BMC Musculoskeletal Disorders

SYSTEMATIC REVIEW Open Access

The effectiveness of instrument-assisted soft tissue mobilization on pain and function in patients with musculoskeletal disorders: a systematic review and meta-analysis

Sien Tang[1*], Li Sheng[1], Xiating Wei[1], Mingjie Liang[1], Jinming Xia[1] and Jueru Chen[1]

Abstract

Background Instrument-assisted soft tissue mobilization (IASTM) is popular in the treatment of musculoskeletal disorders. However, the current literature has produced varying results. The purpose of this study was to collect the most recent studies to evaluate the effectiveness of IASTM on pain and function in patients with musculoskeletal disorders.

Methods The researchers searched the PubMed, Embase, Web of Science, and Cochrane Library databases from inception to February 25, 2025, to identify randomized controlled trials comparing treatment groups receiving IASTM combined with other treatments to those receiving other treatments among participants with musculoskeletal disorders. The outcomes were pain intensity, pain pressure threshold and function. The Cochran Q and I^2 indices were used to estimate heterogeneity. The data were analyzed as the standardized mean difference (SMD). The Cochrane Risk of Bias tool was used to assess the risk of bias. The Grading of Recommendations Assessment, Development, and Evaluation system was used to rate the quality of evidence. Trial sequential analysis and sensitivity analyses were also performed.

Results Eleven trials (involving 427 participants) were included in the quantitative analysis. Six trials had a high risk of bias; three, unclear; and two, low. There was moderate-certainty evidence indicating that IASTM was effective in reducing patient-reported pain ($n=11$) ($n=427$, SMD = 0.60, 95% CI: 0.41 to 0.80, $p<0.01$), and there was low-certainty evidence indicating that IASTM was effective in improving patient-reported function ($n=8$) ($n=333$, SMD = 0.40, 95% CI: 0.03 to 0.77, $p<0.05$). Only one data point was extracted for the pain pressure threshold, and a meta-analysis was not performed. Trial sequential analysis revealed that the cumulative z score crossed the monitoring boundary for superiority for patient-reported pain in patients with nonspecific chronic neck pain and cervicogenic headache at the 4-week IASTM.

Conclusions IASTM can reduce patient-reported pain (with moderate certainty) and improve patient-reported function (with low certainty) in patients with musculoskeletal disorders. Future clinical studies do not need to

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explore the short-term effects of IASTM on patient-reported pain in patients with nonspecific chronic neck pain and cervicogenic headache.

Trial registration The PROSPERO registration ID is CRD42024534643 (April 10, 2024).

Keywords Instrument-assisted soft tissue mobilization, Pain, Soft tissue therapy, Musculoskeletal disease, Meta-analysis

Background

Musculoskeletal disorders are a series of diseases related to the locomotor system, including the bones, muscles, and tendons, and are the most common diseases in humans [1–3]. There were 334.74 million cases of musculoskeletal disorders globally in 2017 and 1.71 billion cases in 2019; furthermore, this number continues to increase [2, 3]. Musculoskeletal disorders can cause pain, range of motion (ROM) deficits, and functional limitations, leading to physical dysfunction and being the main cause of disability [1, 4, 5]. Globally, these diseases ranked first in years lived with disability and ninth in disability-adjusted life-years in 2019 [3, 5]. Musculoskeletal disorders can also have an impact on people's mental health and their daily lives as well as cause burdens for healthcare systems [6, 7].

There are various methods for treating musculoskeletal disorders, including medications and surgery, among which rehabilitation therapy is an important component [3, 8]. Rehabilitation therapy focuses mainly on reducing pain and improving ROM and function [9–11]. Conventional rehabilitation treatment includes stretching, therapeutic exercise, etc [9–11].

Instrument-assisted soft tissue mobilization (IASTM) is a myofascial intervention that uses specially designed handheld devices and is currently widely popular in the treatment of musculoskeletal disorders [12]. There are various types of handheld devices, such as Graston, Edge, and HawkGrips. These devices differ in shape, material and treatment side. IASTM is the use of these handheld devices for the treatment of musculoskeletal disorders by sweeping soft tissues under the application of a lubricant [12]. It is hypothesized that IASTM can increase the pressure pain threshold (PPT), thus reducing pain; it can promote the outflow of fluid from the fascia and increase the water content of the fascia through the supercompensatory effect, thus improving flexibility; and it can stimulate the activation and proliferation of fibroblasts and promote the healing of injured soft tissues, thus restoring function [13–15].

However, clinical experience has not been supported by consistent evidence from systematic reviews [16–23]. To our knowledge, only three systematic reviews and meta-analyses have examined the effectiveness of IASTM [19, 20, 23]. Two of the studies were from the same team, and the latter was an update to the former. Both studies revealed that IASTM did not improve ROM, reduce pain, or improve function [19, 20]. However, a recent meta-analysis by Tang et al. [23]. noted that the two previous studies included randomized controlled trials (RCTs) that compared IASTM with other treatments or placebo, which may have led to an underestimation of the effectiveness of IASTM. Therefore, they used different inclusion criteria (included only RCTs comparing IASTM in combination with other treatments and other treatments), updated the search data to reassess the effect of IASTM on ROM and reported that IASTM improved ROM, overturning the results of the two previous studies [23]. It seems that the results of the two previous studies may be changed to update the data and use different inclusion criteria. Therefore, researchers would like to reassess the effects of IASTM on pain and function by updating data and using different inclusion criteria. The aim of this study was to assess the effect of IASTM on pain and function in patients with musculoskeletal disorders.

Methods

This study was a systematic review and meta-analysis that followed the updated guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020) and was registered on the PROSPERO website (RegNo.: CRD42024534643) [24].

Eligibility criteria

The inclusion criteria were as follows: (1) examined patients with musculoskeletal disorders; (2) compared IASTM combined with other treatments to other treatments; (3) examined at least one outcome related to pain, PPT or function; (4) were RCTs; and (5) were written in English.

The exclusion criteria were as follows: (1) IASTM included warming, stretching or any other nonsweeping procedures; or (2) inability to obtain the data of interest.

Information sources

The researchers searched the PubMed, Embase, Web of Science, and Cochrane Library electronic databases from inception to February 25, 2025. Numerous keywords, including "instrument assisted soft tissue mobilization", "IASTM", "instrument assisted", and "soft tissue mobilization", were used (the details of the search strategy are

shown in Additional file 1). The researchers also manually searched the reference lists of the prior systematic reviews and the references of all the included studies to find any additional trials.

Study selection

Two researchers (S. Tang and L. Sheng) independently carried out the study selection via EndNote 21 software (Ceverbridge Analytics, Philadelphia, PA, USA). The researchers first excluded duplicate studies. The researchers subsequently excluded clearly irrelevant studies after screening the titles and abstracts. Finally, the researchers screened the full texts to select studies that met the inclusion criteria. Any disagreements were resolved by discussion.

Data extraction

Two researchers (S. Tang and L. Sheng) independently extracted the data via a standardized form. Any disagreements were resolved by recreating the data extraction process. The researchers extracted the following data: year of publication, country, patient characteristics (disease, age, and sex), sample size, control group, outcome, and characteristics of IASTM (tool and duration). All indicators related to the changes in pain, PPT and function were of interest to us, and on the basis of these findings, their means and standard deviations (SDs) from baseline in two parallel groups were extracted.

The data were extracted according to the following principles. (1) If the means and SDs from baseline were not reported, the researchers converted the data from the baseline data and the confidence intervals (CIs) (or *P* values), when available, by using the calculator provided in RevMan 5.4 (the Cochrane Collaboration, London, UK). If no outcome data were available, the researchers contacted the authors through emails for their research results. (2) When multiple sets of data were available for the same indicator in a study, the data closest to the current state were selected. (3) When the same indicator was used, heterogeneous units were converted, such as converting results on the Visual Analogue Scale (VAS) from millimeters to centimeters. (4) The outcome at the end of the treatment was used, but intermediate or follow-up data (greater than or equal to 7 days) were not used. (5) The data were positive if the symptoms improved compared with baseline; otherwise, the data were negative.

Assessment of the risk of bias

Two researchers (S. Tang and J. Xia) independently assessed the risk of bias of the included studies (with subjective outcomes and objective outcomes) via the Cochrane Risk of Bias tool [25]. Any disagreements were resolved by consulting a third researcher (L. Sheng). Considering the nature of the IASTM intervention, the researchers used the method described by Nazari et al. [20] to define the overall risk of bias of the included studies in subgroup analysis and trial sequential analyses (TSA): if a study merely had a high risk of bias due to the blinding of participants and personnel, the study was rated as either unclear risk (if one or more of the remaining six domains were rated as unclear risk) or low risk (if the remaining six domains were rated as low risk).

Statistical analysis

The data were analyzed by using Review Manager 5.4 (the Cochrane Collaboration, London, UK) and Stata 14 (StataCorp LLC, Texas, USA) [26]. The researchers used the Cochran Q and I^2 indices to estimate heterogeneity [26]. If $P < 0.1$ and $I^2 > 50\%$, then there was significant heterogeneity, and the random-effects (DerSimonian-Laird) model was applied; if $P \geq 0.1$ and $I^2 \leq 50\%$, there was nonsignificant heterogeneity, and the fixed-effects (inverse variance) model was used [26]. For outcomes with the same unit, the researchers used the mean difference (MD) and reported 95% CI; for outcomes with different units, the researchers used the standard mean difference (SMD) and reported 95% CI [26]. Prespecified subgroup analyses were conducted on the basis of different levels of risk of bias. Results were presented in forest plots. Publication bias was detected via funnel plots and the Egger test when the included studies were 10 or more; asymmetric funnel plots and *P* values < 0.05 indicated the presence of publication bias [26, 27]. Additionally, sensitivity analyses were performed via the leave-one-out method to confirm the stability of the results [26].

Certainty assessment and trial sequential analyses

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system was used to rate the quality of evidence of the included studies [28]. TSA was used to calculate the sample size required for the meta-analysis, to improve the accuracy of the results and to indicate future research directions [29]. Analyses were performed via Trial Sequentional Analysis Viewer 0.9.5.10 Beta (The Copenhagen Trial Unit, Centre for Clinical Intervention Research, Capital Region, Copenhagen University Hospital– Rigshospitalet, 2021.) with a random-effects model based on the included studies having a low risk of bias (the CI was set to 95%, the type 1 error was set to 5% via two-sided analysis, and the power was set to 80%).

Results

Study selection

A total of 2568 articles were initially retrieved: 299 from PubMed, 668 from Embase, 843 from the Web of Science, and 758 from the Cochrane Library. No additional studies were identified from other sources. After removing

duplicates, 1859 articles remained. After screening the titles and abstracts, 1822 clearly irrelevant studies were excluded. The full texts of the remaining 37 articles were retrieved and read carefully. Ultimately, a total of 11 studies were included in this systematic review and meta-analysis (Fig. 1) [30–40].

Study characteristics

The 11 included studies were published between 2012 and 2024 and involved a total of 427 participants [30–40]. Two studies were published in Egypt [30, 34], three in India [31, 35, 37], one in Pakistan [36], three in Turkey [32, 33, 40], and two in the United States [38, 39]. Five studies examined patients with head and neck diseases [30, 32–34, 40], 1 study examined patients with shoulder disease [31], 1 study examined patients with elbow disease [39], and 4 studies examined patients with ankle diseases [35–38]. Two studies did not report the SD of age [35, 37]; the average age in the remaining studies was 37.94 ± 12.83 years [30–34, 36, 38–40]. A total of 68.99% of the participants were females [30–40]. In the control group, stretching combined with exercise was used in 4 out of the 11 studies [30, 32, 35, 39], only exercise was used in 3 studies [37, 38, 40], and stretching plus/or exercise combined with physical agents was used in 4 studies [31, 33, 34, 36]. In terms of outcomes, 11 studies examined patient-reported pain [30–40], 7 studies used the VAS [30, 32–34, 36, 38, 39], and 4 studies used the Numerical Pain Rating Scale (NPRS) [31, 35, 37, 40]. Nine studies examined patient-reported function [30, 31, 33–39]. One of these studies was not included in the meta-analysis because the data of interest were not extracted [37]. Among the interventions, the Graston (4/11) [30, 35, 36, 38] and Astym tools (2/11) [37, 39] were the most commonly used tools. The most common single treatment duration was less than or equal to 10 min (8/11) [30–35, 38, 40]. The most common treatment course was 4 weeks, with 2–3 treatments per week (8/11) [30–32, 34–36, 38, 39]. Two studies reported PPT [33, 34], one of which was not included in the meta-analysis because the data of interest could not be extracted [34]. One study examined balance [38]. Out of 11 studies, 7 were registered [30–32, 34, 36, 37, 40], and 2 were funded [37, 39]. A summary of the 11 studies is shown in Table 1 (at the end of the paper).

Risk of bias

The risk of bias was assessed among studies reporting subjective outcomes (Fig. 2). Among the 11 studies that examined patient-reported pain, there was selection bias

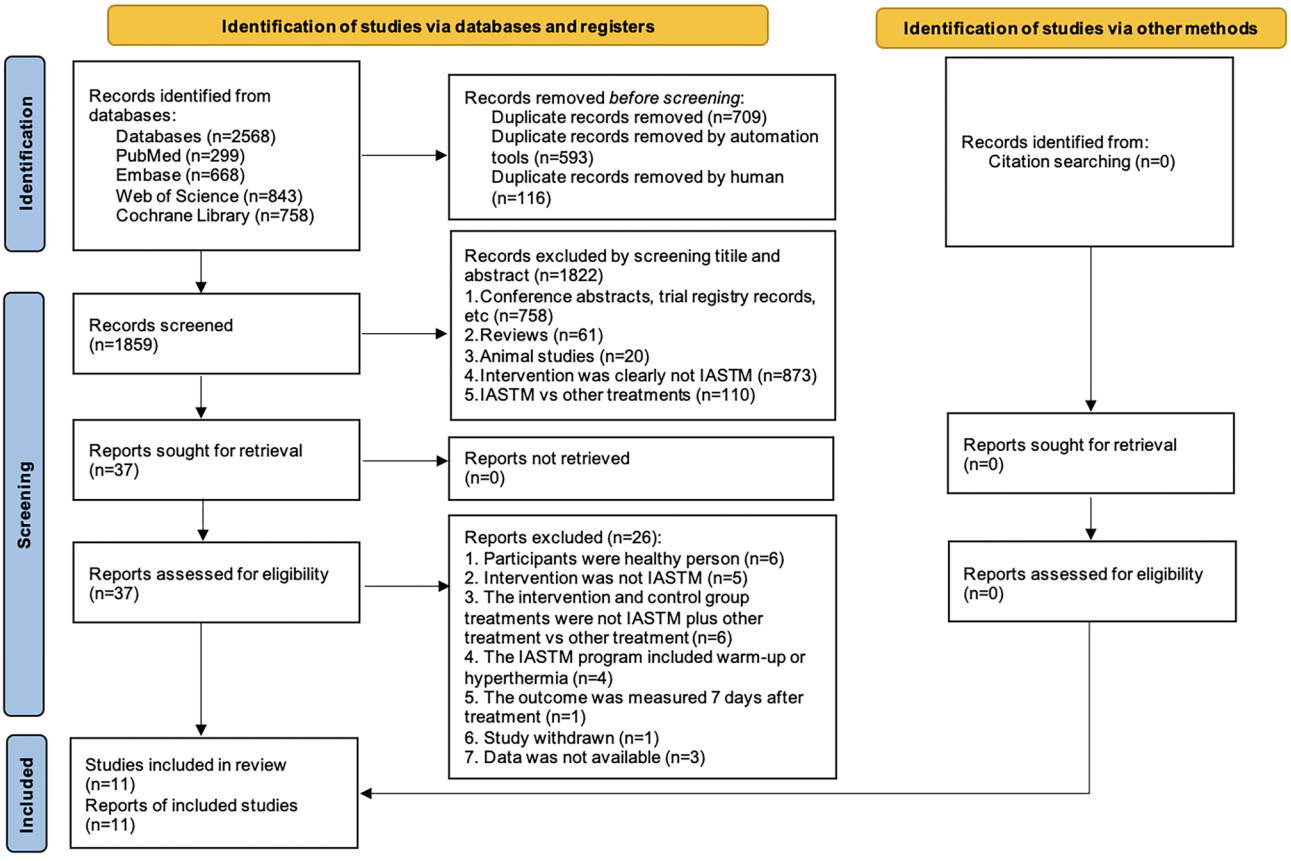

Fig. 1 Study selection process

Table 1 Summary of included studies

Study	Country	Participant/ Age (mean ± SD)/Female (%)	N (IG/CG)	Control group	Outcome	IASTM	IASTM Duration	Funding
Abdel-Aal et al (2021) [30]	Egypt	Patients with cervicogenic headache 41.69 ± 4.89 61.67%	30/30	Stretching, isometric exercises, postural correction exercises	VAS, NDI, cervical ROM, medication intake, headache frequency and duration	Graston	80 s, 3 times a week, 4 weeks	None
Aggarwal et al (2021) [31]	India	Patients with shoulder adhesive capsulitis 49.40 ± 8.13 76.67%	15/15	Hydrocollator pack, Maitland mobilizations, pectoral stretch, posterior capsular stretch, wand exercises, Codman's exercises	NPRS, SPADI, ROM, Apley's scratch test	Edge	2 min, 3 times a week, 4 weeks	No describe
Bostan & Kaya (2024) [32]	Turkey	Patients with chronic neck pain 44.38 ± 13.38 66.70%	24/24	Stretching, strengthening exercises	DNFE, VAS	Arco	6 min, 2 times a week, 4 weeks	None
Candeniz et al (2023) [33]	Turkey	Patients with neck myofascial pain syndrome 31.61 ± 13.23 100%	14/14	Hotpack, ultrasound, TENS, neck exercises at home	PPT, cervical ROM, VAS, HADS, level of satisfaction, NOOS	No description	5 min, 2 times a week, 3 weeks	None
Hamdy et al (2023) [34]	Egypt	Patients with nonspecific chronic neck pain 21.28 ± 1.62 88.33%	30/30	Hot pack, stretching, Strengthening exercises	VAS, PPT, NDI, electrophysiological properties MVIC of UT	Hamilton	2–3 min, 3 times a week, 4 weeks	None
Jones et al (2019) [35]	India	Patients with plantar heel pain 46.1 ± no description no describe	5/6	Warm-up, stretching, strengthening exercises, home exercise	FAAM-ADL, NPRS	Graston	10 min, 2 times a week, 4 weeks	None
Kiran et al (2023) [36]	Pakistan	Patients with plantar fasciitis 34.1 ± 6.67 60.00%	15/15	Ultrasound, stretching, kinesio tape	VAS, FHSQ	Graston	30 min, 2 times a week, 4 weeks	No describe
McCormack et al (2016) [37]	India	Patients with insertional achilles tendinopathy 53.6 ± no description 68.75%	7/9	Eccentric exercise	VASA-A, NPRS, GROC	Astym	20–30 min, 2 times a week, 6 weeks	Performance Dynamics, Muncie, Indiana
Schaefer & Sandrey (2012) [38]	USA	Patients with chronic ankle instability 17.80 ± 4.32 12.50%	13/11	Warm-up, dynamic balance training	FAAM-ADL, FAAM-Sport, VAS, ROM, SEBT	Graston	8 min, 2 times a week, 4 weeks	No describe

Table 1 (continued)

Study	Country	Participant/ Age (mean ± SD)/Female (%)	N (IG/CG)	Control group	Outcome	IASTM	IASTM Duration	Funding
Sevier & Stegink-Jansen (2015) [39]	USA	Patients with chronic lateral elbow approximately 46.96 ± 6.58 approximately 57.94%	46/44	Eccentric exercise, Stretching	DASH, VAS-activity, VAS-function, grip strength	Astym	No description, 2 times a week, 4 weeks	IU Health Ball Memorial Hospital
Torlak et al (2022) [40]	Turkey	Patients with chronic migraine 40.77 ± 6.49 100%	15/15	Neck exercise	NPRS, HIT-6, PSQI, SF-36	Guasha	10 min, 2 times a week, 5 weeks	None

ADL = Activities of Daily Living; CG = Control Group; DASH = Disabilities of the Arm, Shoulder and Hand Outcome; DNFE = Deep Neck Flexor Muscle Endurance; FAAM = Foot and Ankle Ability Measure; FHSQ = Foot Health Status Questionnaire; GROC = Global Rating of Change Scale; HADS = Hospital Anxiety and Depression Scale; HIT-6 = Headache Impact Test-6; IASTM = instrument-assisted soft tissue mobilization; IG = Intervention Group; MVIC = Maximal Voluntary Isometric Contractions; NDI = Neck Disability Index; NOOS = Neck Outcome Score; NPRS = Numerical Pain Rating Scale; PPT = Pressure Pain Threshold; PSQI = Pittsburgh Sleep Quality Index; ROM = Range of motion; SD = Standard Deviation; SEBT = Star Excursion Balance Test; SF-36 = Short Form-36; SPADI = Shoulder Pain and Disability Index; TENS = Transcutaneous electrical nerve stimulation; UT = Upper trapezius; VAS = Visual Analogue Scale; VISA-A = Victorian Institute of Sport Assessment Achilles Specific

in one trial [32], performance bias in 11 trials [30–40], detection bias in 3 trials [32, 33, 38], attrition bias in 3 trials [35, 36, 38], reporting bias in one trial [32], and other bias in one trial [37] (for the overall risk of bias, two studies were rated as low risk [30, 34], three studies were rated as unclear risk [31, 39, 40], and six studies were rated as high risk [32, 33, 35–38]). Regarding the 8 studies examining patient-reported function, performance bias was detected in 8 trials [30, 31, 33–36, 38, 39], detection bias in 2 trials [33, 38], and attrition bias in 3 trials [35, 36, 38] (for the overall risk of bias, two studies were rated as low risk [30, 34], two studies were rated as unclear risk [31, 39], and four studies were rated as high risk [33, 35, 36, 38]). The risk of bias was assessed among studies reporting objective outcomes. With respect to one study examining PPT, there was performance bias [33]. With respect to one study examining balance, there was performance bias and attrition bias [38]. The details of the risk of bias of all the included studies (including studies reporting subjective outcomes and those reporting objective outcomes) are shown in Additional file 2.

Meta-analysis

Effect of IASTM on pain

IASTM significantly reduced patient-reported pain (11 trials [30–40], $n = 427$, SMD = 0.60, 95% CI: 0.41 to 0.80, $p < 0.01$, $I^2 = 36\%$) Fig. . 3). Subgroup analyses revealed that IASTM reduced patient-reported pain in studies with a low risk of bias (2 trials [30, 34], $n = 120$, SMD = 1.00, 95% CI: 0.62 to 1.38, $p < 0.01$, $I^2 = 0\%$), studies with an unclear risk of bias (3 trials [31, 39, 40], $n = 150$, SMD = 0.38, 95% CI: 0.05 to 0.70, $p < 0.05$, $I^2 = 0\%$) and studies with a high risk of bias (6 trials [32, 33, 35–38], $n = 157$, SMD = 0.54, 95% CI: 0.21 to 0.86, $p < 0.01$, $I^2 = 34\%$). (Fig. 3) Publication bias was assessed for patient-reported pain, and although the funnel plot showed partial asymmetryFig. . 4), Egger's test revealed that there was no significant publication bias ($P = 0.437$). Sensitivity analyses revealed that the pooled results were robust (Additional file 3). IASTM significantly improved PPT (1 trial [33], $n = 28$, MD = 2.67, 95% CI: 1.13 to 4.21, $p < 0.01$).

Effect of IASTM on function

IASTM significantly improved patient-reported function (8 trials [30, 31, 33–36, 38, 39], $n = 333$, SMD = 0.40, 95% CI: 0.03 to 0.77, $p < 0.05$, $I^2 = 59\%$) Fig. . 5). Subgroup analyses revealed that IASTM reduced patient-reported function in studies with a low risk of bias (2 trials [30, 34], $n = 120$, SMD = 0.90, 95% CI: 0.30 to 1.50, $p < 0.01$, $I^2 = 60\%$) but not in studies with an unclear risk of bias (2 trials [31, 39], $n = 120$, SMD = 0.32, 95% CI: -0.04 to 0.68, $p > 0.05$, $I^2 = 0\%$) or in studies with a high risk of bias (4 trials [33, 35, 36, 38], $n = 93$, SMD = 0.09, 95% CI: -0.56 to 0.74, $p > 0.05$, $I^2 = 56\%$) Fig. . 5). Sensitivity analyses revealed that the pooled results were robust (Additional file 4). In addition, IASTM significantly improved balance (1 trial [38], $n = 24$, MD = 7.10, 95% CI: 0.80 to 13.40, $p < 0.05$).

Certainty of evidence and trial sequential analyses

The results of the TSA indicated that the required sample size for the meta-analysis of patient-reported pain was 201, and the two studies with a low risk of bias crossed the boundary for equivalence (Additional file 5). The results of TSA also indicated that the required sample size for meta-analysis of patient-reported function was 389, and the two studies with a low risk of bias did not cross the boundary for equivalence (Additional file 6). The quality of evidence for patient-reported pain was rated as moderate, the quality of evidence for patient-reported function was rated as low, the quality of evidence for PPT was

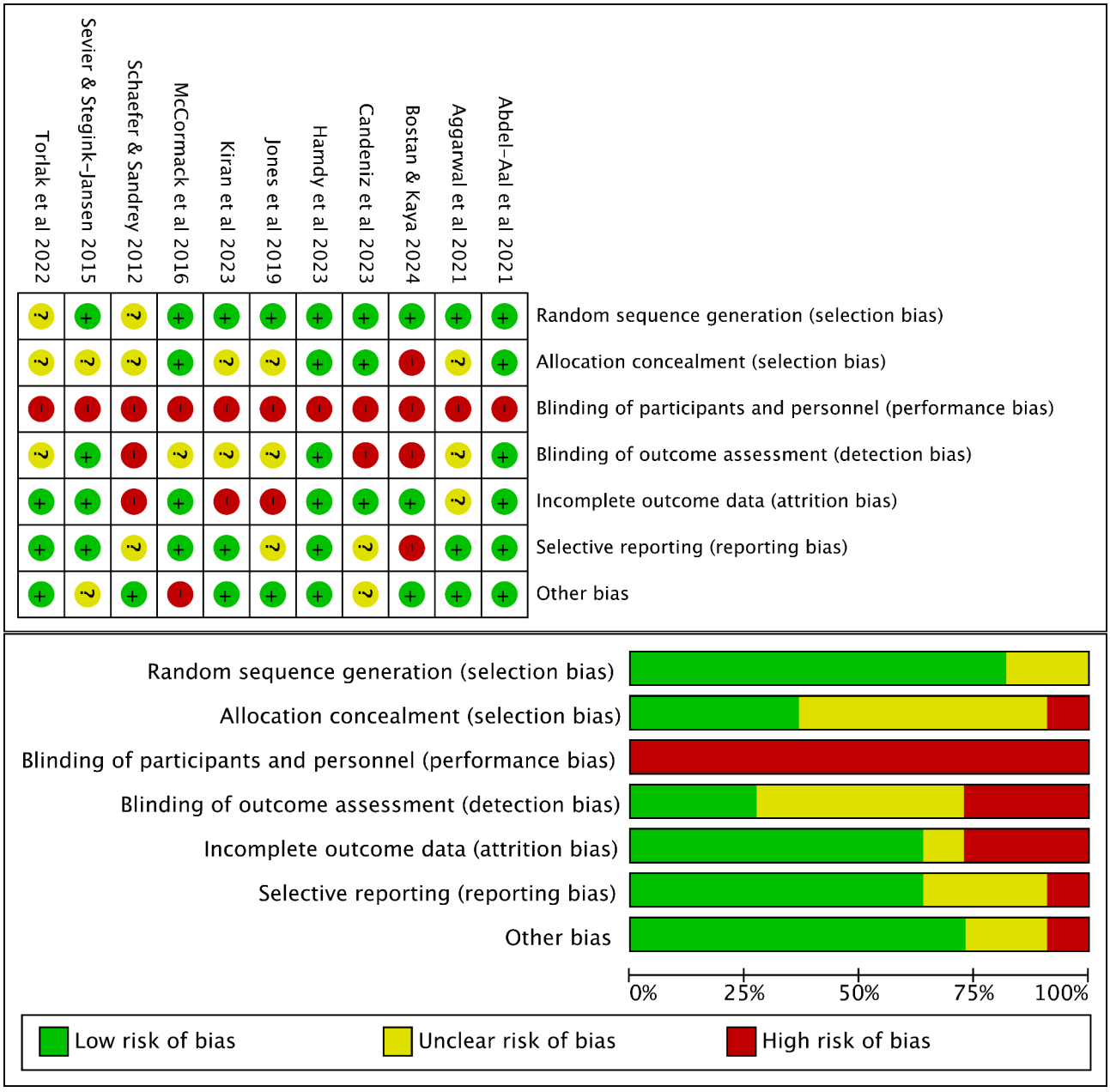

Fig. 2 Risk of bias assessment

rated as low, and the quality of evidence for balance was rated as very low (Table 2).

Discussion

Principal findings

This systematic review yielded moderate-certainty evidence indicating that IASTM can reduce patient-reported pain, and there was low-certainty evidence indicating that IASTM can improve patient-reported function.

Comparison with previous studies

To date, two systematic reviews and meta-analyses have examined the effects of IASTM on pain and function. Both studies are from the same team, and the latter is an update to the former. To our knowledge, the latter is the largest systematic review and meta-analysis examining the effects of IASTM, and both studies revealed that IASTM did not improve ROM, reduce pain, or improve function [19, 20]. The results of this study contrast with those of the previous two studies. The possible reasons for the different results are as follows: first, this study was searched up to February 2025, whereas the previous

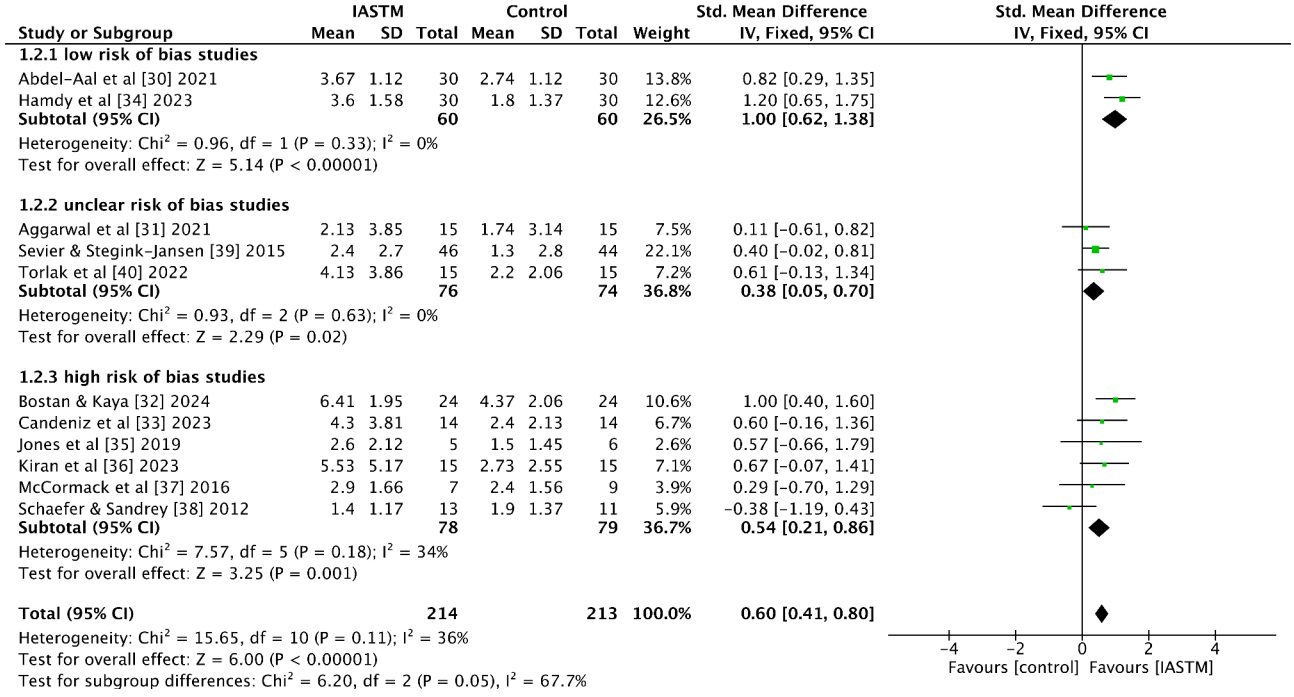

Fig. 3 Forest plot of the effect of IASTM on patient-reported pain

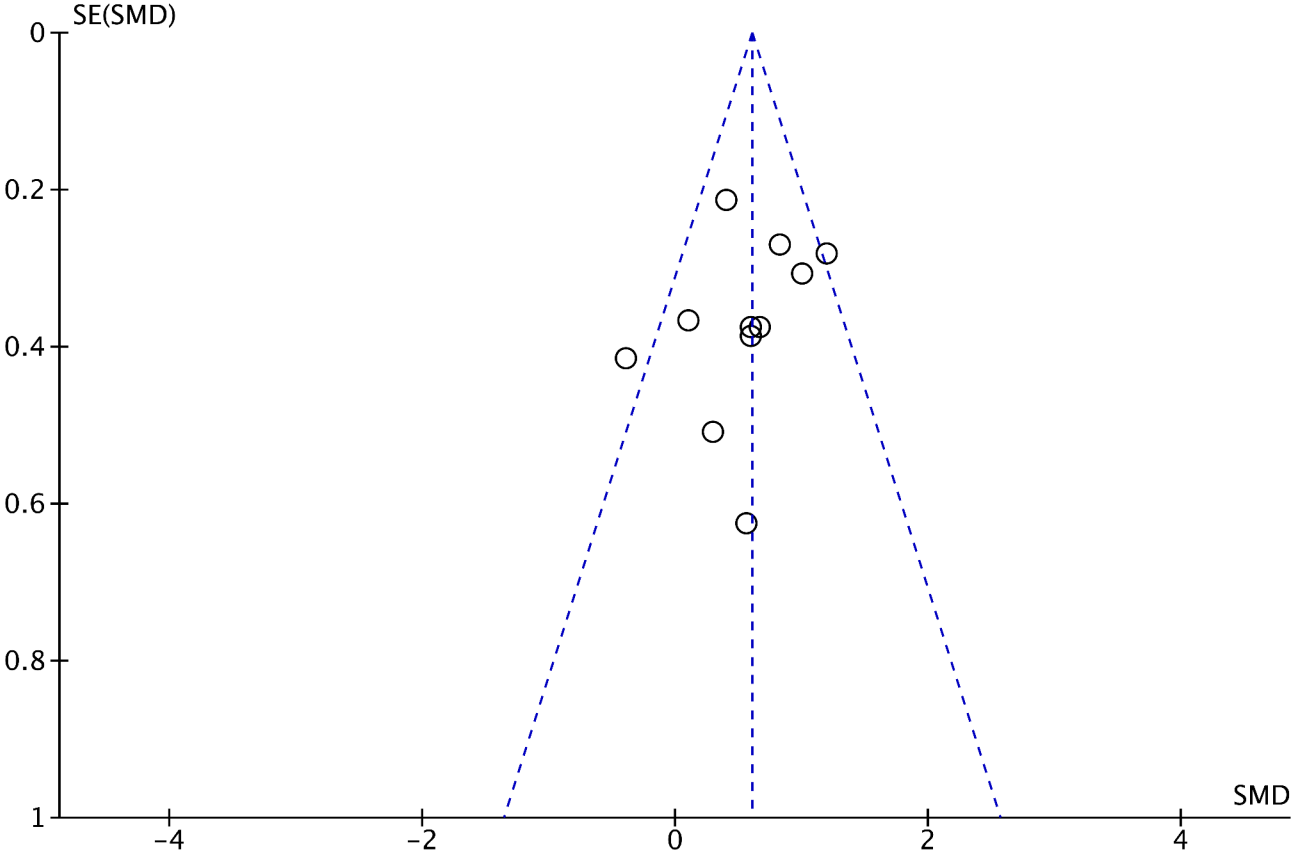

Fig. 4 Publication bias for patient-reported pain

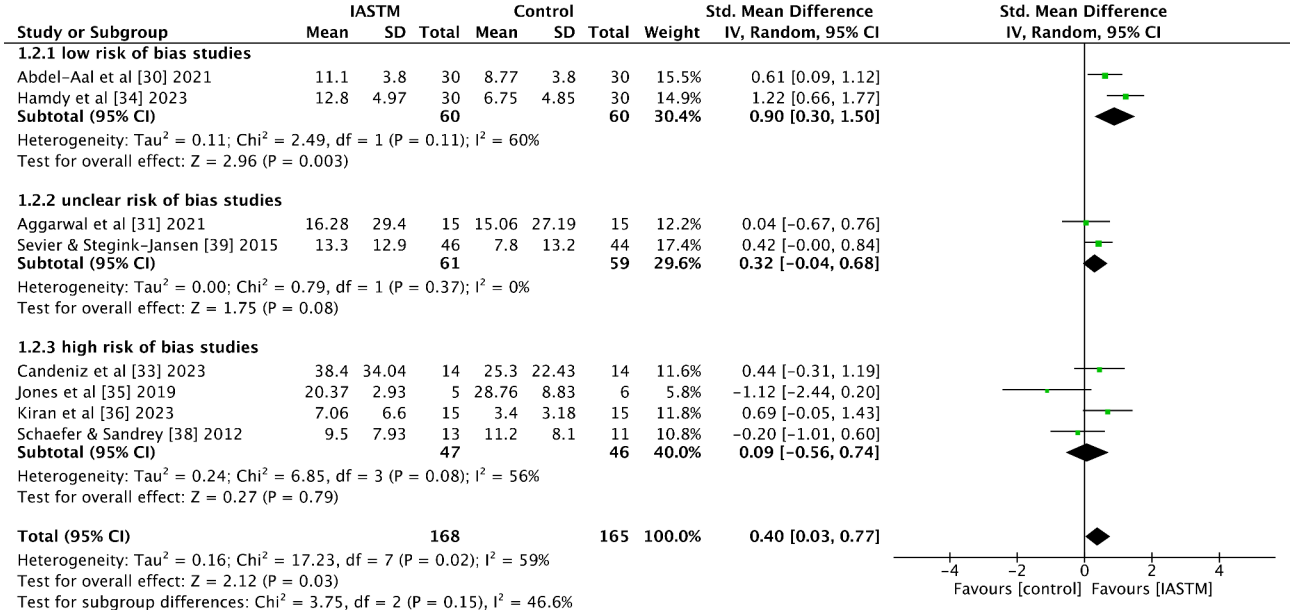

Fig. 5 Forest plot of the effect of IASTM on patient-reported function

two studies were searched up to March 2018 and January 2022 [19, 20]; thus, this study included more studies, most of which yielded positive results when the data were combined. Second, this study included only RCTs comparing IASTM in combination with other treatments to other treatments, whereas the previous studies also included RCTs comparing IASTM with other treatments or placebo [19, 20]. In the previous studies, IASTM did not show statistical validity compared with other treatments or placebo, so the researchers used this as a basis for concluding that IASTM was not effective [19, 20]. However, this ignores the possibility that IASTM was as effective as other treatments or placebo and thus may underestimate the effect of IASTM. A recent meta-analysis overturned the results of the previous two studies on IASTM on ROM by updating data and using different inclusion criteria [23]. This study also overturned the results of the previous two studies on the effect of IASTM on pain and function.

Study implications

Davidson et al. [15] proposed that the action of IASTM on soft tissues can induce microinjury and restart the healing process, thus promoting tissue repair, and reported that IASTM can promote the activation and proliferation of fibroblasts in a rat test. Other rat tests revealed that IASTM can increase local blood perfusion and the proportion of small arteries in the injured tissue and improve the strength and stiffness of the injured tissue [41, 42]. All of these animal experimental results provide a basis for IASTM to promote tissue healing and provide support for IASTM to ameliorate ROM deficits, pain, and functional limitations associated with soft tissue injuries. This study synthesized the results of 11 studies and reported that IASTM improved patient-reported pain and patient-reported function. These 11 studies involved musculoskeletal disorders, including cervicogenic headache, shoulder adhesive capsulitis, chronic neck pain, neck myofasical pain, plantar heel pain, plantar fasciitis, insertional Achilles tendinopathy, chronic ankle instability, chronic lateral elbow, and chronic migraine, which provides a range of clinical applications for the use of IASTM. In addition, this study revealed, through TSA of two low-risk-of-bias studies, that the effectiveness of IASTM for patient-reported pain could be determined earlier, even though the sample size did not meet the statistical requirements. These two low-risk-of-bias studies reported that pain in patients with nonspecific chronic neck pain and cervicogenic headache was relieved by a single treatment of 80 s or 2–3 min, 2–3 times per week for 4 weeks, respectively. On this basis, researchers are inclined to recommend the above treatment parameters to clinical staff for the treatment of musculoskeletal disorders.

Although the study revealed moderate-certainty evidence that IASTM reduces patient-reported pain, it was still unable to produce strong evidence of the effect of IASTM on pain. This is because for patient-reported assessment results, researchers cannot ignore the importance of blinding participants and researchers. Although the study revealed quantitative supportive evidence supporting the beneficial effect of IASTM on PPT, the current evidence (low-certainty) is still insufficient to draw firm conclusions. As a result, future RCTs with a low risk

Table 2 GRADE evidence profile

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication bias**	**IASTM + other treatment**	**other treatment**	**Relative (95% CI)**	**Absolute (95% CI)**	
pain (11 RCTs)	randomized trials	serious[a]	not serious	not serious	not serious	none	214	213	-	SMD **0.60 SD higher** (0.41 higher to 0.80 higher)	⨁⨁⨁◯ Moderate
function (8 RCTs)	randomized trials	serious[a]	not serious	not serious	serious[b]	none	168	165	-	SMD **0.40 SD higher** (0.03 higher to 0.77 higher)	⨁⨁◯◯ Low
PPT (1 RCT)	randomized trials	serious[c]	not serious	not serious	serious[1,d]	none	14	14	-	MD **2.67 higher** (1.13 higher to 4.21 higher)	⨁⨁◯◯ Low
balance (1 RCT)	randomized trials	very serious[e]	not serious	not serious	serious[1,d]	none	13	11	-	MD **7.10 higher** (0.80 higher to 13.40 higher)	⨁◯◯◯ Very low

CI: confidence interval; MD: mean difference; PPT: pressure pain threshold; RCT: randomized controlled trial; SMD: standardized mean difference

Explanations

a. Due to the nature of the intervention, it is not possible to be blind to both the participants and researchers, and results measured by self-reported scales may be compromised

b. The number of participants included did not meet the sample size required for TSA calculations

c. We cannot rule out the influence of factors such as force on the results, and when the nature of the IASTM intervention did not allow for the blinding of participants and researchers, we considered rating down one level

d. Although sample sizes could not be extrapolated from TSA for a single study, the recommended sample sizes on the basis of the GRADE guidelines were not enough

e. Two domains (blinding of participants and researchers and incomplete outcome data) were rated as high risk, and we rated them down two levels

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of bias and objective outcomes are needed to continue to explore the effect of IASTM on pain. Similar recommendations apply to the effect of IASTM on function. In addition, the TSA results revealed that 4 weeks of IASTM reduced patient-reported pain in patients with nonspecific chronic neck pain and cervicogenic headache; therefore, no future studies are needed to explore the short-term effects of IASTM on patient-reported pain in patients with nonspecific chronic neck pain and cervicogenic headache. To our surprise, the two studies with a low risk of bias showed different heterogeneity across outcomes when subgroup analyses of patient-reported pain ($I^2 = 0\%$) and function ($I^2 = 60\%$) were performed. For this difference, the initial hypothesis was that the heterogeneity in the functional group stemmed from the low reliability of the questionnaire used (both used the Arabic version of the Neck Disability Index [30, 34]). However, the initial study revealed that the questionnaire had good reliability (Cronbach's alpha = 0.89) [43]. Unfortunately, the researchers were unable to explain the reasons for the heterogeneity, and the impact of the heterogeneity on the results of this study is unclear. Further studies are needed to explore the possible reasons.

Strengths and limitations

To our knowledge, this is the first systematic review and meta-analysis supporting the effectiveness of IASTM in reducing pain and improving function. Additionally, this study provides a termination signal to terminate clinical studies exploring the short-term effects of IASTM on patient-reported pain in patients with nonspecific chronic neck pain and cervicogenic headache, thereby conserving scientific and medical resources.

This study has several limitations. First, the included studies included only a few musculoskeletal disorders, and the applicability of our results to other types of musculoskeletal disorders is not clear. Second, we included only studies written in English, which may lead to bias. Third, because of the limited data, we were unable to explore the effects of different tools, durations, and demographic factors (such as age, sex and ethnicity) on outcomes. Fourth, the sources of heterogeneity with respect to the effect of IASTM on patient-reported function were not identified, which may affect the accuracy of the results. Fifth, we only evaluated the immediate posttreatment effects and did not focus on long-term effects. Sixth, for the outcomes of PPT and balance, only one study examined each of these outcomes; therefore, we could not judge the domains of "inconsistency" and "publication bias", which may lead to the potential overestimation of the quality of evidence of PPT. Seventh, we conducted unscheduled GRADE and TSA.

Conclusions

IASTM can reduce patient-reported pain (based on moderate-certainty evidence) and improve patient-reported function (based on low-certainty evidence) in patients with musculoskeletal disorders. There is no need to conduct further clinical studies to explore the short-term effects of IASTM on patient-reported pain in patients with nonspecific chronic neck pain and cervicogenic headache.

Abbreviations

CI	Confidence interval
GRADE	Grading of Recommendations Assessment, Development, and Evaluation
IASTM	Instrument-assisted soft tissue mobilization
MD	Mean difference
NPRS	Numerical Pain Rating Scale
PPT	Pressure pain threshold
RCT	Randomized controlled trial
ROM	Range of motion
SD	Standard deviation
SMD	Standard mean difference
TSA	Trial sequential analyses
VAS	Visual Analogue Scale

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12891-025-08492-4.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Acknowledgements

Not applicable.

Author contributions

SE T planned the study, performed the data extraction and statistical analysis; SE T, and LS extracted the data; SET, LS and JM X assessed the risk of bias; SE T, LS, XT W, MJ L and JR C drafted the manuscript. All the authors have read the manuscript and approved it for publication.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 3 September 2024 / Accepted: 3 March 2025
Published online: 14 March 2025

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