pain is a prevalent and debilitating musculoskeletal condition, affecting 7.7 to 62 per 1000 new persons per year[1] and representing the third most common musculoskeletal disorder after low back and knee pain.[2] Rotator cuff tendinopathy, the most common cause of shoulder pain, is characterized by degenerative changes in the tendons of the rotator cuff in the argued absence of active inflammation,[3] even though it is still unclear whether inflammation plays a role in this clinical condition,[4] leading to pain, limited range of motion, and impaired functional capacity of the shoulder.[5,6] The condition can significantly affect the quality of life of affected individuals,[7] negatively influencing their ability to perform daily activities and engage in work-related tasks or recreational pursuits.[8] Because of the lack of diagnostic accuracy for rotator cuff tendinopathy, as well as the uncertainty as to the location of symptoms, symptomatic incidence and prevalence data currently cannot be determined with confidence.[5] This problem is also supported by the most recent Global Burden of Disease study, in which no specific global prevalence data are available for this musculoskeletal disorder, which is conversely categorized among "other musculoskeletal disorders."[9]

Numerous treatment modalities have been employed to manage rotator cuff tendinopathy. A recent systematic review of clinical practice guidelines for the management of rotator cuff disorders highlighted that clinical practice guidelines recommend active treatments (such as exercise), acetaminophen, nonsteroidal anti-inflammatory drugs, and corticosteroid injections.[10] Among these, corticosteroid injections, either through their anti-inflammatory effects or by reducing tenocyte numbers[11,12] (the proliferation of which has been associated with tendinopathy[13]), have been used to provide rapid pain relief,[14–16] whereas physical therapist interventions, such as exercise and manual therapies, aim to improve shoulder function and promote long-term recovery.[17]

Although both corticosteroid injections[16,18] and physical therapist interventions[19–22] have shown promising results, the optimal treatment approach remains uncertain. Moreover, potential risks and side-related effects associated with corticosteroid injections (eg, allergic reactions, pain in the area of injection, potential tendon degeneration, full-thickness tears, and rotator cuff repair revisions)[23–28] have raised concerns, leading to the exploration of alternative, nonpharmacological strategies for rotator cuff tendinopathy.

On the basis of these premises, the aim of this work was to summarize the existing evidence on the effectiveness of corticosteroid injections, alone or in combination with anesthetic injection or any other physical therapist interventions, compared to physical therapist interventions alone on pain, function, quality of life, patient-rated overall improvement, and adverse events in adults with rotator cuff tendinopathy.

METHODS

This is a systematic review with meta-analysis, reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[29] The protocol was registered in the International Prospective Register of Systematic Reviews (CRD42021240882).

Data Sources and Searches

The search strategies were defined by an author with experience in bibliographic searches (S.G.L.) (Suppl. Table 1). PubMed, EMBASE, the Cumulative Index to Nursing and Allied Health Literature, Cochrane Central Register of Controlled Trials, Scopus, Web of Science, and Physiotherapy Evidence Database were searched from inception to March 1, 2023. No date or language restrictions were applied to the search strategies. Furthermore, the reference lists of included studies were hand-searched to retrieve any additional relevant study. Duplicates were removed using EndNote (version 20.4.1; Clarivate Analytics Inc; Philadelphia, PA, USA) as described by Bramer et al.[30]

Study Selection

Study selection was performed by 2 independent reviewers (S.G.L., P.P.), blinded to each other's decision, using Rayyan.[31] Disagreements were solved through discussion and, if necessary, though the involvement of a third author (F.B.).

Type of Study

Considering the aim of this review was to assess the effectiveness and adverse events and we did not expect nonrandomized studies of intervention to provide additional information compared to randomized controlled trials (RCTs) alone, only RCTs were included. Pilot studies, protocols, secondary analysis, conference/meeting abstracts only, crossover studies and any other study design other than RCTs were excluded. Only English studies were assessed for eligibility because of the lack of funding for the translation process. When multiple reports (ie, any document providing relevant information about a particular study, including but not limited to protocols, conference abstracts and secondary analyses, as defined in the PRISMA 2020 guidelines)[29] of individual studies were found, all of them were considered separately and eventually merged after full text reading.

Population

We included studies involving adults (≥18 years old) with shoulder/rotator cuff tendinopathy. Because of the uncertainties around the diagnosis of this clinical condition,[5] we included studies describing the population as rotator cuff disease, rotator cuff-related shoulder pain, shoulder impingement syndrome, rotator cuff tendinitis or tendinopathy, subacromial bursitis, or partial rotator cuff tears.[32] Studies that did not match these terms were considered eligible if the population description was compatible with a clinical presentation of rotator cuff tendinopathy (ie, painful arc and pain with resisted movements and normal passive range of motion).[33] Studies involving adults with adhesive capsulitis/frozen shoulder, rheumatological conditions, significant shoulder trauma, previous shoulder surgery, shoulder instability, shoulder pain after stroke, full-thickness tears or calcific rotator cuff disease[16] were excluded. In case of mixed populations, studies were included only if separate data for the population of interest were available.

We decided not to use any orthopedic tests as inclusion criteria, given the low level of reliability they provide.[34] Nevertheless, we acknowledged that most of the eligible studies may have used them in the clinical assessment of the patients.

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Interventions

We included studies considering at least 1 group receiving single or multiple corticosteroid injections in the subacromial space only, alone or in combination with anesthetic injection or any other physical therapist interventions, irrespective of injection guidance (palpation or ultrasound) and approach (anterior, lateral, posterior). Studies including any other kind of injection (eg, nonsteroidal anti-inflammatory drugs, hyaluronic acid, platelet-rich plasma, prolotherapy) or corticosteroid injections in other regions other than the subacromial space[15] were excluded.

Comparator(s)

We included studies involving at least 1 group receiving physical therapist interventions, including, but not limited to, exercise, manual therapy or physical agents, alone or in combination with each other. Studies providing corticosteroid and/or anesthetic injections in both experimental and control groups were excluded.

Outcomes

We included studies assessing the following outcomes, considering the hierarchy defined by Steuri et al[17]: primary outcomes pain and function/disability and secondary outcomes quality of life, patient-rated overall improvement, and adverse events.

Pain was measured with visual analog scale, numeric rating scale, Shoulder Pain and Disability Index pain subscale or any other pain questionnaire. According to the clinical presentation of rotator cuff tendinopathy, when possible, measures of pain during movement were prioritized over pain at rest and pain at night.

Function/disability was measured with the Shoulder Pain and Disability Index disability subscale (or, if not available, with the Shoulder Pain and Disability Index total score, as in Steuri et al[17]), Constant-Murley Score, Disabilities of the Arm, Shoulder and Hand questionnaire, Shoulder Disability Questionnaire, or any other function/disability questionnaire.

When more than 1 measure of pain or function was reported, we prioritized the one measured with the tool reported first in the lists above.

Quality of life was measured with the EuroQol 5-dimension questionnaire, Western Ontario Rotator Cuff Index, or any other quality-of-life questionnaire.

Patient-rated overall improvement was measured with Likert scales (5–7 levels) or any other questionnaire.

Adverse events were measured as the number of intervention-related adverse events in the intervention or control group.

Data Extraction and Quality Assessment

Two independent reviewers (S.G.L., P.P.) performed data extraction using pretested data extraction forms in Microsoft Excel (Microsoft Corp, Redmond, WA, USA). These forms were pretested to make extraction consistent between reviewers. Disagreements were solved through discussion and, if necessary, though the involvement of a third author (R.B.).

The following data were extracted: study characteristics (authors, years, journal, country, digital object identifier, and source of funding); participant characteristics (inclusion criteria, number of participants at randomization and at each follow-up, mean age, and sex distribution in each group of interest); experimental and control intervention characteristics (description of the interventions, frequency and duration, and injection approach and guidance); outcomes assessed and outcome measures at different time frames (if multiple measures were reported for the same outcome, all of them were extracted, but the one measured with the tool reported first in the lists mentioned earlier was used in the analysis); and numerical data for the outcomes of interest, at the end of treatment and at the last available follow-up (ie, postintervention means and SDs, mean changes from baseline and SDs or 95% CIs, mean differences between groups and 95% CIs for continuous outcomes, and absolute number of events for dichotomous outcomes). Study authors were contacted for clarification or in case of missing data.

Two independent reviewers (S.G.L., P.P.) assessed the risk of bias of included studies using the Cochrane risk-of-bias tool.[35] Disagreements were solved through discussion and, if necessary, though the involvement of a third author (S.P.).

Data Synthesis and Analysis

Meta-analysis using a random-effects model with DerSimonian and Laird method to calculate weighting factors was performed.[36] Therefore, mean differences or standardized mean differences and 95% CIs were calculated for continuous variables. Standardized mean differences of 0.2, 0.5, and 0.8 represent small, medium, and large effect sizes, respectively.[37] For dichotomous outcomes, risk ratios and 95% CIs were calculated. When data have been provided as mean differences between groups and 95% CIs or SEs, whether or not adjusted for baseline imbalances or other important confounding factors, a generic inverse variance method for meta-analysis was preferred. Otherwise, mean change from baseline and SDs or 95% CIs or, if none of the above were available, postintervention means and SDs were used. If SDs were not reported, we imputed them from 95% CIs or SEs for each group.[38] The meta-analyses were performed considering data at short term (≤6 weeks), mid-term follow-up (6–12 weeks), and long-term follow-up (>12 weeks) from randomization. When studies provided more than 1 assessment in any time frame (ie, at 26 and 52 weeks), the longest one was used.

Prior to meta-analysis, we assessed clinical heterogeneity, combining studies that examined similar interventions and outcomes. If individual studies could not be combined, an effect estimate (mean difference or risk ratio) for each study for each outcome of interest was still computed to provide a similar metric compared to pooled studies that can help readers understanding the magnitude of the effect.

We assessed statistical heterogeneity by visual inspection of the forest plot along with the χ-square statistic, which is a test to assess whether observed differences in results are compatible with chance alone. However, it has low power when meta-analyses include studies with small sample size of are few in number; for this reason, a P value of <.1 was considered statistically significant, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions*.[39] We used the I^2 statistic to determine the impact of heterogeneity on the meta-analysis rather than testing whether heterogeneity is present, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions*,[39] and we considered an I^2 from 0% to 40% to indicate that heterogeneity might not be important, 30% to 60% to indicate moderate heterogeneity, 50% to 90% to indicate substantial heterogeneity, and 75% to 100% to indicate considerable heterogeneity. Publication bias was planned to be assessed via visual inspection of funnel plots if 10 or more studies were included in the meta-analysis.[40]

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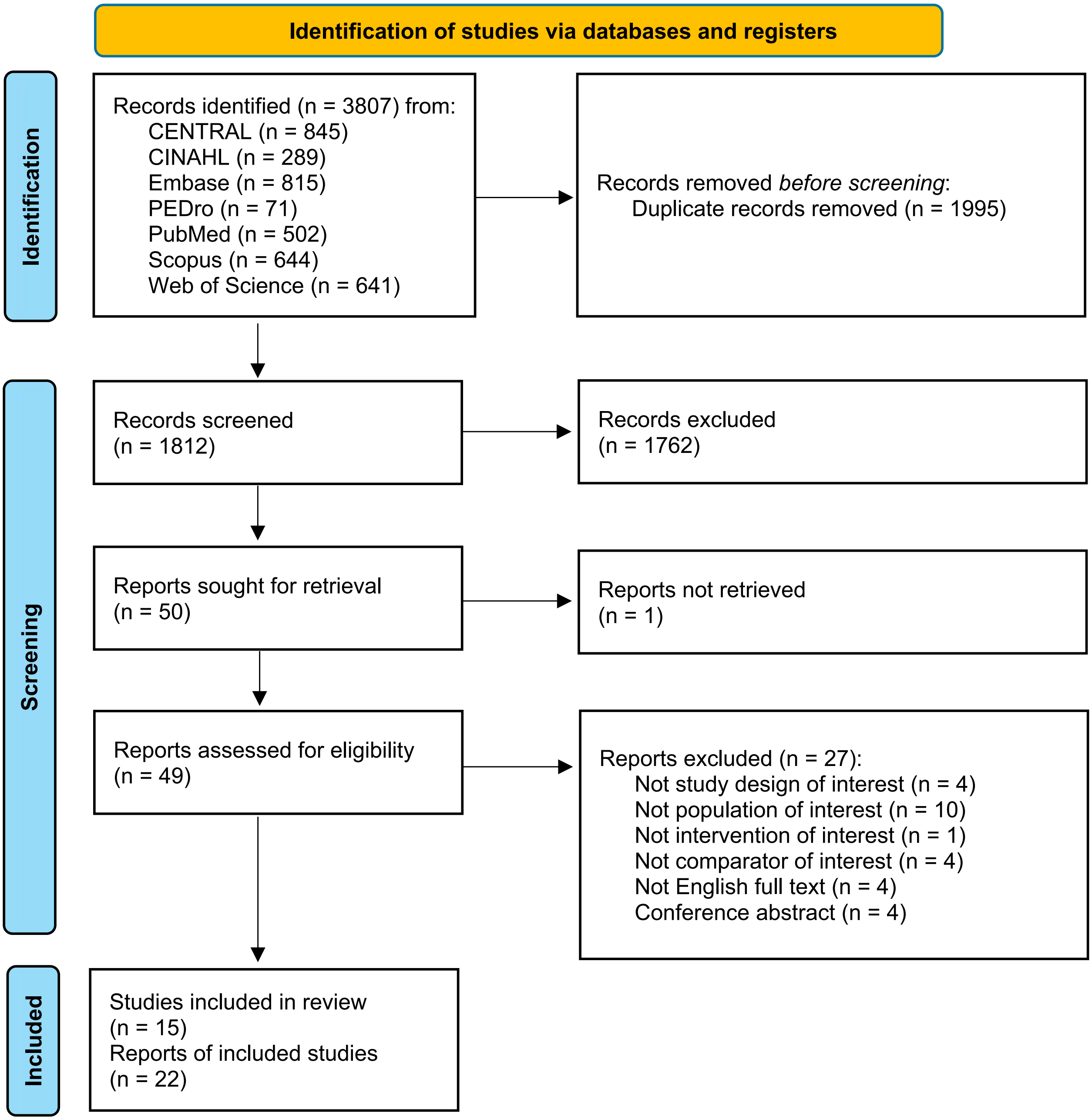

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram. CENTRAL = Cochrane Central Register of Controlled Trials; CINAHL = Cumulative Index to Nursing and Allied Health Literature; PEDro = physiotherapy evidence database.

Subgroup analyses were planned according to the injection guidance (ultrasound-guided versus landmark-guided), in order to consider the possible confounder effect of the injection guidance on the effectiveness of the treatment.[41,42]

All the analyses were performed using Review Manager 5.4.1 software (The Cochrane Collaboration; Copenhagen, Denmark).

Summary of Findings and Assessment of the Certainty of the Evidence

Two authors (S.G.L., P.P.) assessed the certainty of the evidence for the primary outcomes using the Grading of Recommendations, Assessment, Development and Evaluation approach.[43] Disagreements were solved through discussion and, if necessary, with the involvement of a third author (J.P.).

Given that the review included RCTs only, the level of certainty started as high and could be downgraded to moderate, low, or very low, depending on the seriousness of the limitations and considering the following factors: risk of bias, inconsistency of the results, indirectness of the evidence, imprecision of the results, and publication bias.

The assessments were performed and presented in "summary of findings" tables generated using GRADEpro GDT software (GRADEpro guideline development tool; McMaster University and Evidence Prime Inc; Hamilton, Ontario, Canada).

RESULTS

Study Selection

From 1812 individual records identified, 49 study reports were assessed for eligibility and 15 studies (22 reports)[44–65] were finally included (Figure 1). Disagreements in all the phases of study selection, data extraction, risk of bias and

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certainty of the evidence assessment were solved by discussion between the 2 review authors involved in each phase and a third review author was never involved. We contacted the authors of 2 conference abstracts of a seemingly relevant single study for information on the full trial, but we received no answer. The list of excluded studies and the reason for exclusion are reported in Supplementary Table 2.

Characteristics of Studies

Description of Included Studies

We included 15 RCTs (1785 participants): one 2×2 factorial RCT,[56] 4 three-armed RCTs,[47,49,59,61,65] and 10 two-armed RCTs,[44,46,48,50,54,57,58,60,63,64] for a total of 33 arms of interest (16 experimental arms, 17 control arms) (Table 1). Sample size ranged from 26 to 708 participants, and mean age ranged from 31 to 61 years. Nearly half (47%) of the studies were conducted in Turkey, yet they contributed to <25% of the included participants (399 participants; 22%). Four (27%) were not funded, 7 (47%) received nonprofit funding, and the remaining 4 (27%) did not report any information about funding (Suppl. Table 3).

The condition was described as subacromial/shoulder impingement syndrome in 10 studies (67%), rotator cuff pathology/disorder/tendinopathy in 3 studies (20%), and subacromial pain syndrome and supraspinatus tendinitis in 1 study each (7%) (see Suppl. Table 4 for the inclusion criteria defined by each included study).

Participants in the experimental groups received corticosteroid injection(s) alone or in addition to anesthetic injection in 5 experimental arms, or in addition to a physical therapist intervention in the remaining 11 experimental arms. Participants in most control arms received exercises (coupled with physical agents, manual therapy, Kinesio Taping [Kinesio, Albuquerque, NM, USA], acupuncture), whereas extracorporeal shock wave therapy (ESWT) and microwave diathermy were provided alone in 1 control arm each. The characteristics of the experimental and control interventions (description of the interventions, frequency and duration, injection approach and guidance where relevant) are reported in Supplementary Table 5.

Twelve studies (80%) measured pain, all of them (100%) measured function, and only 6 (40%) and 5 (33%) measured quality of life and patient-rated overall improvement, respectively. The outcome measures used and considered in the analyses for each study are reported in Supplementary Table 6.

Risk of Bias in Included Studies

Information on risk of bias is summarized in Figures 2 and 3. Six (40%) and 5 (33%) studies provided no sufficient information on the sequence generation process and on allocation concealment, respectively, and were therefore judged as having an unclear risk of selection bias; the remaining used adequate methods to randomize and allocate patients. Because of the nature of the interventions provided and of the outcomes, all the studies were judged as having a high risk of performance and detection biases. Two studies (13%) were judged as having a high risk of attrition bias, and 3 studies (20%) provided no sufficient information on the number of participants and/or the reasons for dropping out. Ten studies (67%) did not provide information on trial registration, and 1 study (7%) was judged as having a high risk of reporting bias.

Effects of Interventions

Tables 2 and 3 summarize the effects of the interventions on primary (pain and function) and secondary (quality of life and patient-rated overall improvement) outcomes, respectively. Only primary outcomes are presented in the text. Otherwise stated, negative scores (mean differences or standardized mean differences) favor the experimental intervention. All the forest plots are reported in the Supplementary Figure. Short-term analyses ranged from 2 to 6 weeks, mid-term analyses ranged from 8 to 12 weeks, and long-term analyses ranged from 26 to 52 weeks from randomization. The only exception is represented by the study of Hopewell et al,[56] in which intervention lasted 16 weeks and which provided outcome data at 8, 26, and > 52 weeks after randomization, as planned in the protocol. We therefore decided to use those time frames as short-, mid-, and long-term follow-up assessments, respectively. Specifically, 2 studies provided short-term data only,[44,54] and only 6 studies provided a long-term follow-up[46,47,56,57,60,61,63] (Suppl. Table 7).

Publication bias was not assessed because no meta-analysis included 10 or more studies. Because of the lack of data, no subgroup analysis was performed.

Corticosteroid Plus Anesthetic Injection Plus Exercise Versus Exercise

One 2×2 factorial RCT[56] and 2 arms of a 3-armed RCT[65] (754 participants) assessed the effectiveness of additional corticosteroid and anesthetic injections to an exercise program; however, only 1 RCT[56] (708 participants) provided usable data for meta-analysis.

On the basis of moderate-certainty evidence (Suppl. Table 8), this trial provided evidence that additional corticosteroid injections were more effective in reducing pain and improving function at short term (8 weeks) than an exercise program alone, but there was no evidence of a difference either at mid-term (26 weeks) or at long-term (>52 weeks) follow-up.[56]

The results provided by Vergili et al[65] (40 participants) reported no differences in function either at short term (2 weeks) or at mid-term follow-up (8 weeks), and pain was not measured.

Corticosteroid Plus Anesthetic Injection Plus Manual Therapy Plus Exercise Versus Manual Therapy Plus Exercise

One RCT[46] and 4 arms of 2 three-armed RCTs[47,49,61] (317 participants) assessed the effectiveness of an additional corticosteroid and anesthetic injection to an exercise and manual therapy program.

On the basis of low- to very low–certainty evidence (Suppl. Table 9), analyses showed that an additional corticosteroid injection was more effective in reducing pain at short term (4–6 weeks) than an exercise and manual therapy program, but there was no evidence of a difference either at mid-term (12 weeks) or at long-term (26 weeks) follow-up. They also provided evidence of improvements in function at both short-term and mid-term follow-up assessments in favor of the additional corticosteroid injection, but there was no evidence of a difference between the 2 groups at long-term follow-ups.

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Table 1. Characteristics of Included Studies[a]

Trial(s)	Country	Condition	No. of Participants		Interventions	
			Experimental Group	Control Group	Experimental Group	Control Group
Celik et al[44] (2009)	Turkey	Subacromial impingement syndrome	28	28	Corticosteroid + anesthetic injection + standard program (exercises, TENS, US, ice)	Standard program (exercises, TENS, US, ice)
Crawshaw et al[45,46] (2010)	United Kingdom	Subacromial impingement syndrome	115	117	Corticosteroid + anesthetic injection + exercise and manual therapy	Exercise and manual therapy
Daghiani et al[47] (2023) Raeesi et al[61] (2022)	Iran	Subacromial pain syndrome	Ex1: 25; Ex2: 21	22	Ex1: corticosteroid + anesthetic injection; Ex2: corticosteroid + anesthetic injection + exercise and manual therapy	Exercise and manual therapy
Doğan et al[48] (2021)	Turkey	Shoulder impingement syndrome	20	20	Corticosteroid injection + home exercise program	Hot packs + US + IC + exercises
ElGendy et al[49] (2023)	Egypt	Subacromial impingement syndrome	21	C1: 21; C2: 21	Corticosteroid + anesthetic injection + exercise and manual therapy	C1: exercise and manual therapy; C2: ESWT + exercise and manual therapy
Eyigor et al[50] (2010)	Turkey	Rotator cuff pathology	20	20	Corticosteroid + anesthetic injection + home exercise program	TENS + home exercise program
Göksu et al[51–54] (2016)	Turkey	Subacromial impingement syndrome	31	30	Corticosteroid + anesthetic injection + home exercise program	KT + home exercise program
Hopewell et al[55,56] (2021)	United Kingdom	Rotator cuff disorder	360	348	Corticosteroid + anesthetic injection + progressive supervised home exercise program/unsupervised home exercise program	Progressive supervised home exercise program/unsupervised home exercise program
Johansson et al[57] (2011)	Sweden	Subacromial impingement syndrome	55	44	Corticosteroid + anesthetic injection	Manual acupuncture + home exercise program
Lee et al[58] (2022)	Korea	Supraspinatus tendinitis	13	13	Corticosteroid + anesthetic injection	ESWT
Pasin et al[59] (2019)	Turkey	Subacromial impingement syndrome	30	30	Corticosteroid + anesthetic injection + home exercise program	Hot packs + TENS + ultrasonic deep heating + home exercise program
Rabini et al[60] (2012)	Italy	Rotator cuff tendinopathy	46	46	Corticosteroid + anesthetic injection	Microwave diathermy
Rhon et al[62,63] (2014)	United States	Subacromial impingement syndrome	52	46	Corticosteroid injection	Manual therapy + home exercises
Subaşi et al[64] (2016)	Turkey	Shoulder impingement syndrome	35	35	Corticosteroid + anesthetic injection + home exercise program	KT + home exercise program
Vergili et al[65] (2021)	Turkey	Shoulder impingement syndrome	23	C1: 23; C2: 26	Corticosteroid + anesthetic injection + home exercise program	C1: home exercise program; C2: KT + home exercise program

[a]C1 = control group 1; C2 = control group 2; ESWT = extracorporeal shock wave therapy; Ex1 = experimental group 1; Ex2 = experimental group 2; IC = interferential current; KT = Kinesio Taping (Kinesio, Albuquerque, NM, USA); TENS = transcutaneous electrical nerve stimulation; US = ultrasound.

Corticosteroid Plus Anesthetic Injection Plus Exercise Versus Physical Agents Plus Exercise

Three RCTs[44,48,50] and 2 arms of a 3-armed RCT[59] (196 participants), all of which have been conducted in Turkey, assessed the effectiveness of a corticosteroid and anesthetic injection in addition to an exercise program compared to the same exercise program and concomitant physical agents (interferential current, transcutaneous electrical nerve stimulation, ultrasound therapy, ice or hot packs).

On the basis of very low–certainty evidence (Suppl. Table 10), analyses showed that there was no evidence of a difference in pain and function between the interventions either at short term (3–6 weeks) or at mid-term follow-up (8–12 weeks).

Corticosteroid Injection Versus Manual Therapy Plus Exercise

One RCT[63] and 2 arms of a 3-armed RCT[47,61] (145 participants) assessed the effectiveness of corticosteroid injections compared to an exercise and manual therapy program.

On the basis of very low–certainty evidence (Suppl. Table 11), analyses showed that there was no evidence of a difference in pain and function between the interventions either at short

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Table 2. Effects of Interventions on Primary Outcomes (Pain and Function)[a]

Comparison	Outcome	Outcome Measure(s)	Time Frame	Weeks	Effect Estimate		95% CI	No. of Participants	No. of Studies	I^2 (%)	GRADE
					MD	SMD					
Corticosteroid + anesthetic injection + exercise vs exercise	Pain	SPADI (pain subscore)	**Short term**	**8**	**−7.38**		**−11.10 to − 3.66**	615	1	N/A	Moderate
	Pain	SPADI (pain subscore)	Mid-term follow-up	26	0.89		−2.88 to 4.66	595	1	N/A	Moderate
	Pain	SPADI (pain subscore)	Long-term follow-up	>52	−1.55		−4.46 to 1.36	682	1	N/A	Moderate
	Function	SPADI (function subscore)	**Short term**	**8**	**−3.84**		**−6.95 to − 0.73**	614	1	N/A	Moderate
	Function	SPADI (function subscore)	Mid-term follow-up	26	0.20		−2.95 to 3.35	595	1	N/A	Moderate
	Function	SPADI (function subscore)	Long-term follow-up	>52	−0.59		−3.02 to 1.84	682	1	N/A	Moderate
Corticosteroid + anesthetic injection + manual therapy + exercise vs manual therapy + exercise	Pain	SPADI (pain subscore), VAS	**Short term**	**4–6**		**−0.61**	**−0.86 to − 0.35**	245	2	0	Low
	Pain	SPADI (pain subscore), VAS	Mid-term follow-up	12		−0.59	−1.26 to 0.08	245	2	74	Very low
	Pain	SPADI (pain subscore), VAS	Long-term follow-up	26		−0.47	−1.54 to 0.60	234	2	89	Very low
	Function	SPADI (total score)	**Short term**	**4–6**	**−6.74**		**−9.42 to − 4.05**	285	3	0	Low
	Function	SPADI (total score)	**Mid-term follow-up**	**12**	**−7.40**		**−13.56 to − 1.23**	288	3	57	Very low
	Function	SPADI (total score)	Long-term follow-up	26	−4.36		−17.66 to 8.93	234	2	92	Very low
Corticosteroid + anesthetic injection + exercise vs physical agents + exercise	Pain	VAS	Short term	3–6	−0.01		−0.56 to 0.53	196	4	47	Very low
	Pain	VAS	Mid-term follow-up	8–12	0.22		−0.98 to 1.42	140	3	88	Very low
	Function	Constant score, SDQ, QuickDASH	Short term	3–6		−0.27	−0.97 to 0.43	196	4	83	Very low
	Function	Constant score, SDQ, QuickDASH	Mid-term follow-up	8–12		−0.29	−1.10 to 0.51	140	3	82	Very low
Corticosteroid injection vs manual therapy + exercise	Pain	VAS	Short term	4	0.47		−0.37 to 1.31	145	2	29	Very low
	Pain	VAS	Mid-term follow-up	12	0.63		−0.08 to 1.35	143	2	0	Very low
	Pain	VAS	Long-term follow-up	26–52	0.53		−0.17 to 1.23	142	2	0	Very low
	Function	SPADI (total score)	Short term	4	8.04		−6.94 to 23.02	145	2	78	Very low
	Function	SPADI (total score)	Mid-term follow-up	12	8.92		−1.92 to 19.75	143	2	64	Very low
	Function	SPADI (total score)	Long-term follow-up	26–52	8.84		−6.70 to 24.37	142	2	80	Very low

(*Continued*)

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Table 2. Continued

Comparison	Outcome	Outcome Measure(s)	Time Frame	Weeks	Effect Estimate		95% CI	No. of Participants	No. of Studies	I^2 (%)	GRADE
					MD	SMD					
Corticosteroid + anesthetic injection + exercise vs Kinesio Taping + exercise	Pain	VAS	Short term	4	−0.18		−0.95 to 0.58	131	2	27	Very low
	Pain	VAS	Mid-term follow-up	12	−0.10		−1.07 to 0.87	70	1	N/A	Very low
	Function	SPADI (function subscore), SPADI (total score)	Short term	4		−0.14	−0.63 to 0.35	131	2	50	Very low
	Function	SPADI (function subscore)	Mid-term follow-up	12	−0.80		−7.13 to 5.53	70	1	N/A	Very low
Corticosteroid + anesthetic injection vs manual acupuncture + exercise	Function	AL score	Short term	6	0.00[b]		−5.51 to 5.51	99	1	N/A	Very low
	Function	AL score	Mid-term follow-up	12	−4.00[b]		−10.25 to 2.25	99	1	N/A	Very low
	Function	AL score	Long-term follow-up	52	−3.00[b]		−7.88 to 1.88	99	1	N/A	Very low
Corticosteroid + anesthetic injection vs microwave diathermy	Pain	VAS (0–100)	Short term	4	−5.48		−13.84 to 2.88	92	1	N/A	Very low
	Pain	VAS (0–100)	**Mid-term follow-up**	**12**	**−9.45**		**−17.9 to − 1**	92	1	N/A	Very low
	Pain	VAS (0–100)	Long-term follow-up	26	−8.58		−19.46 to 2.30	92	1	N/A	Very low
	Function	Constant score	Short term	4	−7.70[b]		−16.90 to 1.50	92	1	N/A	Very low
	Function	Constant score	Mid-term follow-up	12	−3.37[b]		−8.39 to 1.65	92	1	N/A	Very low
	Function	Constant score	Long-term follow-up	26	1.78[b]		−5.63 to 9.19	92	1	N/A	Very low
Corticosteroid + anesthetic injection + manual therapy + exercise vs manual therapy + exercise + ESWT	Function	SPADI (total score)	Short term	4	1.14		−6.20 to 8.48	40	1	N/A	Very low
	Function	SPADI (total score)	**Mid-term follow-up**	**12**	**11.20**		**5.70 to 16.70**	40	1	N/A	Very low
Corticosteroid + anesthetic injection vs ESWT	Pain	VAS	**Short term**	**4**	**−2.01**		**−3.46 to − 0.56**	25	1	N/A	Very low
	Pain	VAS	Mid-term follow-up	12	−0.62		−2.15 to 0.92	25	1	N/A	Very low
	Function	Constant score	**Short term**	**4**	**10.08**[b]		**1.5 to 18.66**	25	1	N/A	Very low
	Function	Constant score	Mid-term follow-up	12	2.12[b]		−8.73 to 12.97	25	1	N/A	Very low

[a]Statistically significant results are shown in bold type. AL score = Adolfsson-Lysholm shoulder assessment score, ranging from 0 (most severe disability) to 100 (no disability); Constant score = Constant-Murley Score, ranging from 0 (most severe disability) to 100 (no disability); ESWT = extracorporeal shock wave therapy; GRADE = grading of recommendations, assessment, development and evaluation; MD = mean difference; N/A = not applicable; QuickDASH = quick disabilities of the arm, shoulder and hand questionnaire, ranging from 0 (no disability) to 100 (most severe disability); SDQ = shoulder disability questionnaire, ranging from 0 (no disability) to 100 (most severe disability); SMD = standardized mean difference; SPADI = shoulder pain and disability index, ranging from 0 (no disability) to 100 (most severe disability); VAS = visual analog scale, ranging from 0 (no pain) to 10 (most severe pain) or from 0 (no pain) to 100 (most severe pain). [b]Positive scores favor the experimental intervention.

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Table 3. Effects of Interventions on Secondary Outcomes (Quality of Life and Patient-Rated Overall Improvement)[a]

Comparison	Outcome	Outcome Measure(s)	Time Frame	Weeks	Effect Estimate		95% CI	No. of Partici-pants	No. of Studies	I^2 (%)
					MD	RR				
Corticosteroid + anesthetic injection + exercise vs exercise	Quality of life	EQ-5D-5L	Short term	8	0.03[b]		0.00 to 0.06	577	1	N/A
	Quality of life	EQ-5D-5L	Mid-term follow-up	26	−0.01[b]		−0.03 to 0.01	564	1	N/A
	Quality of life	EQ-5D-5L	Long-term follow-up	>52	0.00[b]		−0.02 to 0.02	662	1	N/A
	Patient-rated overall improvement	GIT	**Short term**	**8**	**0.69**[b]		**0.35 to 1.03**	567	1	N/A
	Patient-rated overall improvement	GIT	Mid-term follow-up	26	0.04[b]		−0.31 to 0.39	552	1	N/A
	Patient-rated overall improvement	GIT	Long-term follow-up	>52	0.20[b]		−0.06 to 0.46	664	1	N/A
Corticosteroid + anesthetic injection + manual therapy + exercise vs manual therapy + exercise	Quality of life	WORC	Short term	4	−3.15		−9.44 to 3.14	43	1	N/A
	Quality of life	WORC	Mid-term follow-up	12	−6.83		−14.30 to 0.64	43	1	N/A
	Quality of life	WORC	**Long-term follow-up**	**26**	**−11.88**		**−19.37 to − 4.39**	41	1	N/A
	Patient-rated overall improvement	No. of patients reporting recovery or improvement	Short term	4–6		1.08	0.87 to 1.34	237	2	88
	Patient-rated overall improvement	No. of patients reporting recovery or improvement	Mid-term follow-up	12		0.98	0.88 to 1.10	205	1	N/A
	Patient-rated overall improvement	No. of patients reporting recovery or improvement	Long-term follow-up	26		1.04	0.93 to 1.17	205	1	N/A
Corticosteroid + anesthetic injection + exercise vs physical agents + exercise	Quality of life									
		SF-36 physical functioning	Short term	3	−4.08[b]		−14.02 to 5.87	100	2	53
		SF-36 physical role	Short term	3	−8.65[b]		−30.37 to 13.07	100	2	83
		SF-36 bodily pain	Short term	3	−2.54[b]		−14.41 to 9.32	100	2	82
		SF-36 general health	Short term	3	1.00[b]		−5.50 to 7.50	60	1	N/A
		SF-36 vitality	Short term	3	1.70[b]		−6.40 to 9.80	60	1	N/A
		SF-36 social functioning	Short term	3	−2.94[b]		−16.26 to 10.39	100	2	77
		SF-36 emotional role	Short term	3	−1.75[b]		−15.00 to 11.49	100	2	0
		SF-36 mental health	Short term	3	1.00[b]		−2.07 to 4.07	60	1	N/A
		SF-36 physical functioning	Mid-term follow-up	8–12	−4.91[b]		−13.46 to 3.64	140	3	56
		SF-36 physical role	Mid-term follow-up	8–12	−6.43[b]		−18.06 to 5.19	140	3	58
		SF-36 bodily pain	Mid-term follow-up	8–12	−0.83[b]		−9.82 to 8.16	140	3	71

(*Continued*)

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Table 3. Continued

Comparison	Outcome	Outcome Measure(s)	Time Frame	Weeks	Effect Estimate		95% CI	No. of Partici-pants	No. of Studies	I^2 (%)
					MD	RR				
		SF-36 general health	Mid-term follow-up	8–12	−2.42[b]		−10.75 to 5.91	100	2	56
		SF-36 vitality	Mid-term follow-up	8–12	0.36[b]		−4.74 to 5.46	100	2	11
		SF-36 social functioning	Mid-term follow-up	8–12	−4.06[b]		−14.80 to 6.69	140	3	69
		SF-36 emotional role	Mid-term follow-up	8–12	−2.74[b]		−14.80 to 9.32	140	3	55
		SF-36 mental health	Mid-term follow-up	8–12	1.43[b]		−2.00 to 4.86	100	2	0
	Patient-rated overall improvement	No. of patients reporting recovery or improvement	Short term	4		0.95	0.79 to 1.13	40	1	N/A
	Patient-rated overall improvement	No. of patients reporting recovery or improvement	Mid-term follow-up	12		0.95	0.83 to 1.09	40	1	N/A
Corticosteroid injection vs manual therapy + exercise	Quality of life	WORC	**Short term**	**4**	**16.81**		**5.67 to 27.95**	47	1	N/A
	Quality of life	WORC	**Mid-term follow-up**	**12**	**23.75**		**12.27 to 35.23**	45	1	N/A
	Quality of life	WORC	**Long-term follow-up**	**26**	**21.17**		**9.41 to 32.93**	44	1	N/A
Corticosteroid + anesthetic injection + exercise vs Kinesio Taping + exercise	N/A									
Corticosteroid + anesthetic injection vs manual acupuncture + exercise	Quality of life	EQ-VAS	Short term	6	−6.00[b]		−12.89 to 0.89	99	1	N/A
	Quality of life	EQ-VAS	Mid-term follow-up	12	−7.00[b]		−14.62 to 0.62	99	1	N/A
	Quality of life	EQ-VAS	Long-term follow-up	52	−2.00[b]		−10.27 to 6.27	99	1	N/A
	Patient-rated overall improvement	No. of patients reporting recovery or improvement	**Mid-term follow-up**	**12**		**0.69**	**0.48 to 0.97**	89	1	N/A
Corticosteroid + anesthetic injection vs microwave diathermy	N/A									
Corticosteroid + anesthetic injection + manual therapy + exercise vs manual therapy + exercise + ESWT	N/A									
Corticosteroid + anesthetic injection vs ESWT	N/A									

[a]Statistically significant results are shown in bold type. EQ-5D-5L = EuroQoL 5-dimension questionnaire, ranging from 0 (worst imaginable health) to 100 (best imaginable health); EQ-VAS = EuroQol visual analog scale, ranging from 0 (worst imaginable health state) to 100 (best imaginable health state); ESWT = extracorporeal shock wave therapy; GIT = Global Impression of Treatment, ranging from −5 (very much worse) to 5 (completely recovered); MD = mean difference; N/A = not applicable; RR = risk ratio; SF-36 = 36-Item Short Form Health Survey, ranging from 0 (less favorable health state) to 100 (more favorable health state); WORC = Western Ontario Rotator Cuff Index, ranging from 0 (best score) to 2100 (worst score). [b]Positive scores favor the experimental intervention.

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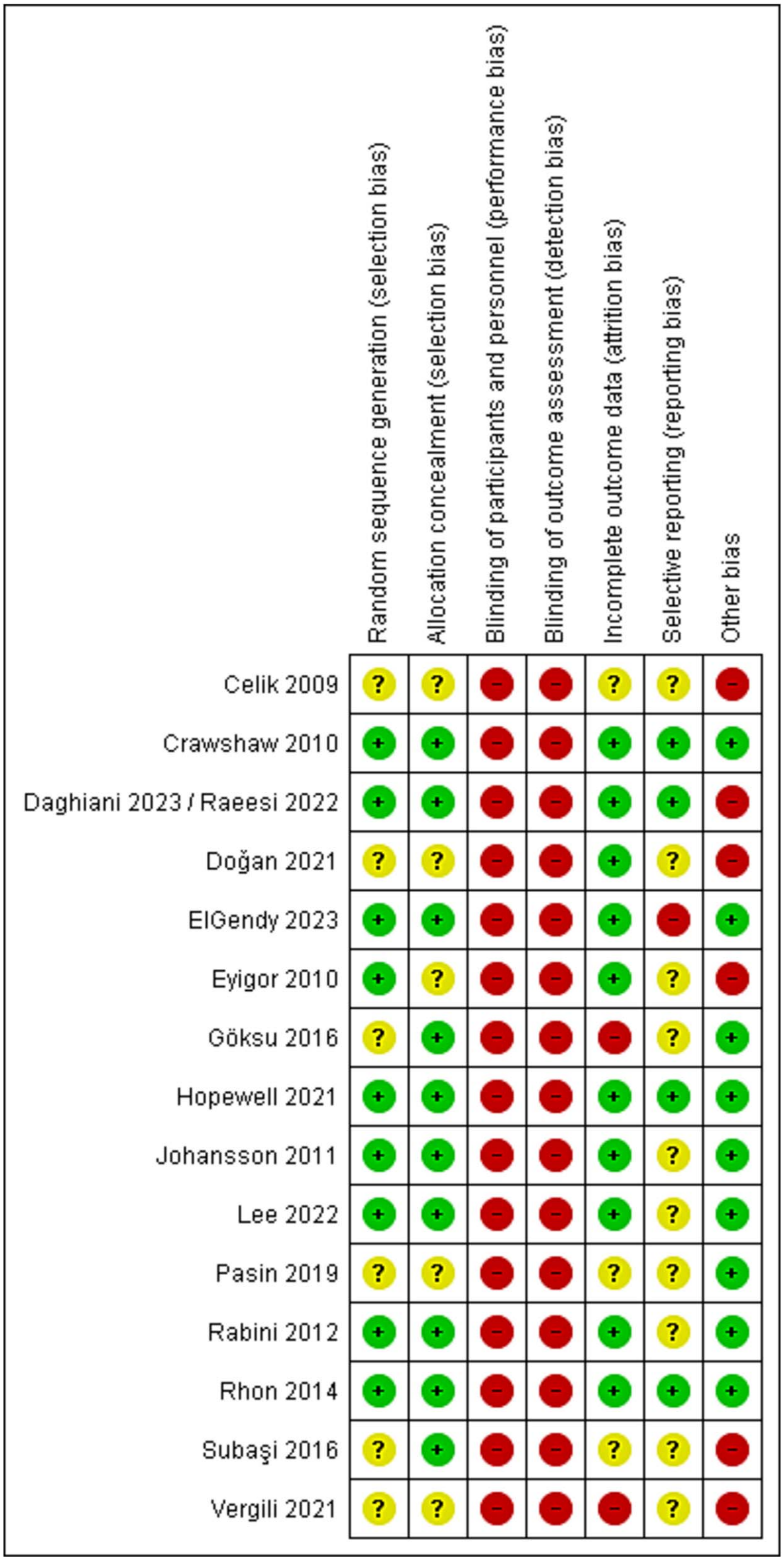

Figure 2. Risk of Bias Summary.

term (4 weeks) or at mid-term (12 weeks) or long-term (26–52 weeks) follow-up.

Corticosteroid Plus Anesthetic Injection Plus Exercise Versus Kinesio Taping Plus Exercise

Two RCTs[54,64] and 2 arms of a 3-armed RCT[65] (180 participants), all of which have been conducted in Turkey, assessed the effectiveness of a corticosteroid and anesthetic injection in addition to an exercise program compared to the same exercise program and the application of Kinesio Taping; however, only 2 RCTs[54,64] (131 participants) provided usable data for meta-analysis.

On the basis of very low–certainty evidence (Suppl. Table 12), analyses showed that there was no evidence of a difference in

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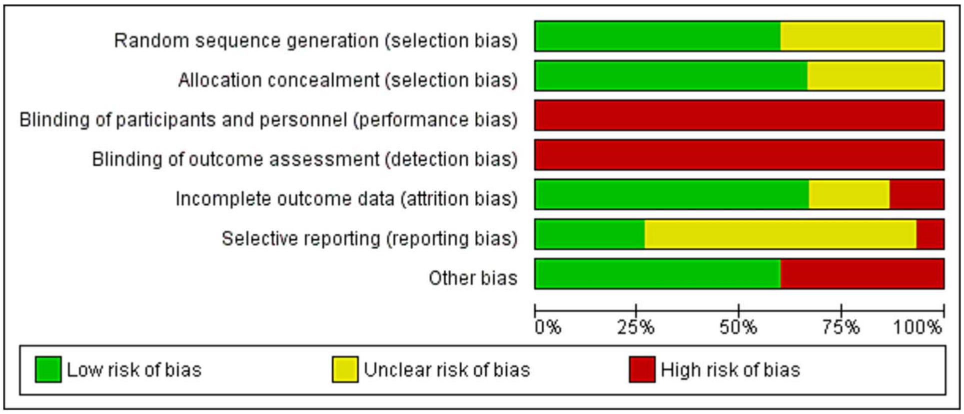

Figure 3. Risk of Bias Graph.

pain and function between the interventions either at short term (4 weeks) or at mid-term (12 weeks) follow-up.

The results provided by Vergili et al[65] (39 participants) indicated that Kinesio Taping and an exercise program were more effective in improving function at both short-term (2 weeks) and mid-term (8 weeks) follow-up assessments than corticosteroid and anesthetic injection in addition to the same exercise program.

Corticosteroid Plus Anesthetic Injection Versus Manual Acupuncture Plus Exercise

Only 1 RCT[57] (99 participants) assessed the effectiveness of corticosteroid and anesthetic injections alone compared to manual acupuncture and exercise program.

On the basis of very low–certainty evidence (Suppl. Table 13), this trial provided no evidence of a difference in function between the interventions either at short term (6 weeks) or at mid-term (12 weeks) or long-term (52 weeks) follow-up.

Corticosteroid Plus Anesthetic Injection Versus Microwave Diathermy

Only 1 RCT[60] (92 participants) assessed the effectiveness of corticosteroid and anesthetic injections alone compared to microwave diathermy.

On the basis of very low–certainty evidence (Suppl. Table 14), this trial provided no evidence of a difference in pain and function between the interventions either at short term (4 weeks) or at mid-term (12 weeks) or long-term (26 weeks) follow-up except for pain at mid-term follow-up in favor of the corticosteroid group.

Corticosteroid Plus Anesthetic Injection Plus Manual Therapy Plus Exercise Versus Manual Therapy Plus Exercise Plus ESWT

Only 2 arms of a 3-armed RCT[49] (42 participants) assessed the effectiveness of a corticosteroid and anesthetic injection in addition to exercise and manual therapy program compared to the same exercise and manual therapy program and 3 sessions of ESWT.

On the basis of very low–certainty evidence (Suppl. Table 15), this trial provided no evidence of a difference in function between the interventions at short term (4 weeks). Conversely, manual therapy, exercise, and ESWT were more effective in improving function at mid-term follow-up (12 weeks) than corticosteroid and anesthetic injection in addition to an exercise and manual therapy program.

Corticosteroid Plus Anesthetic Injection Versus ESWT

Only 1 RCT[58] (26 participants) assessed the effectiveness of a corticosteroid and anesthetic injection compared to a single session of ESWT.

On the basis of very low–certainty evidence (Suppl. Table 16), this trial provided evidence that a corticosteroid and anesthetic injection was more effective in reducing pain and improving function at short term (4 weeks) than a single session of ESWT, with no evidence of a difference at mid-term follow-up (12 weeks).

Adverse Events

Only 8 studies (53%)[46,47,49,50,56,57,60,61,63] reported information about adverse events following the interventions. None of them reported any adverse events other than transient pain from the corticosteroid injection[63] and minor complications associated with the acupuncture needle penetration.[57] For this reason, meta-analysis was not carried out.

DISCUSSION

Our systematic review, encompassing 15 randomized controlled trials and a total of 1785 participants, aimed to assess the effectiveness of corticosteroid injection(s), alone or in combination with anesthetic injection or any other physical therapist interventions, compared to physical therapist interventions alone on pain, function, quality of life, patient-rated overall improvement and adverse events in adults with rotator cuff tendinopathy. The interventions examined were equally varied, ranging from corticosteroid injection(s), with or without anesthetic, in isolation or in combination with other treatment modalities to exercise, manual therapy, Kinesio Taping and the application of physical agents. Surprisingly, not all the studies assessed pain, but all of them assessed function. It should be noted that all the studies comparing corticosteroid and anesthetic injection to physical agents and Kinesio Taping, all of which in addition to an exercise program, have been conducted in Turkey, which might be a potential source of bias.

The specific effectiveness of corticosteroid injection(s) compared to other interventions varied depending on the intervention and the duration of follow-up. At short term, when administered alone or in addition to anesthetic, corticosteroid injection seems not to be more effective than exercise and manual therapy program, acupuncture and exercise, and

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microwave diathermy in improving pain and function, but it might improve pain and function compared to a single session of ESWT. Conversely, when provided in addition to physical therapist interventions and compared to the same (ie, exercise alone or coupled with manual therapy), corticosteroid injection might result in some small to moderate improvements, despite some limited controversial evidence exists.[65] Finally, when examining corticosteroid injection coupled with exercise (alone or coupled with manual therapy) compared to the same physical therapist interventions in addition to physical agents, Kinesio Taping and 3 sessions of ESWT, it seems to have little to no effect on pain and function, despite some limited evidence supports the Kinesio Taping group.[65] Considering the secondary outcomes, corticosteroid injections do not seem to provide better results compared to physical therapist interventions, either administered alone on in addition to these interventions, aside from corticosteroid and anesthetic injection in addition to an exercise program, which seems to result in a better patient-rated overall improvement compared to the exercise program alone. Conversely, exercise and manual therapy programs seem to improve quality of life compared to a corticosteroid and anesthetic injection alone.

On the other hand, when mid- and long-term follow-up assessments have been considered, whether administered alone or in combination with other physical therapist interventions, corticosteroid injection seems not to be more effective than any physical therapist interventions other than slight improvements in function at midterm (12 weeks) and quality of life at long term (26 weeks) only when administered together with exercise and manual therapy program or in pain at midterm (12 weeks) when compared to microwave diathermy. Conversely, exercise and manual therapy programs seem to improve quality of life at both mid-term (12 weeks) and long-term (26 weeks) follow-up assessments as well as acupuncture and exercise for patient-rated overall improvement at midterm (12 weeks) compared to a corticosteroid and anesthetic injection alone. Nevertheless, considering mid- and long-term follow-up assessments, it should be noted that the heterogeneity in the duration of follow-up assessments might have influenced the effect estimate. For example, the long-term follow-up of corticosteroid injections compared to an exercise and manual therapy program ranges from 26 weeks[61] to 52 weeks,[46] which might explain the considerable heterogeneity in long-term function analysis. Nonetheless, similar heterogeneity can be seen at both short- and mid-term follow-up assessments, when the duration is the same for both studies (4 and 12 weeks, respectively), and no heterogeneity is found in long-term pain analysis.

Our results are in line with other systematic reviews on the topic, comparing corticosteroids to miscellaneous active controls[17] or including only 3 RCTs in patients with subacromial impingement syndrome.[66] However, a critical aspect that should be considered is that the evidence from our review is of moderate to mostly very low certainty, mainly because of risk of bias, inconsistency in individual studies results and low number of participants considered. Specifically, given that the characteristics of the interventions did not allow patients and care providers to be blinded and the patient-reported nature of the outcomes, it is not possible to rule out that the knowledge of the intervention received might have influenced the results. For this reason, all the certainty of the evidence had been downgraded by 1 level, despite acknowledging and accepting this limitation since blinded RCTs would have never been methodologically and ethically feasible.

Additionally, heterogeneity in population description may be a significant limitation. The included studies considered individuals with different terminologies and inclusion criteria for rotator cuff tendinopathy, often relying on orthopedic tests despite their limited reliability.[34] An important issue discussed in the literature, which also limits the precise definition of epidemiological data, is the diagnosis and precise definition of rotator cuff tendinopathies. This issue is also highlighted by the randomized controlled trials analyzed, which often use different terms to identify the condition and varied diagnostic criteria. This inherent heterogeneity, together with the diversity in therapeutic interventions in the included studies, may complicate the interpretation of the results and limit the generalizability of our findings to specific patient groups. Additionally, generalizability and applicability may also be limited by poor reporting in some of the studies included. For example, although both compared additional corticosteroid injection to exercise and manual therapy, Raeesi et al[61] implemented a more precise and well-defined manual therapy protocol, comprising 12 face-to-face sessions over a span of 4 weeks and thus providing a structured and intensive treatment schedule, whereas Crawshaw et al[46] implemented relatively unspecified manual therapy techniques with no fixed number of sessions, leaving the management of sessions to the discretion of the physical therapist. This dissimilarity between these 2 studies may be another possible explanation for the differences in the effect estimates and the considerable heterogeneity seen in the function meta-analyses already discussed above. Poor reporting, which has already been pointed out in rotator cuff disease trials,[67] may therefore hinder the application of such interventions in clinical practice or in other studies. Thus, it should be noted that better reporting is therefore urgently needed and can be achieved by adhering to the Template for Intervention Description and Replication (TIDieR) checklist[68] or, especially when it comes to exercise, to the Consensus on Exercise Reporting Template (CERT).[69] Similarly, it should be noted that poor reporting in the description of time frame assessments may result in an unclear follow-up definition, which might have an impact on the meta-analyses combining studies with possibly different time frames.

Lastly, the studies' limited reporting on adverse events is a noteworthy limitation. Although some studies provided information on potential adverse effects, the scope of adverse events was somewhat restricted. This lack of comprehensive reporting hinders a full analysis of safety issues associated with the interventions and calls for better reporting of adverse events,[70,71] which have also been included in the core outcome set for shoulder disorders.[72]

Such limitations demand a cautious interpretation of the findings and underscore the need for future research to improve methodological quality, which is likely to have an impact on the effect estimates provided. Nonetheless, our synthesis of the available evidence does offer insights into the comparative effectiveness of these interventions and their potential implications for clinical practice, specifically considering that some evidence of moderate certainty exists.

Clinical Implications

The analysis of the data from this systematic review and meta-analysis indicates a tendency towards corticosteroid treatment

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effectiveness at short term. This finding suggests that corticosteroid injections, especially when provided in combination with other physical therapist interventions, may lead to short-term improvements in pain and function, thus being a viable adjunct for patients seeking immediate relief from their symptoms. Nonetheless, we cannot rule out that the improvements seen at short term may be due to an inflammatory condition that is unrelated to rotator cuff tendinopathy. However, it should be noted that it appears to be no apparent trend indicating significant differences in the midterm to long term, even though some studies lacked long-term follow-up, making it challenging to assess the durability of treatment effectiveness and safety.[73] Furthermore, considering the potential adverse events associated with the injections, although not highlighted in our analyses, physical therapist interventions may be an important standalone option in rotator cuff tendinopathy. Nevertheless, it should be noted that such interventions require higher levels of adherence compared to a simple injection to be effective. In practical terms, when exercise-based interventions are provided, monitoring and fostering patient adherence compared to corticosteroid injections may be more difficult. Therefore, when considering physical therapist interventions, patients' compliance and commitment play a significant role in determining the appropriateness of such approaches. Clinicians should therefore consider strategies to promote and monitor adherence to exercise programs to ensure consistent and effective management, such as patients' education[74,75] and supervision.[76] This characteristic also underscores the importance of tailoring treatment plans to patient needs and preferences while, at the same time, taking into account the available evidence as a guide.

In summary, the clinical implications of this study highlight the potential for short-term effectiveness of corticosteroid injections in rotator cuff tendinopathy. However, the lack of long-term follow-up data, safety concerns, adherence challenges, and the diversity of treatment protocols call for a thoughtful and individualized approach to patient care. Careful considerations of these factors are essential when making treatment decisions in clinical setting.

Study Limitations

The main limitations rely on the inclusion of English studies only, which could introduce a potential language bias, as valuable research published in other languages may have been excluded. Moreover, differences in inclusion criteria and participants' description might have resulted in the inclusion of a heterogeneous population, which is partially a consequence of the different terminologies and labels that have been used in the past decades, and therefore limit generalizability. Additionally, gray literature has not been searched, even though it can provide relevant studies and offer different perspectives on the topic. Furthermore, different characteristics of the control interventions, especially regarding provider and patient-dependent interventions such as exercise (supervised versus unsupervised,[77] specific versus generic,[78,79] progressive versus nonprogressive,[80] higher versus lower dose[32]) were not considered, even if they may have influenced the effect estimates. Finally, the effectiveness of the interventions was considered at long term to track how they affected the outcomes over time. Nevertheless, it should be acknowledged that it is difficult to control for confounding variables potentially influencing our results, such as additional interventions patients might have received following the interventions as well as additional pain etiologies.

CONCLUSIONS

In conclusion, the evidence suggests that corticosteroid injections tend to be more effective than physical therapist interventions in the short term at best, especially in addition to other physical therapist interventions, with improvements in function and pain outcomes. Indeed, it is worth mentioning that no significant differences were observed in the midterm and long term in most of the studies, which raises questions about sustained benefits. Nevertheless, the evidence is of moderate to mostly very low certainty. Additional high-quality research taking core outcomes[72] into consideration is therefore needed to thoroughly evaluate the effectiveness and safety of corticosteroid injections compared to physical therapist interventions, since adverse events were not extensively examined in many of the studies included in this analysis.

CRediT – CONTRIBUTOR ROLES

Stefano Giuseppe Lazzarini (Conceptualization [Lead], Data curation [Lead], Formal analysis [Lead], Investigation [Lead], Methodology [Lead], Project administration [Lead], Resources [Lead], Software [Lead], Supervision [Lead], Writing—original draft [Lead], Writing—review & editing [Lead]), Riccardo Buraschi (Data curation [Equal], Formal analysis [Equal], Investigation [Equal], Writing—review & editing [Equal]), Joel Pollet (Data curation [Equal], Formal analysis [Equal], Investigation [Equal], Writing—review & editing [Equal]), Francesco Bettariga (Data curation [Equal], Formal analysis [Equal], Investigation [Equal], Writing—review & editing [Equal]), Simone Pancera (Data curation [Equal], Formal analysis [Equal], Investigation [Equal], Writing—review & editing [Equal]), Paolo Pedersini (Conceptualization [Lead], Data curation [Equal], Formal analysis [Equal], Investigation [Equal], Project administration [Equal], Resources [Equal], Supervision [Equal], Writing—original draft [Lead], Writing—review & editing [Lead]).

SUPPLEMENTARY MATERIAL

Supplementary material is available online.

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SYSTEMATIC REVIEW REGISTRATION

The protocol was registered in PROSPERO (CRD42021240882).

DISCLOSURES

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

DATA AVAILABILITY

All data relevant to the study are included in the article or are available as supplementary files.

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