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Review Article

Dry needling for mechanical neck pain: A systematic review and meta-analysis of randomized controlled trials

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ABSTRACT

Background: Dry needling (DN) has emerged as a potential treatment for mechanical neck pain, but the evidence remains inconclusive. This study aimed to assess the efficacy of DN in improving pain and functionality in patients with chronic mechanical neck pain.

Methods: A systematic review and meta-analysis of randomized controlled trials (RCTs) were conducted following the Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines. Databases, including PubMed, Cochrane Library, Scopus, and Google Scholar, were searched from December 2013 to January 2024. Studies involving adult participants with chronic mechanical neck pain treated with DN were included in the study. The primary outcomes were pain pressure threshold (PPT), Neck Disability Index (NDI), and cervical range of motion. Statistical analysis used a random-effect model.

Results: Nine RCTs with a total of 540 participants were included in the study. DN significantly improved the PPT with an MD of 0.52 (95% confidence interval [CI], 0.39–0.65; $P < 0.001$). NDI also showed a significant improvement, with an MD of −0.68 (95% CI, −1.32–−0.05; $P = 0.04$). In terms of cervical range of motion, DN improved flexion (MD 4.07, 95% CI, 0.39–7.75; $P = 0.03$) and right rotation (MD 8.20, 95% CI, 3.05–13.35; $P = 0.002$), but no significant differences were observed in extension, left rotation, or lateral flexions ($P > 0.05$).

Conclusion: DN appears effective in short-term pain relief and functional outcomes for patients with mechanical neck pain but shows limited impact on the cervical range of motion.

Keywords: Dry needling, Mechanical neck pain, Meta-analysis, Pain relief, Randomized controlled trials, Randomized clinical trials

INTRODUCTION

Studies have shown neck pain to be a major contributor to disability, ranking it fourth in terms of years lived with disability.[18] The sheer prevalence of mechanical neck pain is staggering, with

nearly half of the Western population experiencing it at some point in their lives.[8] Chronic neck pain is also more common in women, affecting roughly 15% compared to 10% of men.[27]

Dry needling (DN) is rapidly gaining popularity among patients seeking newer options for the treatment of mechanical neck pain-associated symptoms.[9] However, the current evidence for DN in managing mechanical neck pain is mixed, with studies showing both positive and comparable effects to other therapies.[1,3,9-11,17,19,21,26] To clarify the effectiveness of this approach, we conducted a systematic review and meta-analysis of recent randomized controlled trials (RCTs) on DN for mechanical neck pain. This analysis will synthesize data to provide a clearer picture of the therapy's efficacy, informing decision-making for both healthcare professionals and patients.

MATERIALS AND METHODS

This meta-analysis was performed and documented in accordance with the Cochrane guidelines and the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) framework.[22] The study protocol is registered with PROSPERO under the registration number (CRD42024547730).

Literature search

We conducted a thorough search for pertinent terms in electronic databases such as MEDLINE/PubMed, Scopus, Cochrane Library, and Google Scholar from December 2013 to January 2024 using a search strategy consisting of medical subject headings terms about DN, mechanical neck pain, and chronic neck pain. Studies published in English were included in this review. A detailed search strategy adopted for conducting database searching is shown in Supplementary Table 1.

Inclusion and exclusion criteria

Studies were included if they were RCTs involving participants aged 18 years or older diagnosed with chronic and mechanical neck pain who received DN therapy as part of the intervention. The rest of the eligibility criteria is shown in Supplementary Table 2.

Study screening and selection

We utilized Mendeley Desktop version 1.19.8 (Mendeley Ltd., Amsterdam, The Netherlands) to remove duplicates and screen the articles obtained from our online search. Following the deduplication process, two authors independently conducted the initial screening of titles and abstracts. The articles that passed this stage underwent a thorough full-text review by the same authors. In cases where discrepancies arose, a third reviewer was consulted to resolve the differences.

Data extraction

Data were extracted by three reviewers independently into an Excel spreadsheet to ensure consistency of data extraction. Relevant data items extracted included the last name of the first author, publication year, sample size, the mean age of patients, number of female patients, duration of symptoms, baseline height and BMI values, and baseline Neck Disability Index (NDI) scores, if available. Our outcomes included pain pressure threshold (PPT) after treatment, NDI score post-treatment, cervical range of motion in terms of flexion, extension, right and left rotation, right and left lateral flexion if available, and numerical pain rating scale (NPRS) score.

Quality and risk of bias (RoB) assessment using RoB-2 tools

The Cochrane RoB tool for randomized trials (RoB 2) was utilized to evaluate the RoB in the included RCTs.[25] This tool examines bias across five domains: (i) the randomization process, (ii) deviations from intended interventions, (iii) missing outcome data, (iv) measurement of the outcome, and (v) selection of the reported result. Two authors independently assessed the RoB for each study, categorizing it as low, high, or some concerns. Any disagreements were resolved through discussion with a third reviewer.

Outcomes measured

Our primary outcomes of interest were PPT (Visual Analog Scale score), NDI score, and cervical range of motion. Secondary outcomes were the determination of the NPRS score to assess pain relief after the DN treatment.

Meta-analysis

For statistical analysis, we employed Review Manager (RevMan, version 5.4; the Cochrane Collaboration, Copenhagen, Denmark).[23] The mean difference (MD) and corresponding 95% confidence intervals (95% CI) were calculated using the random-effects model, which was chosen due to the anticipated heterogeneity in the effect sizes. Heterogeneity was assessed for each synthesis using the I^2 statistic and the Chi-square test, with $P = 0.1$ set as the threshold for significant heterogeneity across the included studies. In line with the Cochrane Handbook guidelines for systematic reviews and meta-analyses, publication bias assessment was deemed infeasible for outcomes with fewer than 10 studies. To address the issue of excess heterogeneity, a sensitivity analysis was conducted by excluding studies identified as having a high RoB and low quality.

RESULTS

Literature search

Figure 1 shows the screening and selection process of included studies using a PRISMA flowchart. After database searching, a total of 22,915 articles were found. After deduplication, a total of 22,518 articles were shortlisted for screening based on titles and abstracts, out of which 551 articles were finalized for a full-text review. Nine RCTs, including a total of 540 patients, were included, out of which 332 patients were female.

Characteristics of the included studies

Tables 1 and 2 demonstrate the characteristics of the included studies. Nine RCTs, encompassing a total of 540 patients, were found suitable as per our prefixed inclusion criteria and hence included in the meta-analysis. Out of 540 patients, 332 were female, showing the prevalence over males. The mean age of the patients ranged from 21 years to 48 years. The mean duration of symptoms associated with neck pain among the patients ranged from 7.1 to 23.38 months. The included studies were published from 2014 to 2023.

Quality assessment of included studies

Supplementary Figure 1 shows the summary plot of the RoB assessment of the included studies. A high RoB was present in the overall assessment. Supplementary Figure 2 shows the traffic light plot of the included studies indicating a high RoB for all included studies except Valera-Calero *et al.*,[26] and Gallego-Sendarrubias *et al.*[10] The high risk was mainly present due to the lack of information regarding the measurement of outcomes in most studies. Gallego-Sendarrubias *et al.*,[9] Aki *et al.*,[1] Mejuto-Vázquez *et al.*,[19] and Llamas-Ramos,[17] had some concerns regarding the randomization process. Mejuto-Vázquez *et al.*,[19], Onat *et al.*,[21] and Aki *et al.*,[1] had some concerns regarding deviations from the intended interventions.

Statistical analysis and heterogeneity

Five out of nine studies reported the PPT after treatment, showing that DN provided a significant benefit over control group therapy in the neck region, with a pooled MD of 0.52 (95% CI, 0.39–0.65; $P < 0.001$; $I^2 = 0\%$) [Figure 2]. In

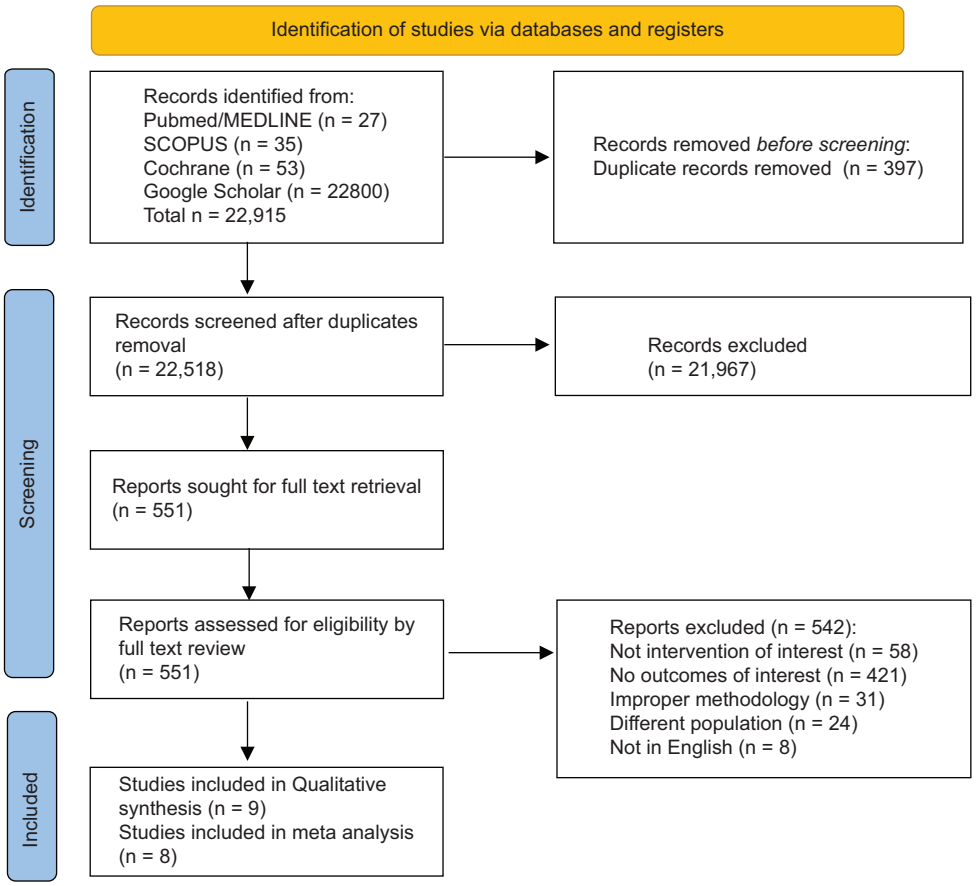

Figure 1: Preferred Reporting Items for Systematic Review and Meta-Analyses flowchart showing the study screening process. SD: Standard deviation, CI: Confidence interval

Table 1: Summary of the baseline characteristics of the included studies.

Study name	Sample size (*n*)		Females (*n*)		Age (years)*	
	DN group	Control group	DN group	Control group	DN group	Control group
Valera-Calero *et al.* (2023)[26]	32	28	?	?	22.3±7.9	21.4±2.3
Gallego-Sendarrubias *et al.* (2022)[11]	25	25	15	14	43.0±12.0	42.0±10.5
Gattie *et al.* (2021)[12]	40	37	29	32	45.28±13.23	48.22±15.18
Arias-Buría *et al.* (2020)[2]	15	15	5	4	21±3	22±2
Gallego-Sendarrubias *et al.* (2020)[10]	47	53	34	29	34.1±7.6	34.6±8.9
Llamas-Ramos (2015)[17]	47	47	30	32	31±3	31±2
Mejuto-Vázquez *et al.* (2014)[19]	9	8	5	4	25±4	24±7
Onat *et al.* (2019)[21]	36	36	29	26	44.1±14.2	45.1±12.5
Aki *et al.* (2020)[1]	20	20	NR	NR	37.55±8.20	37.30±7.35

*Items reported as Mean±SD, DN: Dry needling, NR: Not reported, NDI: Neck disability index ?:This study did not clearly report the number of females (or males) in each group.

Table 2: Summary of clinical characteristics of the included studies.

Study name	Duration of Symptoms (months)*		Baseline NDI*		Baseline NDI (%)*	
	DN group	Control group	DN group	Control group	DN group	Control group
Valera-Calero *et al.* (2023)[26]	NR	NR	NR	NR	17.9±7.5	17.0±7.4
Gallego-Sendarrubias *et al.* (2022)[11]	9.1±1.4	9.3±1.6	13.5±2.5	12.5±2.5	NR	NR
Gattie *et al.* (2021)[12]	23.38±51.35	11.41±16.57	NR	NR	39	38.49
Arias-Buría *et al.* (2020)[2]	7.5±1.3	8.0±1.1	21.7±2.2	20.0±2.1	NR	NR
Gallego-Sendarrubias *et al.* (2020)[10]	NR	NR	NR	NR	NR	NR
Llamas-Ramos (2015)[17]	7.4±2.6	7.1±2.9	NR	NR	NR	NR
Mejuto-Vázquez *et al.* (2014)[19]	NR	NR	NR	NR	NR	NR
Onat *et al.* (2019)[21]	NR	NR	NR	NR	13.4±4.9	14.6±6.9
Aki *et al.* (2020)[1]	NR	NR	NR	NR	NR	NR

*Items reported as Mean±SD, DN: Dry needling, NR: Not reported, NDI: Neck disability index

terms of the NDI score, three out of nine studies indicated that DN led to a significant improvement compared to control group therapy, with a pooled MD of −0.68 (95% CI, −1.32–−0.05; $P = 0.04$; $I^2 = 0\%$) [Figure 3]. For cervical range of motion, DN produced notable results in flexion improvement over control therapy, with a pooled MD of 4.07 (95% CI, 0.39–7.75; $P = 0.03$; $I^2 = 83\%$), while extension showed no significant difference, with a pooled MD of 3.22 (95% CI, −1.29–7.72; $P = 0.16$; $I^2 = 88\%$) [Figure 4]. In right rotation, DN showed significant improvement with a pooled MD of 8.20 (95% CI, 3.05–13.35; $P = 0.002$; $I^2 = 71\%$), though no significant change was seen for left rotation (pooled MD of 4.39; 95% CI, −4.41–13.18; $P = 0.33$; $I^2 = 90\%$) [Figure 4]. Non-significant results were also observed for right and left lateral rotation, with pooled MDs of 1.91 (95% CI, −0.19–4.01; $P = 0.07$; $I^2 = 0\%$) and 1.44 (95% CI, −0.80–3.69; $P = 0.21$; $I^2 = 0\%$), respectively [Figure 4]. A sensitivity analysis aimed at reducing heterogeneity across studies confirmed comparable outcomes between DN and control therapies, as shown in Supplementary Figure 3. Finally, two out of nine studies reported the NPRS indicating a significant reduction in pain post-treatment for the DN therapy group as compared to the control group therapy with a pooled MD of −1.05 (95% CI, −1.75–0.35; $P = 0.003$; $I^2 = 0\%$) [Figure 5].

DISCUSSION

This meta-analysis indicates that DN could be more beneficial than sham needling or manual therapy for alleviating pain, reducing pressure sensitivity (increased pressure pain threshold), and enhancing function, as measured by the NDI and NPRS, in patients with chronic mechanical neck pain. Nevertheless, the results showed no substantial difference between DN and control groups in terms of improvement in cervical range of motion, suggesting that DN may not provide a significant advantage in this area. Further studies are required to validate these conclusions.

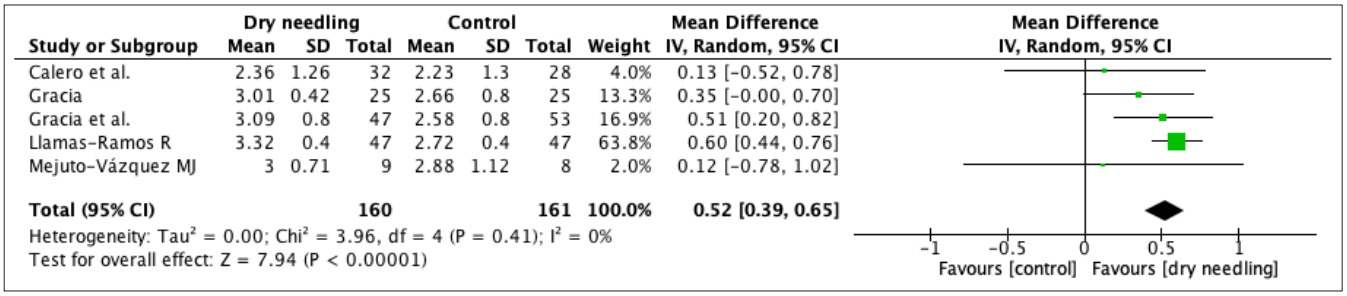

Figure 2: Forest plot of pain pressure threshold. SD: Standard deviation, CI: Confidence interval

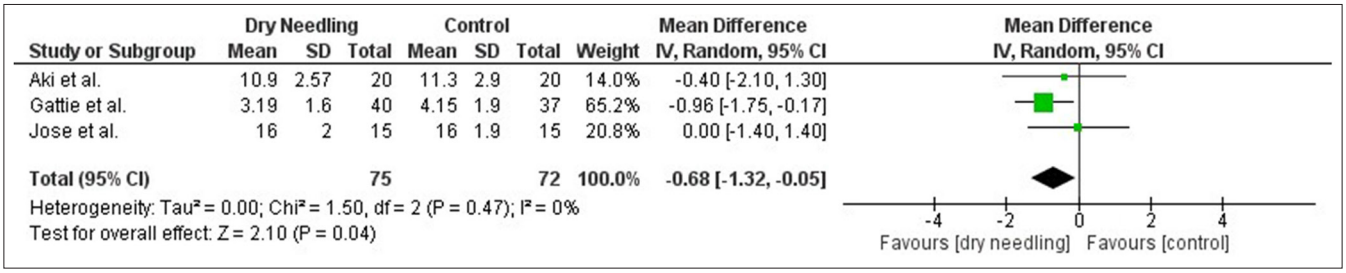

Figure 3: Forest plot of neck disability index. SD: Standard deviation, CI: Confidence interval

Economically, neck pain exacts a heavy toll, costing the United States an estimated $87.6 billion annually.[13] Patients usually seek a multitude of treatments to manage mechanical neck pain symptoms, but most of these treatments deliver short-term efficacy.[28] Manual therapy consisting of home-based exercises or chiropractic application is the first choice for such patients.[6] Many patients adopt a guideline-recommended exercise regimen to acquire relief from the pain.[4] While manual therapy remains a common choice, concerns exist regarding long-term efficacy and potential risks associated with manipulations.[4,7,28] Alternative approaches, like DN, offer potential benefits with minimal side effects but suffer from a lack of conclusive evidence.[17]

DN, a treatment used by physical therapists to target pain and movement problems, involves inserting thin needles into tight spots in your muscles called trigger points. These needles help relax the muscles and improve the range of motion, often used along with exercise and massage.[2] While DN may help reduce pain from musculoskeletal conditions in the short term, more high-quality studies are needed to confirm its long-term effectiveness.[12] DN has gained significant popularity among therapists globally as a pain management technique over the past decade.[12] Several systematic reviews and meta-analyses have been conducted to assess the effects of DN on musculoskeletal pain in various body areas. Consistently, these studies conclude that DN is more effective at alleviating pain compared to sham needling.[5,15,16,23] Our meta-analysis supports these conclusions. However, most research emphasizes pain reduction, with only limited studies examining its role in improving range of motion. Another meta-analysis evaluated the effects of DN on musculoskeletal pain over different periods.[24] It found that DN alone provided greater pain relief than placebo, up to 72 h post-treatment, and was also more effective than other interventions. Furthermore, the combination of DN with other treatments was more beneficial than the treatments used alone.[24] These findings align with and reinforce the results of our meta-analysis.

Although numerous systematic reviews and meta-analyses have evaluated the effectiveness of DN in treating musculoskeletal pain, relatively few have specifically focused on its impact on mechanical neck pain. A 2020 study that examined the use of DN for myofascial trigger points in individuals with neck pain found that DN provided short-term benefits in pain relief and reduced disability when compared to sham needling or other therapies.[20] These results are consistent with our study. However, the 2020 study reached a different conclusion concerning cervical range of motion, indicating that DN had no significant effect in this area.[14]

Our study observed significant improvements in motion-related outcomes. Another meta-analysis on chronic neck pain supported our findings as well.[6] It indicated DN's superiority over manual and other therapies in pain management and showed positive effects on functional neck capacity.[14] Despite the growing body of research on DN for neck pain, most systematic reviews and meta-analyses emphasize the necessity for further high-quality studies due to the generally low-to-moderate quality of existing evidence.[6] A key limitation in much of the DN research is the absence of adequate blinding and appropriate control groups.[6] However, despite these challenges, there is increasing support for DN's

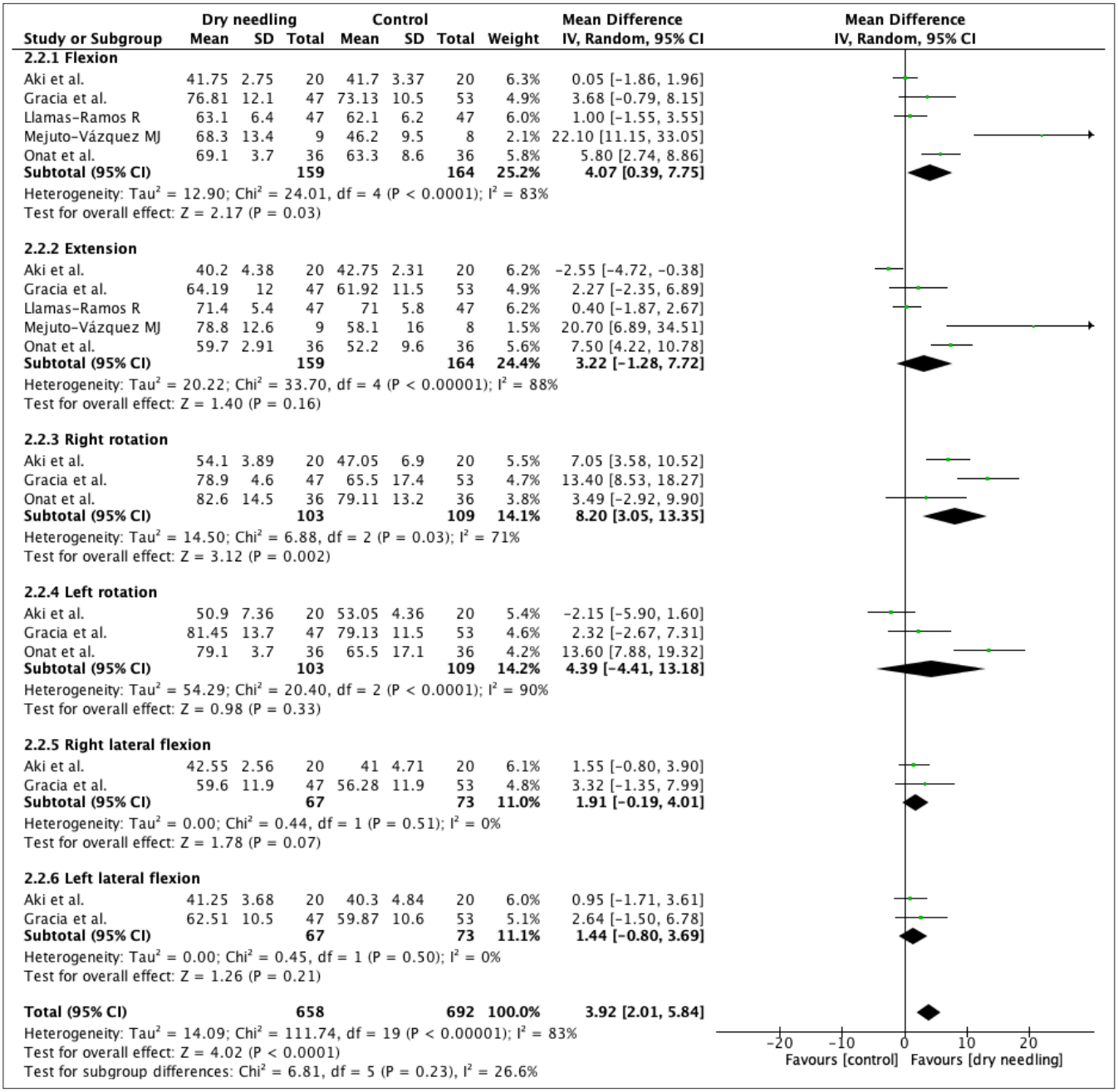

Figure 4: Forest plot of cervical range of motion. SD: Standard deviation, CI: Confidence interval

effectiveness, as reflected in the practical experiences of numerous practitioners around the world.

Although our review yielded substantial findings, certain limitations should be taken into account when assessing the results of our meta-analysis. The main limitation is the inclusion of studies with a high RoB, which could diminish the overall quality of the evidence in the combined results. In addition, we focused exclusively on published literature in English from the past decade, which may have led to considerable publication bias. Moreover, the notable heterogeneity observed for some outcomes could restrict the generalizability of our findings and contribute to significant inconsistencies, thus reducing the overall quality of evidence. The extracted data also has gaps; for instance, only four of the nine studies reported symptom duration, and baseline NDI was missing in most studies. Finally, variations in post-intervention measurements were observed among the included studies. While most reported outcomes immediately after treatment or within one week, only a small number provided data on longer-term follow-up.

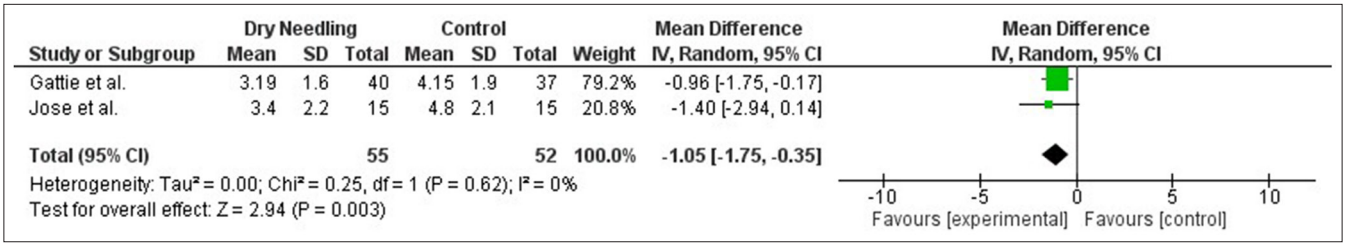

Figure 5: Forest plot of numerical pain rating scale. SD: Standard deviation, CI: Confidence interval

To overcome these limitations, future studies should focus on performing large-scale RCTs with strong protocols and strict adherence to maintain high methodological standards. In addition, employing standardized outcome measurement strategies would further enhance the reliability and comparability of findings across studies. Furthermore, future studies should strive to recruit a more diverse pool of participants to explore treatment effects or associations in a broader population, allowing for a more generalizable understanding of the phenomenon under investigation.

CONCLUSION

The findings of this meta-analysis suggest that DN shows promise as a short-term intervention for mechanical neck pain, offering benefits such as reduced pressure sensitivity and improved functionality when compared to control treatments. Nevertheless, although DN appears effective in alleviating short-term pain and enhancing functionality, it does not seem to result in significant improvements in neck range of motion relative to control groups. Further research is necessary to validate these outcomes.

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Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent was not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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