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REVIEW ARTICLE (META-ANALYSIS)

Efficacy of Extracorporeal Shockwave Therapy on Pain and Function in Myofascial Pain Syndrome of the Trapezius: A Systematic Review and Meta-Analysis

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Abstract

Objective: To evaluate the effect of extracorporeal shockwave therapy (ESWT) on pain and function in myofascial pain syndrome (MPS) of the trapezius.

Data Sources: PubMed, EMBASE, Web of Science, Physiotherapy Evidence Database, and The Cochrane Central Register of Controlled Trials were systematically searched from the time of their inception to September 2019.

Study Selection: Randomized controlled trials comparing the effects of ESWT on MPS of the trapezius were included in this review.

Data Extraction: Data related to study participants, intervention, follow-up period, measure time, and outcomes were extracted. The Physiotherapy Evidence Database scale and the Cochrane Collaboration Tool for Assessing Risk of Bias were used to assess study quality and risk of bias.

Data Synthesis: In total, 10 articles (n=477 patients) met our criteria and were included in this study. The overall effectiveness was calculated using a meta-analysis method. The meta-analysis revealed that ESWT exhibited significant improvement in pain reduction compared with sham ESWT or ultrasound treatment, but no significant effect when compared with conventional treatments (dry needling, trigger point injection, laser therapy) as for pain intensity and neck disability index.

Conclusions: ESWT appears to benefit patients with MPS of the trapezius by alleviating pain. ESWT may not be an ideal therapeutic method to replace conventional therapies but could serve as an adjunct therapeutic method to those treatments.

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Myofascial pain syndrome (MPS) is a musculoskeletal disorder with sensory, motor, and autonomic symptoms.[1] It is characterized by the presence of hyperirritable spots, known as myofascial trigger points (MTrPs) in palpable taut bands of skeletal muscle fibers, which is consistent with the pain symptom.[2-4] A recent survey of patients with chronic nonspecific neck pain showing MPS found that MTrPs were prevalent (93.75%) in the upper trapezius muscles,[5] causing tenderness, motor dysfunction,[4] autonomic phenomena, and other abnormal health conditions.

Management of MPS is based on the correction of mechanical imbalance along with inhibition and elimination of the formation of trigger points.[6] There are various therapeutic interventions available to alleviate pain in the clinic, including drug therapy, exercise, physical therapy, acupuncture, and needling therapy (dry needling, trigger point injection). However, the most appropriate, proper, and effective methods are still under debate, and MPS remains among the most challenging diseases contributing to musculoskeletal pain conditions.[6,7]

As a noninvasive, safe, and tolerable physical therapy, extracorporeal shockwave therapy (ESWT) has been reported

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to exert various therapeutic effects on musculoskeletal conditions.[8,9] Since Kraus et al first reported that ESWT might treat myogelosis of the masseter muscle in 1999,[10] it has been reported that focused shockwaves or radial shockwaves can be used to treat MPS. However, evidence-based medical evidence to determine the effectiveness of ESWT for MPS of the trapezius muscles is currently limited. In 2015, a review conducted by Ramon et al showed that ESWT seems to be a promising new possibility for the management of MPS over the whole body,[11] but quality of the evidence was low because of the small number of patients and the lack of quantitative methodological analysis. In recent years, there have been several randomized controlled trials (RCTs) on the effect of ESWT in patients with MPS of the trapezius, but their results are inconsistent with each other. Therefore, we aimed to determine whether ESWT is effective in reducing pain and improving functional capacity in patients with MPS of the trapezius in this systematic analysis.

Methods

This systematic review and meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[12] A comprehensive search of the literature was conducted using PubMed, EMBASE, Web of Science, Physiotherapy Evidence Database (PEDro), and The Cochrane Central Register of Controlled Trials databases from database inception to September 2019. We searched the Medical Subject Headings, text words, and word variants for "extracorporeal shock wave therapy" and "myofascial pain syndrome." Reference lists of the relevant studies were manually screened to identify further studies for inclusion.

Studies were included if they met the following criteria: (1) RCTs, (2) included patients diagnosed with MPS of trapezius muscle (treated muscle) with the presence of MTrPs, (3) experiment groups treated with ESWT, (4) control groups treated with sham ESWT or other treatments, and (5) used at least 1 of either pain intensity or functional disability as an outcome measure to assess the effect. Studies were excluded if: (1) they were reviews, case reports, or conference articles; (2) non-English articles; (3) when different types of ESWT were compared with each other; and (4) RCT had no data results. Data were extracted by 2 reviewers independently. A test data form was used to extract the following data: general article information (first author, year of publication), country or region of the population, sample size, mean age of the participants, intervention (type, session length, frequency, and total duration of ESWT and/or other intervention), follow-up period, measure time, and outcomes. Extracted data were entered into a database and checked by another reviewer. The PEDro tool was used to assess the methodological quality of the individual studies.[13] Studies scoring less than 4 points were deemed to be of poor quality, those scoring 4 to 5 points were deemed to be fair quality, those scoring 6 to 8 points were deemed to be of good quality, and those scoring 9 or 10 points were deemed to be of excellent quality. To determine the risk of bias, the Cochrane Collaboration Tool for Assessing Risk of Bias[14] was used to evaluate whether each study had a high, low, or unclear risk of bias. The research articles included in this study were assessed independently by 2 reviewers. For any disagreements, decisions were made after discussion with a third reviewer.

Review Manager software (RevMan, version 5.3)[a] was used to perform meta-analyses. The mean difference (MD) was presented as the effect size, and its 95% confidence interval (CI) was computed or replaced by the standard mean difference (SMD). The potential heterogeneity across studies was tested and quantified with the I^2 statistics. If heterogeneity existed (I^2 >50%, P<.05), a random-effects model was applied. If not, the fixed-effects model was chosen. Moreover, subgroup analysis was performed to establish the effectiveness relative to the treatment methods in the control group. Sensitivity analysis was conducted by deleting each study individually to evaluate the quality and consistency of the results if high heterogeneity presented.

List of abbreviations:

CI	**confidence interval**
ESWT	**extracorporeal shockwave therapy**
MD	**mean difference**
MPS	**myofascial pain syndrome**
MTrP	**myofascial trigger point**
NDI	**neck disability index**
PEDro	**Physiotherapy Evidence Database**
RCT	**randomized controlled trial**
SMD	**standard mean difference**

Results

Study selection

The details of the study selection flow diagram are shown in figure 1. A total of 75 records were identified through the initial electronic searches of PubMed (n=21), EMBASE (n=19), Web of Science (n=16), PEDro (n=8), and The Cochrane Central Register of Controlled Trials (n=11). See supplemental appendix S1 (available online only at http://www.archives-pmr.org/) for the full electronic search strategy for the EMBASE and PubMed databases. After removing duplicates, 41 citations remained. Seventeen potentially relevant articles were selected based on the title and abstract of the articles. After careful and detailed evaluation by the reviewers, we identified 10 clinical trials to be included for quantitative analysis in our final review. Of the 7 excluded studies, 4 were not RCTs.[11,15-17] In 2 trials,[18,19] ESWT was applied in both comparison groups and aimed to explore better parameters of ESWT for MPS. One trial evaluated the effect of ESWT plus other treatment on nonspecific shoulder-neck pain versus a reference group.[20]

Study characteristics

The characteristics of all the involved RCTs are summarized in table 1. Ten studies with a total of 480 patients diagnosed with MPS of the trapezius muscle were included. Among the 10 studies, the total number of patients in each study ranged from 20 to 70. The duration of MPS associated with neck and shoulder pain was all chronic; however, 4 studies did not describe this item. The intervention group received radial/focused ESWT targeting the confirmed MTrPs. The frequency of intervention in the studies varied from 1 session per week to 3 sessions per week, the duration of treatment lasted from 2 to 4 weeks, and the total

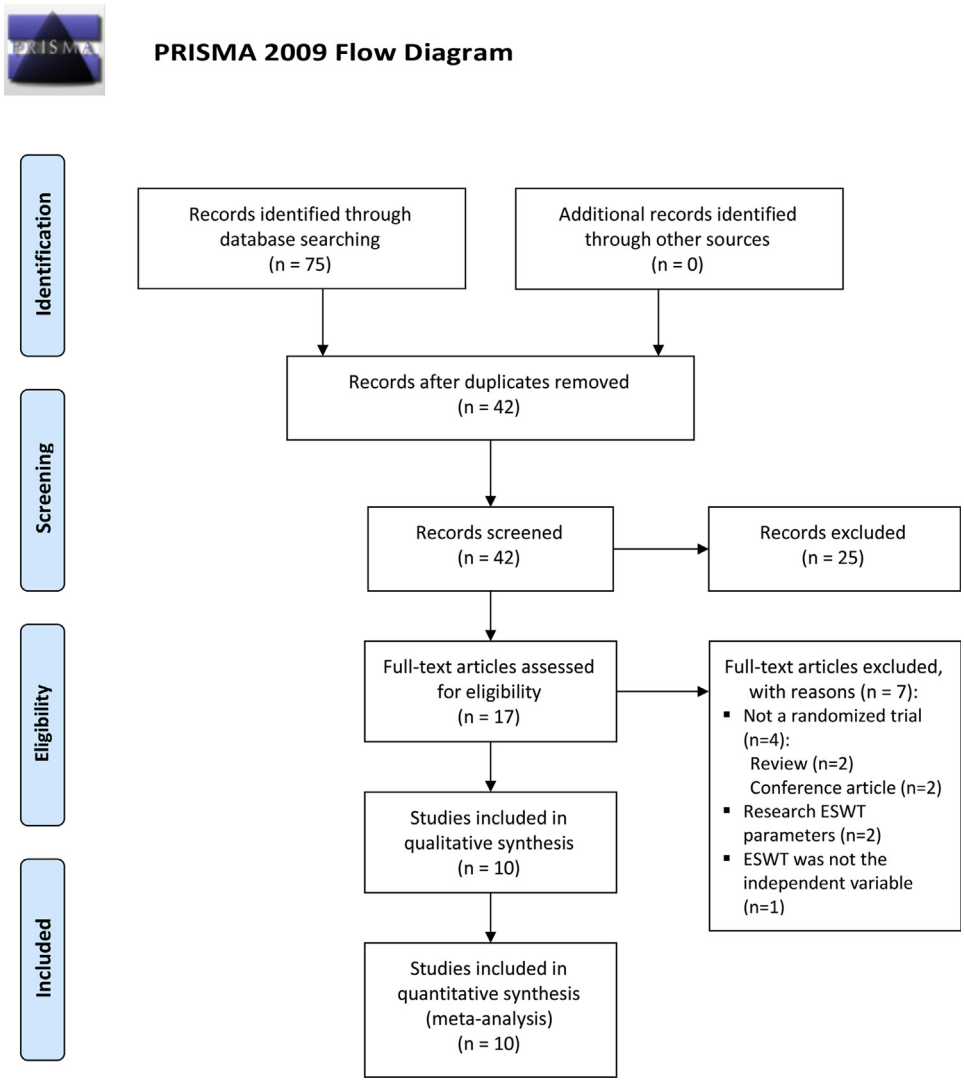

Fig 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart of study selection.

number of sessions ranged from 3 to 12 sessions. In addition, the total time of follow-up ranged from none to 12 weeks. No procedure-related adverse events were reported. Details about the control treatments are recorded in table 1. In addition, there was a follow-up assessment of participants in 5 studies[26-29] to evaluate the long-term effects of ESWT on MPS of the trapezius.

Different scales, such as the visual analog scale,[21-23,25-29] numerical pain rate scale,[27] or patient global assessment[24] were used as quantitative indicators of pain intensity. Functional disability related to shoulder and neck pain on daily activities was measured using the neck disability index (NDI). The higher the score, the more serious pain and dysfunction in the cervical area.[24]

Methodological quality and risk of bias within studies

The quality of the included studies is presented in table 2. Four studies were labeled as good quality trials, 5 studies were deemed to be fair quality, and 1 was found to be poor quality. Figure 2 shows the results of the assessment of bias of risk.

ESWT versus sham ESWT

Two trials[23,27] involving a total of 60 patients with MPS assessed the postintervention effectiveness of ESWT compared with sham ESWT in terms of alleviating pain intensity. The data available from the pooled studies in the fixed-effects models significantly favored ESWT in pain intensity for MPS on trapezius muscle compared with sham treatment ($I^2=0\%$; MD = −2.02; 95% CI, −2.86 to -1.17; $P<.00001$) (fig 3).

ESWT versus control treatments

Compared with conventional treatments, the effectiveness of ESWT on MPS for neck and shoulder pain right after intervention were assessed in terms of pain intensity in 10 trials.[21,22,24-30] Strong evidence for statistical heterogeneity was detected among

Table 1 Descriptive data of the included studies

Study	Country	Sample Size	Age (y) ESWT/ Control	Duration	ESWT Group	Control Group	Follow-up	Measure Time	Outcomes
Cho et al[21]	Korea	12 12 12	47.06±13.53 47.67±10.49 48.08±12.24	—	ESWT: 0.12 mJ/mm^2, 12 sessions (3 sessions/wk for 4 wk)	Exercise ESWT+Exercise	—	Before treatment, after the entire 4-wk treatment	VAS, PPT, NDI, CMS
Jeon et al[22]	Korea	15 15	40.86±13.07 45.00±15.46	—	ESWT: 1500 impulses. 0.10 mJ/mm^2 3 sessions (1 sessions/wk for 3 wk)	TPI+TENS: 3 TPI treatments with a 1-wk interval; 5 TENS treatments in a week for 20 min a day	—	Before treatment, 1 wk after the 1st and 3rd treatments	VAS, MPQ, PRS, ROM (curvature, extension, rotation, lateral bending), PPT
Ji et al[23]	Korea	9 11	32.82±12.71 34.00±15.56	—	ESWT: 1000 impulses, 0.056 mJ/mm^2, 4 sessions (2 sessions/wk for 2 wk)	Sham ESWT	—	Before treatment, right after treatment	VAS, PPT
Gur et al[24]	Turkey	30 29	37.00±11.51 35.07±12.23	33.83±31.38 mo 35.34±31.50 mo	ESWT: 1000 impulses, 0.25 mJ/mm^2, 3 sessions at 3-d intervals	Ultrasound: 1.5 Wt/cm^2 dosage in pulse mode for 5 min with 1 MHz, 10 sessions (5 sessions/wk for 2 wk)	12 wk	Before treatment, at 3 and 12 wk of treatment	PGA, MDGA, NPADS, NHP, HAMA
Lee and Han[25]	Korea	11 11 11	51.61±8.3 51.92±7.53 52.67±7.58	—	ESWT: 1000 impulses, 5 Hz, 8 sessions (2 sessions/wk for 4 wk)	PNF; TPI	—	Before treatment, right after treatment	VAS, PPT, NDI, CMS
Taheri et al[26]	Iran	26 20	42.3±10.4 45.3±7.7	>1 mo	Exercise-medication-shockwave therapy: 1000 impulse, 3 J/m^2 and 10 Hz, 3 sessions, 2 wk	Exercise-medication-LLLT group: Indolaser device, type Ga-AL-As with 6 J/cm^2, average power 100 mW for a total of 3 min on each spot, 10 sessions	4 wk	Before treatment, right after treatment, and 4 wk after treatment	VAS, NDI, SPADI
Akturk et al[27]	Turkey	20 20 20	33.45±8.02 35.45±8.07 35.65±11.03	>6 mo	ESWT: 1.6-3.0 bar, 2000-3000 shocks, maximum 3 min/session, 4 sessions (2 sessions/wk for 2 wk)	Sham ESWT; Ultrasound: 1.5 Wt/cm^2 for 5 min, 10 sessions (5 sessions/wk for 2 wk)	4 wk	Before treatment, right after treatment, 1 mo after treatment	PPT, TPS, VAS, SF-36, HADS

(*continued on next page*)

Table 1 (*continued*)

Study	Country	Sample Size	Age (y) ESWT/ Control	Duration	ESWT Group	Control Group	Follow-up	Measure Time	Outcomes
Kiraly et al[28]	Hungary	30 31	57.26±14.31 62.62±9.62	>8 wk	ESWT: 1000 impulses, 1.5-2 bar, 10 Hz, 0.25 mJ/mm^2, 3 sessions (1 session/wk for 3 wk)	LLLT: 2000 Hz (800 mW), 3 J/cm^2 for 2 min, and 5000 Hz (2000 mW), 9 J/cm^2 for 2 min; 15 sessions (5 sessions/wk for 3 wk)	12 wk	Before treatment, right after treatment, 1 mo after treatment	VAS, NDI, SF-36
Luan et al[29]	China	30 32	32.47±10.58 33. 09±12.78	8.30±3.10 mo 8.91±2.73 mo	ESWT: 2000 shockwaves, 0.10 mJ/mm^2, 3 sessions (1 session/wk for 3 wk)	Dry needling	4 wk, 12 wk	Before treatment, immediately after the first therapy, 1 mo, 3 mo	VAS, PPT, NDI, shear modulus
Manafnezhad et al[30]	Iran	35 35	37±9.1 39.2±7.2	12 mo	ESWT: 1000 impulses, 60 mJ, 16 Hz, 3 sessions (1 session/wk for 3 wk)	Dry needling	—	NPRS and PPT in intervention sessions 1 to 4 NDI in session 1 and 1 wk after the last session	NPRS, NDI, PPT

CMS, Constant-Murley Scale; ESWT, extracorporeal shockwave therapy; HADS, hospital anxiety and depression scale; HAMA, Hamilton Anxiety Evaluation Scale; LLLT, Low Level Laser Therapy; MDGA, Physician's Global Assessment; MPQ, McGill pain questionnaire; NDI, neck disability index; NHP, Nottingham Health Profile; NPADS, Neck Pain and Disability Scale; NPRS, numeric pain rating scale; PGA, Patient Global Assessment; PPT, pressure pain threshold; PRS, Pain Rating Scale; ROM, range of motion; SF-36, The MOS 36-item short-form health survey; SPADI, Shoulder Pain and Disability Index; TENS, transcutaneous electrical nerve stimulation; TPI, trigger point injection; TPS, trigger point pain score.

Table 2 Methodological quality assessment of the included studies

Study	Eligibility Criteria	Random Allocation	Concealed Allocation	Baseline Comparability	Blind Subjects	Blind Therapists	Blind Assessors	Adequate Follow-up	Intention-to-Treat Analysis	Between-Group Comparisons	Point Estimates and Variability	Total
Cho et al[21]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	5/10
Jeon et al[18]	Y	Y	N	Y	N	N	N	N	N	Y	Y	4/10
Ji et al[22]	Y	Y	N	Y	Y	N	N	N	N	Y	Y	5/10
Gur et al[24]	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10
Lee and Han[25]	Y	Y	N	Y	N	N	N	N	N	Y	Y	4/10
Taheri et al[26]	Y	Y	N	N	N	N	N	N	N	Y	Y	3/10
Akturk et al[27]	Y	Y	N	Y	N	N	N	N	N	Y	Y	4/10
Kiraly et al[28]	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	8/10
Luan et al[29]	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	7/10
Manafnezhad et al[30]	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10

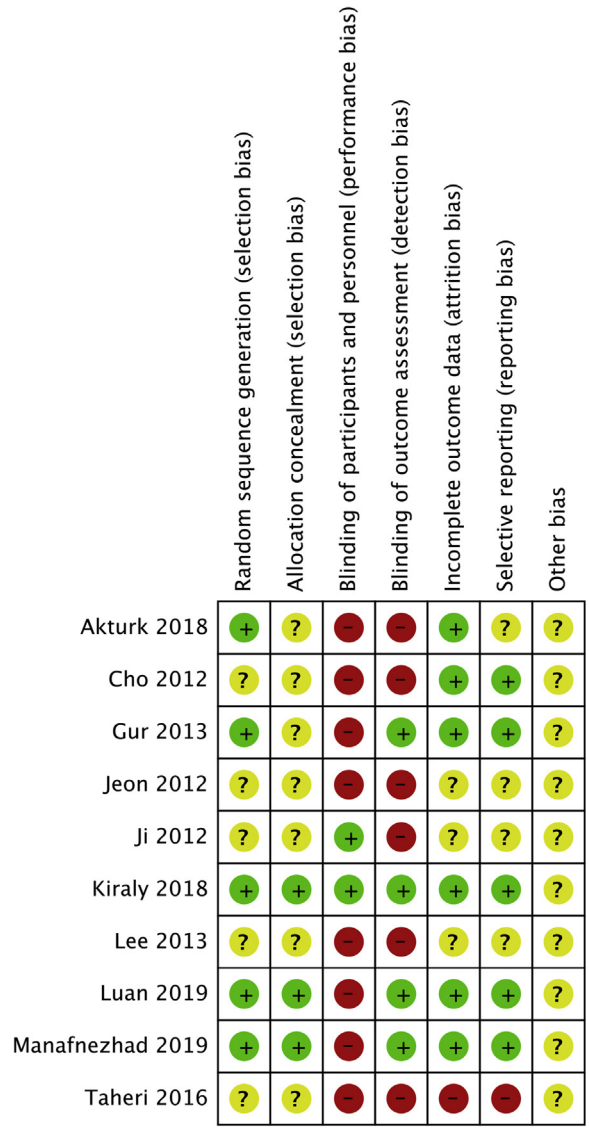

Fig 2 Assessment of bias risk. (+) indicates a low risk of bias, (?) indicates an unclear risk, and (−) indicates a high risk of bias.

trials in dry needling, trigger point injection, laser therapy, and other treatment subgroups with no significant relief in pain. In the ultrasound subgroup, ESWT intervention was more effective for pain reduction with low heterogeneity ($I^2 = 36\%$; SMD = −1.20; 95% CI, −1.74 to −0.66; $P < .0001$) (fig 4).

The NDI represents the influence of neck pain on one's daily activities. With regard to neck function, NDI was assessed in 5 RCTs.[21,25,26,28,30] Sensitivity analyses were conducted by removing 1 study[26] that offered inferior evidence for the immediate effect of ESWT. The pooled result of the remaining studies showed that the heterogeneity became 0. Although ESWT decreases the NDI score in the ESWT group compared with control treatments, no statistical significance was found ($I^2 = 0\%$; MD = −0.28; 95% CI, −1.01 to 0.44; $P = .45$) (fig 5).

During follow-up, only 1 study[27] suggested that 4 sessions of ESWT were more effective in the treatment of MPS and decreased clinical manifestations more than sham ESWT after 4 weeks of follow up. Additionally, 6 included studies presented follow-up results of 4 weeks[15,26,27] or 12 weeks[15,24,28] after treatment to

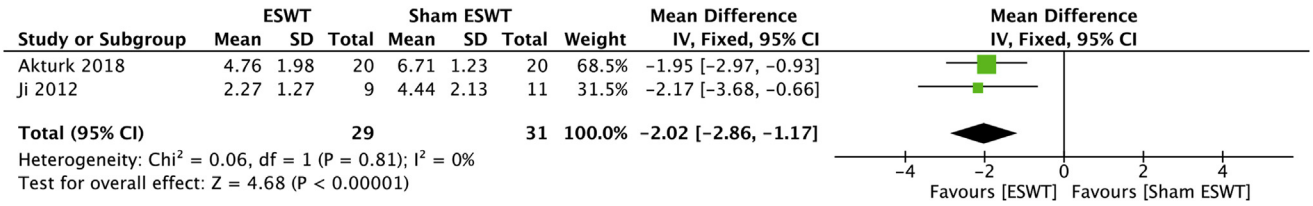

Fig 3 Forest plot of included studies comparing the effects of EWST and sham ESWT on pain reduction in patients with myofascial pain syndrome of the trapezius.

discuss the long-term effect of ESWT on MPS of the trapezius compared with conventional control treatments. As a result, no significant difference was observed between ESWT and those treatments as for pain intensity (I^2=27%; SMD=−0.20; 95% CI, −0.41 to 0.02; P=.08) (fig 6A) and NDI parameters (I^2=0%; MD=−0.16; 95% CI, −0.82 to 0.51); P=.64) (fig 6B).

Discussion

The preliminary finding of this systematic review and meta-analysis indicated that patients with MPS of the trapezius appeared to experience improvement in pain relief after ESWT treatment, compared with sham ESWT or ultrasound. However, there is no evidence that the effect of ESWT is superior to other conventional treatments (eg, dry needling, trigger point injection, laser therapy) in alleviating pain intensity and improving functional disability of the neck.

Pain intensity is one of the most important variables used to assess the efficacy of any pain-relieving treatment. The main mechanism of pain and inflammation in an active MTrP of the trapezius was linked to the synthesis and release of hypoxic responsive proteins, inflammatory mediators, neuropeptides, catecholamines, and cytokines.[31-33] This meta-analysis proves that ESWT may be an effective and safe treatment modality. In recent years, studies have indicated that ESWT exposure improved the blood flow distribution around the treated muscle leading to anti-inflammatory action and pain reduction. One previous study also

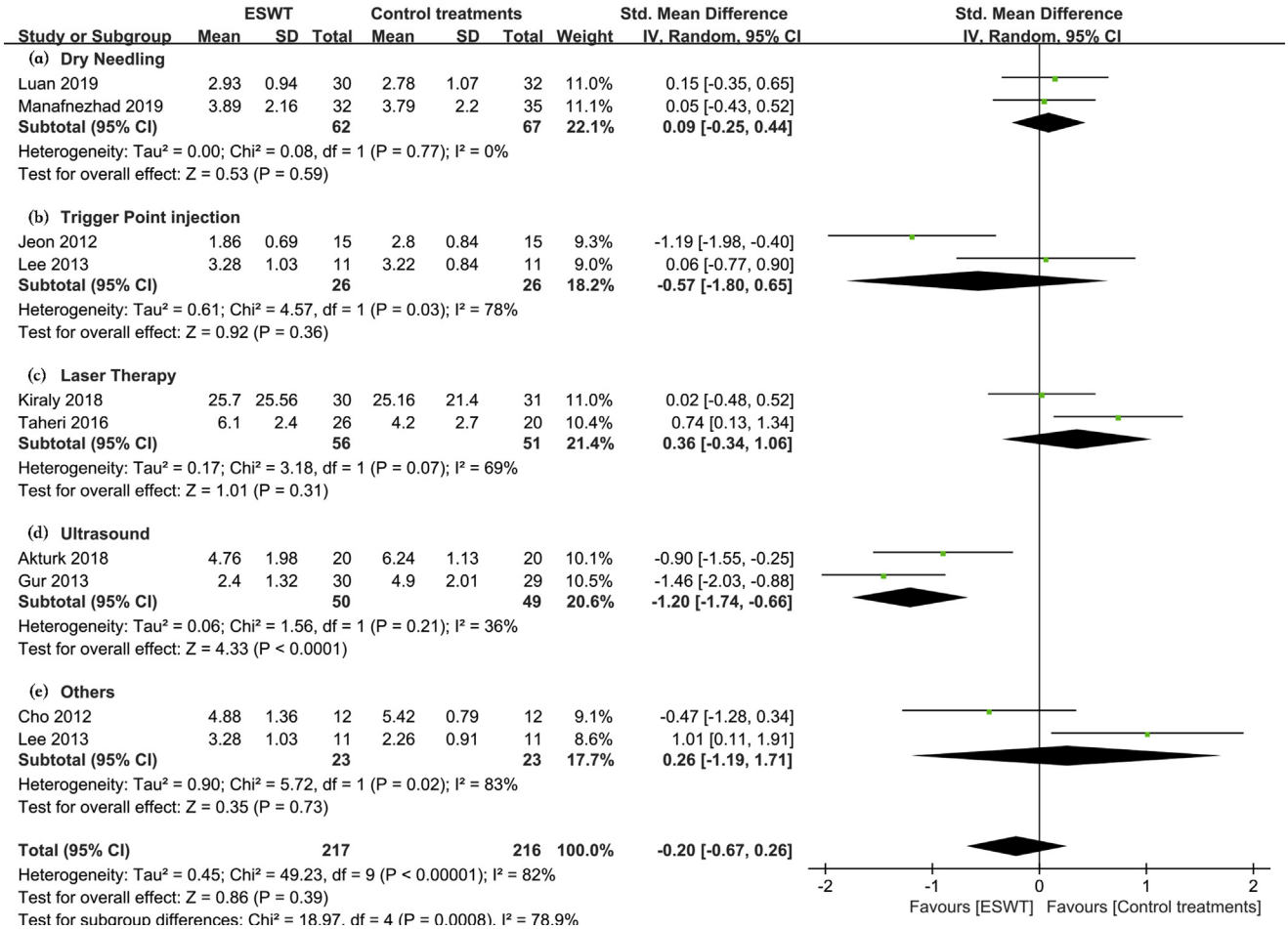

Fig 4 Forest plot of included studies comparing the effects of extracorporeal shockwave therapy with dry needling, trigger point injection, laser therapy, ultrasound, and other treatment subgroups for pain reduction in patients with myofascial pain syndrome of the trapezius.

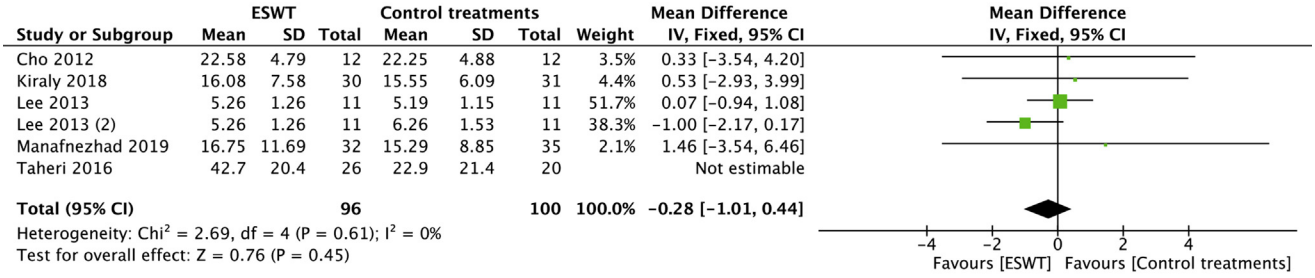

Fig 5 Sensitivity analysis of included studies comparing the effects of extracorporeal shockwave therapy with representative treatments on the neck disability index in patients with myofascial pain syndrome of the trapezius.

demonstrated that ESWT-induced pain relief effects could be explained by the cascade of biochemicals in response to hypoxia stimulation, acting as the up-regulation of nitric oxide levels, ingrowth of endothelial nitric oxide synthase activity, and down-regulation of nuclear factor kappa B expression.[34]

As conventional treatments for MPS in trapezius muscle, dry needling and trigger point injection are invasive treatments targeting the pain trigger points and have been used widely in clinical practice. As a noninvasive method, ESWT could help to avoid adverse events or allergic reactions, which may be induced by needle stimulation. However, it is worth noting that there was no significant superiority of ESWT in pain relief and functional capacity improvement of the neck compared with conventional treatments, including needling techniques, in this meta-analysis. Considering these, it is reasonable to state that ESWT may not be an ideal therapeutic method to replace

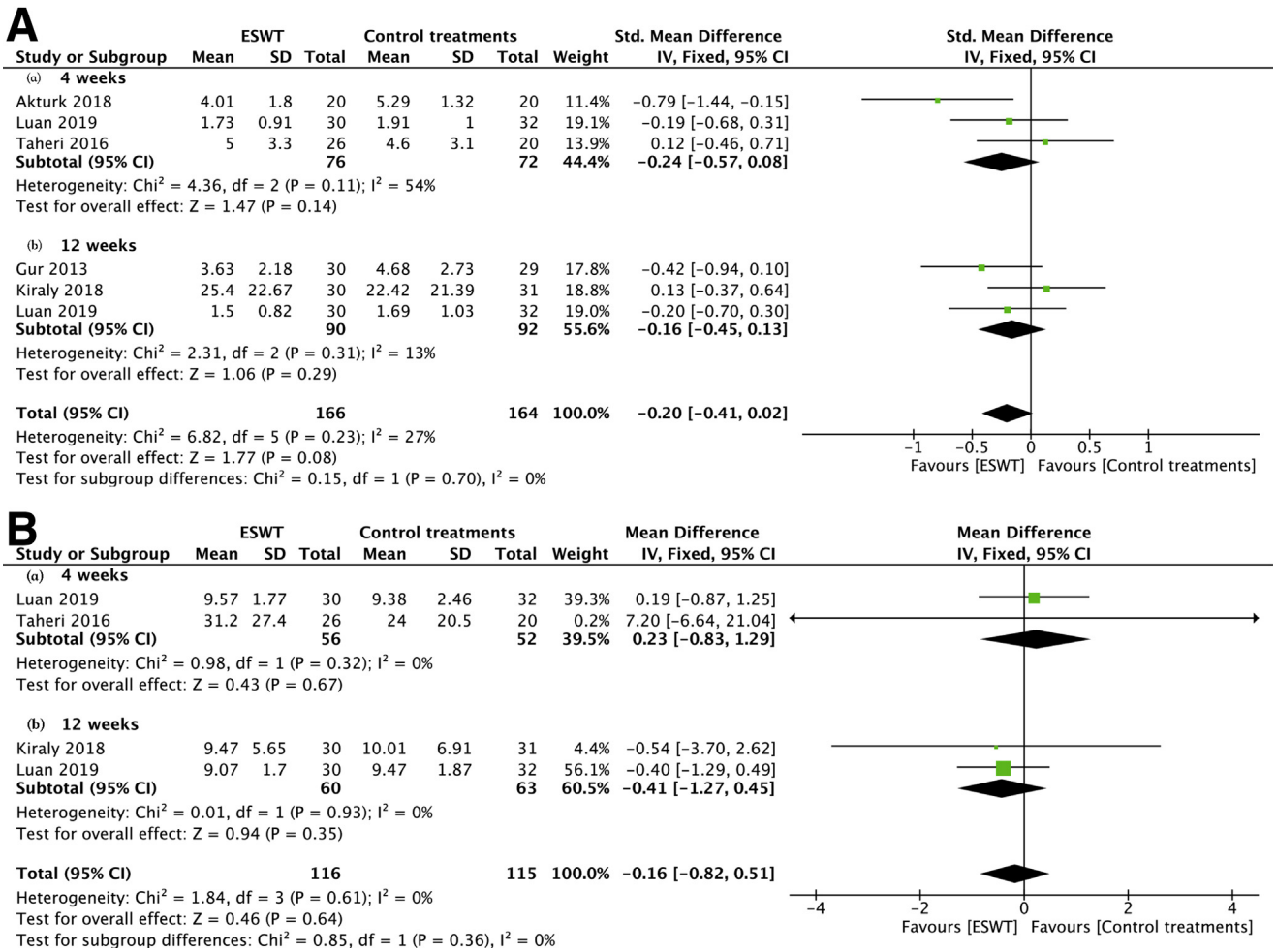

Fig 6 Forest plot of included studies comparing the effects of extracorporeal shockwave therapy with representative treatments on pain reduction (A) and neck disability index (B) in patients with myofascial pain syndrome of the trapezius at follow-up at 4 (a) and 12 (b) weeks.

conventional therapies. Nonetheless, some studies have indicated that ESWT could serve as an adjunct therapeutic method to conventional treatments. One study conducted by Damian et al detected that radial shockwave combined with physical therapy helped musicians with nonspecific shoulder-neck pain feel temporarily pain relief.[20] Another study observed significant improvements of pain relief and functional capacity with ESWT plus stabilization exercises versus ESWT alone.[21] These findings demonstrate that combining ESWT with other treatments might reasonably be considered as novel therapeutic methods for MPS in the clinic. Future studies focused on patient satisfaction with treatment and appropriate initial therapy would be helpful in guiding treatment.

To date, there is no uniform suggestion regarding intensity of energy, number of shocks, or duration of treatment with ESWT in MPS of the trapezius. This study found that the highest proportion of the included treatment protocol consisted of 3 sessions conducted over a 3-week period, performed with energy flux density range of 0.10 to 0.25 mJ/mm^2. Among the trials included, Gur et al observed reduction of pain intensity in both ESWT-treated groups, with a more significant reduction shown with 3 sessions of treatment than in a single-session regimen.[18] In addition, Park et al demonstrated that high-energy ESWT was more effective in improving NDI and neck flexion range of motion compared with low-energy ESWT.[19] Thus, more studies are needed to further determine which parameters of ESWT are the most effective.

Study limitations

The present study still has some potential limitations. The inclusion criteria of this study were limited to studies written in English. Therefore, it is possible that relevant studies published in other languages could be missed. Additionally, because of the small number of included studies and sample size, it is possible that there is not enough statistical power to support our findings. In addition, because our study was conducted without distinguishing which type of ESWT is most effective and what parameters are optimal, this meta-analysis remains to be further improved in future.

Conclusions

ESWT appears to be correlated with greater pain relief compared with sham ESWT or ultrasound in patients with MPS of the trapezius. However, because the number of included trials was small and because of the heterogeneity of the studies, this study could not reach a conclusion on the long-term effects of EWST on pain or the effect of the treatment on function. Thus, the conclusion needs careful reference. It appears that ESWT may not be an ideal therapeutic method to replace conventional therapies, but that it could serve as an adjunct therapeutic method to those treatments. Additional high-quality clinical trials with large sample sizes are needed to analyze the effect of ESWT in the future.

Supplier

a. RevMan; Cochrane Collaboration.

Keywords

Extracorporeal shockwave therapy; Myofascial pain syndromes; Pain; Trapezius

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