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Review Article

NON-PHARMACOLOGICAL MODALITIES FOR TREATING CERVICOGENIC HEADACHE: A SYSTEMATIC REVIEW

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ABSTRACT

This study aimed to investigate the outcomes of the non-pharmacological modalities in adult patients with cervicogenic headaches. The systematic review, guided by the PRISMA approach, investigated twenty-nine randomized controlled trials/randomized studies, published from 1997 to 2022, concerning the efficacy of non-pharmacological interventions for cervicogenic headache. The primary endpoints were headache duration, frequency, and intensity; however, the secondary endpoints included several clinical complications of cervicogenic headache. The findings from this study revealed a 97.5-100% satisfaction level in patients who underwent physiotherapy sessions for their cervicogenic headaches. The pooled outcomes revealed noticeable improvements in the range of motion of the cervical spine following the administration of manual therapy, apophyseal glide, trigger point-directed dry/superficial needling, spine mobilization, massage, and Graston procedure. In addition, dry needling, multimodal therapy, spinal manipulative therapy, routine physiotherapy, and other non-pharmacological approaches were found to be effective in improving the disability-level perception of patients with cervicogenic headaches. While the evidence negated the impact of non-pharmacological approaches on psychological distress and cognitive/social functioning, their positive influence on quality of life, pain perception, pressure pain thresholds, performance of neck muscles, and muscle fatigue was emphasized by most of the included studies. This study emphasized the cervicogenic headache management potential of non-pharmacological modalities, including dry needling and cervical spine manipulation procedures; future studies should compare our results with pharmacological modalities to transform the treatment landscape for patients with cervicogenic headaches.

Keywords: Cervical spine, Cervical spine muscles, Cervicogenic headache, Dry needling, Spinal manipulation.

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INTRODUCTION

The cervicogenic headache originates from the neck's soft tissues or bony structures unilaterally, and the neck movements aggravate its intensity and frequency in the affected patients [1]. It predominantly reduces the cervical spine's/neck's overall range of motion and requires a differential assessment based on the similarity of its symptoms with other pain conditions, including primary headache syndromes, tension headaches, and migraine. The diagnostic affirmation of the cervicogenic headache warrants the evaluation of the following conditions: (1) Pain perception in the face/head and origin in the cervical spine, (2) relief in headache following the interruption of the nerve supply to the cervical spine or after administering a diagnostic blockade, and (3) resolution of the pain pattern within 3 months of treating the lesion/causative condition [2]. The chronicity of the cervicogenic headache is observed in adult patients of the age group 30–44 years, with a prevalence of 0.4–4%. The cervicogenic headache impacts the health-related quality of life of females and males in equal proportion. At a median age of 49.4 years, patients require medical attention to treat the tenderness in the pericranial muscle [1].

The first non-pharmacologic treatment option for managing cervicogenic headache is physical therapy; other predominant techniques include therapeutic exercise and manipulative treatment [2]. The manipulation and joint mobilization procedures aim to treat the dysfunction of the cervical joint and its cervicogenic headache implications. The muscle stretching interventions based on Gebauer's stretch/spray and post-isometric relaxation assist in reducing the tightness of cervicogenic headache-inducing muscles, including pectoralis major, pectoralis minor, sub-occipitalis, scalenes, levators, upper trapezius, and sternocleidomastoid (accessory respiratory muscles). The device-based soft tissue mobilization, including the Graston® procedure, facilitates the movements of levator muscles, upper trapezius, and sternocleidomastoid (i.e., the upper cervical spine muscles). The therapeutic exercises effectively improve postural awareness and sternocleidomastoid activity in patients with cervicogenic pain. Alternatively, the medical management of cervicogenic headache relies on the administration of pulsed radiofrequency energy, low-level laser treatment, steroid/anesthetic blockades, and occipital nerve blocks.

The contemporary literature provides conflicting evidence regarding the efficacy of non-pharmacological modalities in patients with cervicogenic headaches. The meta-analysis outcomes of Pourahmadi *et al.* reveal a 1:3 efficacy ratio of dry needling intervention for cervicogenic headache [3]. Contrarily, few systematic reviews indicate the higher efficacy of wet needling, compared to dry needling, against musculoskeletal pain in cervicogenic headaches [4]. Alternatively, outcomes of a case report indicate the pain-reducing capacity of the dry needling sessions in patients with occipital neuralgia [5]. Outcomes of a recent meta-analysis by Bini *et al.* provide moderate evidence concerning the pain management potential of exercise/manual interventions in cervicogenic headaches [6]. In addition, their superior efficacy against sham approaches remains debatable. Another systematic review by Demont *et al.* indicates the long-term efficacy of neck exercise and short-term pain management capacity

of manual therapy in cervicogenic headaches [7]. A critical review by Moore *et al.* emphasizes the need for further investigation to understand the utilization, safety, and efficacy of manual treatment against cervical headaches [8]. A meta-analysis by Fernandez *et al.* indicates the short-term, small, but superior outcomes of spinal manipulative therapy than miscellaneous manual approaches. The findings support the role of spinal manipulative treatment in minimizing disability and frequency/intensity of pain in cervicogenic headaches [9]. Based on these research gaps, this systematic review aims to unravel the role of various non-pharmacological modalities in reducing the clinical manifestations of cervicogenic headaches in adult patients.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement guided the framework of this systematic review [10].

Search strategy and data collection

A comprehensive literature search was undertaken across a range of credible databases, including PubMed Central, JSTOR, EMBASE, and Scopus, to retrieve the articles of interest. The following search term combinations were constructed through Boolean Operators to retrieve the relevant hits: (1) Cervicogenic headache AND dry needling, (2) Cervicogenic headache AND manual therapy, (3) Cervicogenic Headache AND Exercise, (4) Cervicogenic Headache AND Spinal Manipulation OR Spinal Mobilization OR Graston procedure, (5) Cervicogenic Headache AND Physiotherapy, (6) Cervicogenic Headache AND Physical Therapy, (7) Cervicogenic Headache AND Mobilization OR Kinesio Tapes OR Apophyseal Glide OR Trigger Point Therapy, (8) Cervicogenic Headache AND Massage Therapy OR Multimodal Treatment, (9) Cervicogenic Headache AND Relaxation Exercises OR Cervicothoracic Myofascial Release, and (10) Cervicogenic Headache AND Dynamic Muscle Exercises OR Stretching. Studies were screened based on their design/methods, inclusion/exclusion criteria, publication year, outcomes, comparators, and interventions. The manual screening of citations in published articles minimized the risk of missing recent studies with relevant outcomes. Two authors independently collected relevant data on Microsoft Excel; double-data entry checks were performed to nullify the risk of data entry errors. Discrepancies between the authors were resolved and moderated with the intervention of a third independent author and by establishing a mutual consensus.

Inclusion and exclusion parameters

Thirty randomized controlled trials/randomized studies published from 1997 to 2022 were included in this meta-analysis. However, authors did not include meta-analyses, systematic reviews, review papers, scoping reviews, literature reviews, opinion papers, cross-sectional studies, observational studies, cohort assessments, case studies, case reports, retrospective/prospective studies, editorials/letters to editors, and scientific correspondences in this study. Importantly, studies evaluating the pharmacological-only management of cervicogenic headaches were excluded from this systematic review.

Non-pharmacological modalities

This systematic review evaluated the outcomes of the following non-pharmacological approaches or their various combinations: (1) Physiotherapy, (2) Graston intervention, (3) Manipulation technique/spinal manipulative therapy, (4) Mobilization, (5) Neck-based exercise, (6) Aerobic exercise, (7) Sham/real dry needling, (8) Mulligan natural apophyseal glide, (9) Manual therapy, (10) Chiropractic spinal manipulative procedure, (11) Dry needling, (12) Superficial needling, (13) Kinesio tapes, (14) Physical/functional exercise, (15) Massage therapy, (16) Trigger point treatment, (17) Relaxation techniques, (18) Cervicothoracicmyofascial release, (19) Dynamic muscle exercises, and (20) Stretching exercises. The comparators included controls based on placebo treatments, miscellaneous modalities, or lack of interventions.

Endpoints/outcomes

The significant primary endpoints included the headache duration, frequency, and intensity. The predominant secondary endpoints included the following clinical complications of cervicogenic headache: (1) Range of motion/mobility level (cervical spine), (2) Disability level perception, (3) Psychological distress, (4) Cognitive functioning, (5) Social functioning, (6) Quality of life, (7) Pain perception, (8) Pressure pain thresholds, (9) Performance of neck muscles, and (10) Tone/fatigue of neck muscles.

Risk of bias (ROB)

The Robvis tool guided the ROB assessment of the included randomized controlled/randomized studies [11]. The following parameters were systematically evaluated: (1) Randomized process-related bias, (2) Confounding due to intended intervention-based deviations, (3) Missing outcome data-based bias, (4) Outcome measurement bias, and (5) Selection bias.

Data synthesis

The included studies were sorted and grouped by their experimental treatments versus the comparator interventions. The clinical as well as statistical significance of the primary and secondary endpoints was analyzed in concordance with corresponding dependent variables. The statistical significance of variables depended on the p-value reference (≤0.05), whereas the clinical significance was determined by assessing the clinically relevant impact of each study intervention on the respective outcome. The pain assessment parameters included a Visual Analog Scale, neck disability index, global rating of change, fear-avoidance belief questionnaire, craniocervical flexion test, headache impact test-6, modified Von Korff pain scale/Von Korff disability scale, and flexion rotation test.

RESULTS

Screening and selection of studies

Two hundred and thirty-two records were initially explored through databases including PubMed/Medline, JSTOR, Embase, Scopus, CINAHL, and Web of Science. An additional 144 records were explored through ClinicalTrials.Gov, Medline Plus, Science Direct, and EBSCO (Fig. 1).

Ninety-one articles were subsequently selected after removing the duplicates, which was followed by the exclusion of 58 records. Of these, 33 articles were examined for eligibility, followed by the exclusion of four studies due to missing data, inappropriate publication, and flawed design/methodology. Finally, 29 studies were included in this systematic review. Table 1 details the literature synthesis, including a comprehensive summary of outcomes concerning the primary and secondary endpoints.

Headache assessment

All of the included studies provided statistically significant results concerning the role of non-pharmacological modalities in improving the intensity, frequency, or duration of the cervicogenic headache, compared to the control intervention [12]. The results of the non-pharmacological approaches were either equivalent to or better than the placebo strategy or control intervention in patients treated for cervicogenic headaches. Importantly, a 97.5–100% patient satisfaction level was reported in patients who underwent physiotherapy sessions for their cervicogenic headache [12]. The Graston intervention, spine manipulation/mobilization, neck-based exercises, sham/real dry needling, manual therapy, home-based exercise therapy, chiropractic spinal manipulation, Kinesio tape-based treatment, light massage, apophyseal glide-based intervention, muscle-directed deep dry/superficial needling, temporomandibular disorder-targeting

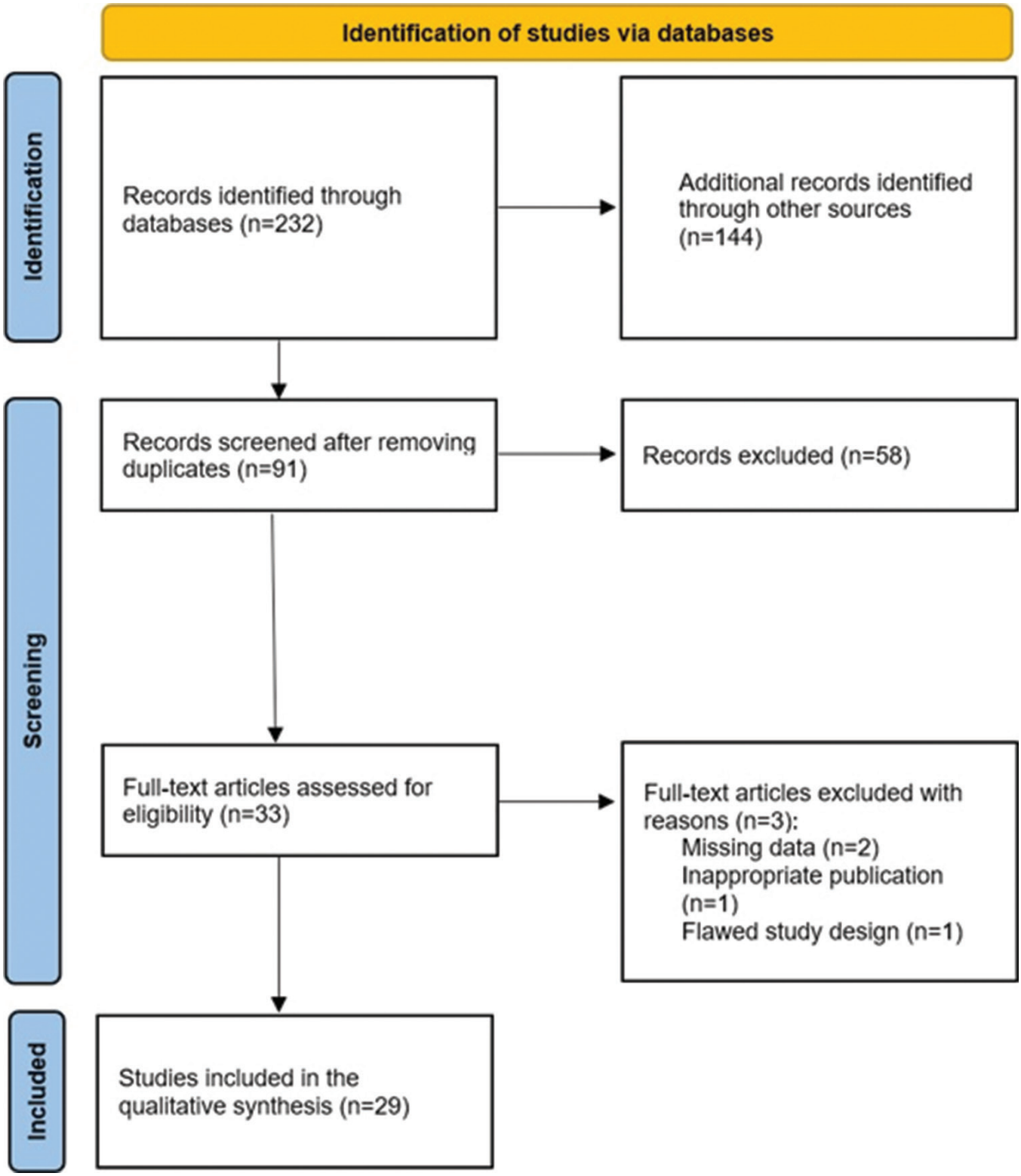

Fig. 1: PRISMA flow chart detailing the screening procedure

additional manual procedures, cervical spine-oriented manual therapy, craniooccipital/suboccipital relaxation, functional exercise protocol, cervicothoracic myofascial release, and stretching/dynamic exercises effectively reduced the headache intensity, frequency, or duration in the treated patients ($p<0.05$).

Range of motion/mobility level of the cervical spine

Except for one study [13], the pooled results from seven studies indicated noticeable improvements in the range of motion of the cervical spine following the administration of manual therapy, apophyseal glide (natural and self-sustained), trigger point-

Table 1: Systematic review

Author/Study	Study type/design	Sample size	Diagnosis	Study methods/ intervention	Endpoints	Inference (s)
Rani *et al*. 2021 [12]	A randomized, pilot, active, parallel-group, and participant-blinded study	80 patients	Cervicogenic headache	Physiotherapy sessions were administered 4 times every 7 days, for a total duration of 4 weeks	Primary outcomes: 1. Treatment acceptability 2. Treatment adherence 3. Treatment retention 4. Assessment procedure/ outcomes 5. Patient recruitment Secondary endpoints: 1. Neck disability index outcomes 2. Headache – duration, frequency, and intensity	In the absence of adverse effects, the patient satisfaction rate concerning the physiotherapy interventions ranged between 97.5% and 100%
Lerner-Lentz *et al*. 2021 [15]	A randomized clinical study	45 patients	Cervicogenic headache	Mobilization or manipulation techniques were used to effectively treat the cervicogenic headache	Primary outcome: 1. Perceived disability level Secondary endpoints: 1. Pain intensity 2. Psychological distress, cognitive functioning, social functioning, and quality of life due to headache 3. Range of motion of the cervical spine	No statistically significant differences were observed between the study groups for the Patient Acceptable Symptoms Scale and Global Rating of Change Findings from the Headache Impact Test and Numeric Pain Rating Scale did not differ significantly between the groups
McDevitt *et al*. 2022 [21]	A crossover and randomized controlled study	48 patients	Cervicogenic headache	Thoracic spine manipulation was performed for the management of cervicogenic headache	Primary outcome 1. Headache disability inventory Secondary endpoints 1. Neck disability index 2. Numeric pain rating scale/global rating of change	At baseline, the study groups did not differ significantly in the headache disability index (MD: 7.39, 95% CI: 4.39-19.18; p=0.214) At 4 weeks, statistically significant differences were observed between the study groups for the neck disability index (MD: 6.90, 95% CI 0.05-13.75; p=0.48) At 4 weeks, the thoracic spine manipulation established minimal clinically important differences on the 4+global rating of change (OR: 38.0, 95% CI 6.6, 220.0; p<0.01)
Daher *et al*. 2020 [22]	A randomized controlled, multicenter, and prospective study	139 patients	Cervicogenic headache and neck pain	Administration of neck-based exercise in addition to or without aerobic exercise	Primary outcomes: 1. Global rating of change 2. Visual analog scale Secondary endpoints: 1. Neck disability index questionnaire 2. Fear-avoidance belief questionnaire	In comparison to the control group, patients who underwent aerobic exercise had significant improvements in the Visual Analog Scale (6.73-1.89 vs 6.65-3.32) (p<0.001); similar improvements were observed in both neck disability index and fear-avoidance belief questionnaires (p<0.001) After 6 months of follow-up, cervicogenic headaches had a significant decline in patients who underwent aerobic exercise

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Table 1: (*Continued*)

Author/Study	Study type/design	Sample size	Diagnosis	Study methods/ intervention	Endpoints	Inference (s)
Haas *et al*. 2018 [25]	A randomized controlled dual-center study	256 patients	Cervicogenic headache	Spinal manipulative therapy was administered to the study group, whereas the control group received focused light massage	Primary outcome: 1. The headache diary to record the cervicogenic headaches frequency Secondary endpoints: 1. Cervicogenic headache days 2. Pain intensity 3. Disability 4. Patient satisfaction 5. Medication usage 6. Perceived pain improvement	Eighteen spinal manipulative sessions resulted in a decline in cervicogenic headache in 4 weeks (16 units – 8 units) ($p<0.05$) Both secondary and primary endpoints had statistically significant mean differences between the study groups (MD–2.9, p=0.017; MD–3.3, p=0.004) Dose-dependent pain-related improvements did not correlate with spinal manipulative therapy dosages/number of sessions
Mousavi-Khatir *et al*. 2022 [16]	A randomized, triple-blind, and controlled study	69 patients	Cervicogenic headache	Simultaneous administration of routine physiotherapy with sham/real dry needling	Primary outcomes: 1. Frequency of headache 2. Intensity of headache Secondary endpoints: 1. Range of motion (cervical spine) 2. The activity of the neck's deep flexor muscles 3. Disability of the neck	In comparison to patients in control/sham groups, the dry needling intervention significantly improved the disability of the neck, the intensity/ frequency of the headache, the activity of the deep cervical flexor muscles, and the range of motion (cervical spine)
Mohamed and Shendy 2018 [17]	A randomized controlled (pre-test and post-test) study	30 patients	Cervicogenic headache	Weekly administration of three sessions of Mulligan natural apophyseal glide procedure (total duration of the therapy: 4 weeks)	Primary endpoint: 1. The intensity of cervicogenic pain Secondary endpoints: 1. Functional disability of the neck 2. Range of motion (cervical spine)	The Mulligan natural apophyseal glide procedure led to statistically significant improvements in the functional disability of the neck and intensity of pain in experimental group patients compared to those in the control group ($p<0.05$) Both study groups had no statistically significant differences in their range of motion (cervical spine) after receiving the Mulligan natural apophyseal glides ($p>0.05$)
Gildir *et al*. 2019 [31]	A parallel-group, double-blind, and randomized controlled study	160 patients	Chronic tension-type headache, originating from the cervical spine	Administration of sham/dry needling	Primary endpoint: 1. Intensity of headache Secondary endpoints: 1. Headache duration 2. Headache frequency 3. Quality of life	Patients who were administered dry needling had statistically significant improvements in the Short Form-36 subscale scores and headache (duration, frequency, and intensity)
Rodríguez-Sanz *et al*. 2022 [32]	A randomized controlled study	40 patients	Cervicogenic headache	Administration of home/ routine exercise interventions+ manual therapy	Primary endpoint: 1. Flexion of the cervical spine (upper end) Secondary endpoints: 1. Pain pressure thresholds 2. The flexion-rotation test 3. Craniocervical flexion test 4. Headache impact test-6 5. Intensity of headache 6. Global rating of the change score scale 7. Self-treatment adherence 8. Follow-up outcomes at 3 and 6 months, respectively	In comparison to patients who received routine exercise measures, those with exercise and manual therapy improved significantly in all major primary and secondary endpoints ($p<0.05$)

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Table 1: (*Continued*)

Author/Study	Study type/design	Sample size	Diagnosis	Study methods/ intervention	Endpoints	Inference (s)
Bodes-Pardo *et al*. 2013 [18]	A randomized pilot clinical study	20 patients	Cervicogenic headache	Administration of manual therapy	Primary endpoint: 1. The intensity of the headache Secondary endpoints: 1. Pressure pain thresholds 2. Range of motion (cervical spine) 3. The intensity of the neck pain	Compared to the stimulation-only technique, the active trigger point-based and sternocleidomastoid-directed manual therapy effectively improved pressure pain thresholds, range of motion of the cervical spine, and activity of the deep flexor muscles (cervical region)
Chaibi *et al*. 2017 [33]	A randomized controlled study	19 patients	Cervicogenic headache	Administration of non-manual techniques/sham manipulation/and chiropractic spinal manipulative procedure	Primary endpoint: 1. Headache frequency Secondary endpoints: 1. The duration of the headache 2. The headache indexes	After a follow-up of 6-12 months, compared to the placebo group, noticeable improvements in the frequency of the headache were noted in patients receiving the chiropractic spinal manipulative procedure
Dunning *et al*. 2016 [23]	A randomized, multicenter, clinical study	110 patients	Cervicogenic headache	Administration of exercise/ mobilization intervention or manipulation treatments (thoracic and cervical)	Primary endpoint: 1. The intensity of the headache Secondary endpoint: 1. Global rating of change 2. Medication intake 3. Disability 4. Duration of headache 5. Frequency of headache	At the 3-month follow-up, in comparison to the exercise and mobilization treatment, the disability level and intensity of the headache were markedly reduced in patients who were administered with thoracic/cervical manipulation ($p<0.001$) Importantly, at every follow-up, upper thoracic/ cervical manipulation effectively minimized the headache duration and frequency compared to exercise/mobilization (all $p<0.001$) Patients with manipulation intervention had higher improvements during the first and the fourth follow-up weeks ($p<0.001$)
Esin *et al*. 2018 [34]	A placebo-controlled, randomized, and blinded trial	101 patients	Cervicogenic headache	Administration of physical exercises, kinesio tapes, and placebo treatments	Primary endpoint: 1. Frequency of headache Secondary endpoints: 2. Intensity of headache	Compared to the placebo group, patients who received kinesio tapes had a significant decline in the intensity and frequency of headaches
Haas *et al*. 2010 [24]	A randomized controlled prospective study	80 patients	Chronic cervicogenic headache	Administration of spinal minimal light massage or manipulative therapy	Primary endpoint: 1. Modified Von Korff pain scale Secondary endpoint: 2. Modified Von Korff disability scale	Compared to contemporary treatments, spinal manipulative therapy effectively minimized the duration, frequency, and intensity of the cervicogenic headache
Hall *et al*. 2007 [19]	A placebo-controlled, double-blind, and randomized study	32 patients	Cervicogenic headache	The administration of apophyseal glide (natural and self-sustained)/ placebo treatments	Primary endpoint: 1. Flexion rotation test Secondary endpoint: 2. Headache index	The range of the flexion rotation test was 15° higher in the treatment versus the placebo groups ($p<0.001$) Time-based differences in the headache indices were recorded between the study groups ($p<0.001$)

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Table 1: (*Continued*)

Author/Study	Study type/design	Sample size	Diagnosis	Study methods/ intervention	Endpoints	Inference (s)
Jafari *et al*. 2016 [36]	A randomized controlled study	19 patients	Cervicogenic headache	The myofascial trigger point location was treated with ischemic compression	Primary endpoint: 1. The intensity of the headache Secondary endpoint: 1. The threshold of the pressure pain 2. The tolerance of pressure 3. The trigger point region 4. The elastic modulus of the trigger point 5. The duration of the headache 6. The frequency of headache 7. The intensity of the headache	Compared to the control group patients, those who received ischemic compression had remarkable improvements in the myofascial trigger point location (p=0.017), threshold concerning the pressure pain (p=0.039), pressure tolerance (p<0.001), headache duration (p<0.015), headache frequency (p=0.005), and headache intensity (p=0.002)
Jull *et al*. 2022 [37]	A randomized controlled study	200 patients	Cervicogenic headache	Administration of an exercise measure (low-load) and a manipulative intervention	Primary endpoint: 1. Frequency of headache Secondary endpoints: 1. Duration of headache 2. Intensity of headache	No statistically significant differences between the study groups were recorded for neck pain, intensity of headache, and frequency of headache (all p<0.05) The combination treatments did not produce superior outcomes compared to the individualized therapies
Malo-Urriès *et al*. 2017 [38]	A randomized controlled study	82 patients	Cervicogenic headache	Administration of spinal mobilization (transthoracic, upper cervical) versus the control intervention	Primary endpoints: 1. Pressure pain threshold (cervical) 2. Mobility of the cervical spine Secondary endpoint: 1. Headache	Compared to the control group, statistically significant improvements were observed in the flexion-rotation test (p<0.001), total mobility of the cervical spine (p=0.002), and headache intensity (p=0.039) following the administration of spinal mobilization The pressure pain threshold values did not statistically differ between the study groups (p>0.05)
Nilsson *et al*. 1997 [39]	A randomized controlled prospective study	53 patients	Cervicogenic headache	Administration of the following interventions: • Upper cervical spine – laser treatment (low-level) • Deep friction massage across thoracic regions (upper and lower, including the trigger points) • Cervical manipulation (low-amplitude)	Primary endpoint: 1. Frequency of headache, evidenced by analgesic use alteration Secondary endpoint: 1. Intensity of headache	Patients who received manipulation intervention had a 36% decline in their analgesic use pattern (p=0.04); alternatively, the soft tissue group patients had no change in their analgesic use paradigm A 37% decline in headache hours was reported in patients of the soft tissue group compared to 69% in those who received manipulation treatment (p=0.03)

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Table 1: (*Continued*)

Author/Study	Study type/design	Sample size	Diagnosis	Study methods/ intervention	Endpoints	Inference (s)
Sedighi *et al*. 2017 [20]	A randomized study	30 patients	Cervicogenic headache	Administration of deep dry versus superficial needling Targeted trigger points: Trapezius muscle (upper end) Suboccipital muscle	Primary endpoint: 1. Headache index Secondary endpoint: 1. Tenderness of the trigger point 2. Range of motion (cervical spine)	Noticeable reductions were observed in the tenderness of trigger points and headache index in patients who received dry needling; other improvement parameters based on deep dry needling included functional rating index ($p<0.01$) and range of motion (cervical spine) ($p<0.001$)
Sharma *et al*. 2011 [26]	A randomized controlled study	27 patients	Cervicogenic headache	The following interventions were administered to the respective patient groups: Control treatment Exercise therapy Multimodal therapy	Primary endpoints: 1. Headache duration 2. Headache intensity 3. Headache frequency Secondary endpoints: 1. Deep neck flexor performance indices 2. Neck disability index score	Compared to the control intervention and the exercise therapy, the multimodal treatment led to remarkable improvements in deep neck flexor performance, neck disability, and headache (duration, intensity, and frequency)
Piekartz and Lüdtke. 2011 [27]	A randomized controlled and single-blinded study	43 subjects	Cervicogenic headache	Administration of temporomandibular disorder-targeting additional manual procedures and cervical spine-oriented manual therapy	Primary endpoint: 1. Colored analog scale to evaluate the headache intensity Secondary endpoint: 1. Neck disability index 2. Pain/pressure threshold 3. Mandibular deviation 4. Chronic pain status grading 5. Mandibular joint noise registration 6. Conti amnestic questionnaire	Compared to the routine care group, patients with cervicogenic headache and temporomandibular joint disorders had significant improvements in neck function and headache intensity following the administration of additional manual therapy
Yang and Kang. 2017 [40]	A randomized controlled study	30 subjects	Cervicogenic headache	The following procedures were administered to patients in distinct groups: 1. Suboccipital relaxation 2. Craniocervical flexion exercise 3. Control intervention	Primary endpoint: 1. Intensity of headache Secondary endpoints: 1. Sternocleido mastoideus and upper trapezius muscle fatigue 2. Sternocleido mastoideus muscle tone	In comparison to the control intervention, craniocervical flexion exercise and suboccipital relaxation procedures effectively improved the intensity of the cervicogenic headache, sternocleidomastoideus muscular tone, and sternocleidomastoideus/ trapezius muscle fatigue
Youssef and Shanb. 2013 [13]	A randomized clinical study	36 patients	Cervicogenic headache	The administration of massage versus mobilization treatment	Primary endpoints: 1. The global perceived effect 2. The headache impact test Secondary endpoints: 1. Headache-based absenteeism 2. Healthcare contacts 3. Medication intake 4. Intensity of headache 5. Frequency of headache 6. Neck disability index 7. Range of motion (cervical spine)	In comparison to the massage intervention, the mobilization technique led to noticeable improvements in all endpoints, excluding the neck disability index

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Table 1: (*Continued*)

Author/Study	Study type/design	Sample size	Diagnosis	Study methods/ intervention	Endpoints	Inference (s)
Abdel-Aal *et al*. 2021 [14]	A randomized, single-blinded controlled study	60 subjects	Cervicogenic headache	The administration of the control intervention versus the exercise intervention plus the Graston procedure	Primary endpoint: 1. Visual analog scale Secondary endpoint: 1. Medication intake 2. Duration of headache 3. Frequency of headache 4. Range of motion (cervical spine) 5. Neck disability index	Excluding the extension of the neck (p=0.08), patients who received the Graston procedure with the exercise intervention had statistically significant improvements in all endpoints (p<0.05)
Dunning *et al*. 2021 [28]	A parallel-group, randomized, multicenter, clinical study	142 subjects	Cervicogenic headache	The following interventions were concomitantly administered: 1. Exercise 2. Spinal mobilization 3. Dry needling 4. Spinal manipulation	Primary endpoint: 1. Numeric pain rating scale to measure the intensity of the headache Secondary endpoint: 1. Global rating of change 2. Medication intake 3. Neck disability index 4. Duration of headache 5. Frequency of headache	After 3 months of follow-up, compared to exercise plus non-thrust mobilization, a statistically significant decline in the disability level, frequency of headache, intensity of the headache, and duration of the headache (all p<0.001) was recorded in patients who received electrical dry needling plus the spinal manipulation
Moustafa *et al*. 2021 [29]	A randomized controlled, parallel-group, pilot study	60 subjects	Cervicogenic headache	Administration of a multimodal program based on the following inclusions: 1. Functional exercise protocol 2. Cervicothoracic myofascial release 3. Mobilization of the cervical spine	Primary outcome: 1. The frequency of headache Secondary endpoints: 1. Daily defined dose 2. Headache impact test-6 3. Headache disability inventory 4. Cervical lordosis 5. Forward head posture distance	Compared to the control group patients, those who received the experimental interventions had statistically significant improvements in forward head posture distance and cervical lordosis (both p<0.001) After 1–2 years, cervicogenic headache outcomes significantly improved in patients who received the multimodal program in comparison to the control treatment (p<0.00)
Patra *et al*. 2018 [41]	A randomized study	150 subjects	Cervicogenic headache	Administration of dry needling with natural apophyseal glide, or treatment with manual therapy/combined measures	Primary endpoint: 1. Pressure point threshold Secondary endpoint: 1. Headache-related disability	Compared to the individualized treatment, patients who received combined therapy had statistically significant improvements in both primary and secondary endpoints (p<0.05)
Ylinen *et al*. 2010 [30]	A randomized controlled study	180 subjects (all females)	Cervicogenic headache	The following interventions were customized for the respective study groups: 1. Stretching exercises for the control group 2. Stretching plus dynamic muscle exercises for the endurance group 3. Stretching and dynamic exercises for the isometric group	Primary endpoint: 1. Severity of headache Secondary endpoint: 1. Neck pain intensity 2. Upper extremity pain intensity	In comparison to the baseline, after 12 months of follow-up, a decline in headache by 37%, 58%, and 69% was observed in control, endurance, and strength groups, respectively The highest headache severity and the greatest reduction in neck pain were recorded in strength group patients compared to the other groups (p<0.001)

CI: Confidence interval

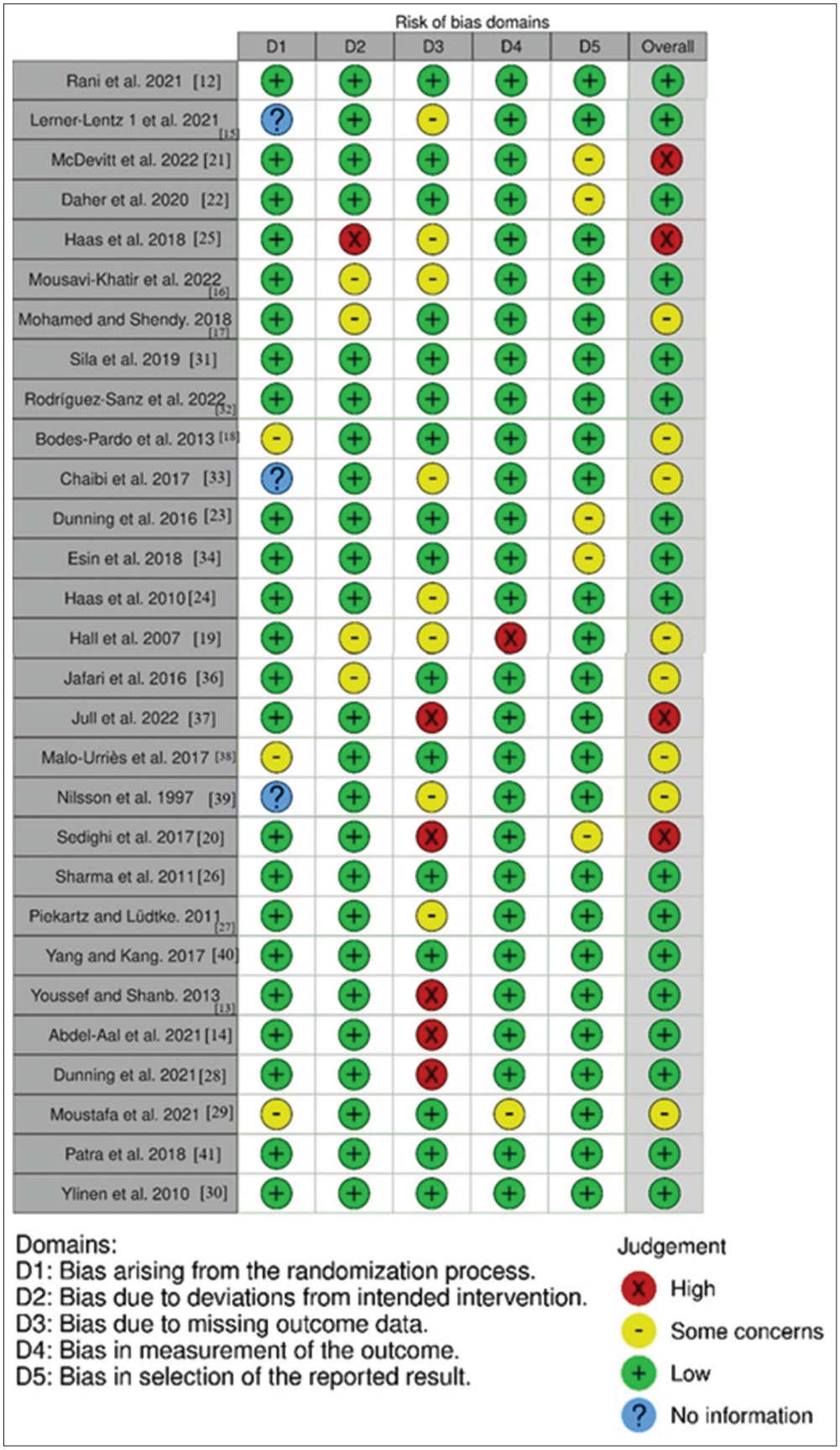

Fig. 2: Risk of bias summary

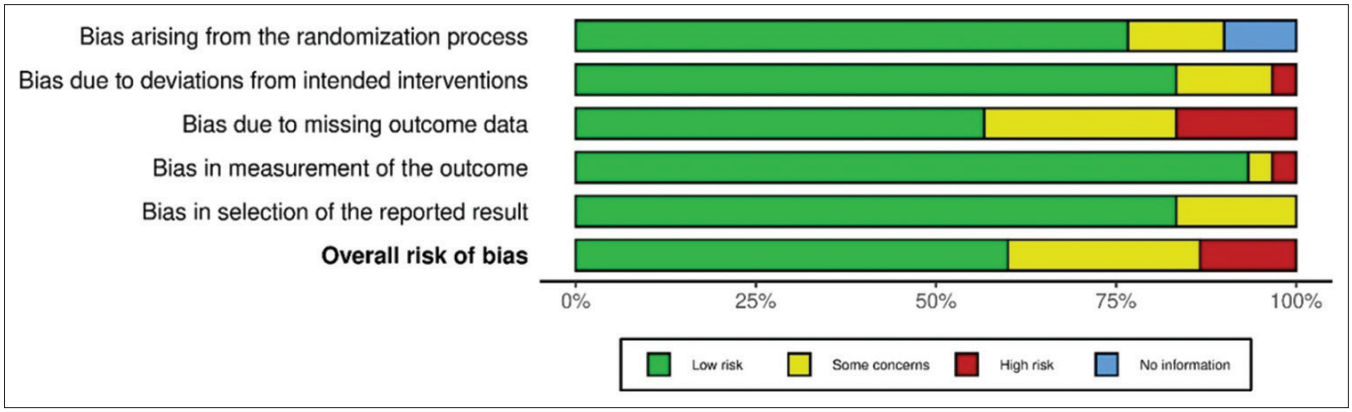

Fig. 3: Risk of bias graph

directed dry/superficial needling, spine mobilization, massage, and Graston procedure ($p<0.05$) [14-20]. One study emphasized better improvements in the activity of the deep cervical flexor muscles after dry needling intervention, compared to other non-pharmacological modalities [16], whereas another study emphasized similar improvements in the neck range of motion after Mulligan natural apophyseal glides ($p>0.05$) [17]. Similarly, one study indicated the comparable potential of the stimulation-only technique, the active trigger point-based, and sternocleidomastoid-directed manual therapy in improving the activity and pain thresholds of the deep flexor muscles of the neck region [18]. The findings of a study indicated a statistically significant improvement in the range of cervical spine motion in patients who underwent the dry needling intervention [20].

Disability level perception

Findings from one study indicated high patient satisfaction rates (i.e., 97.5–100%) following the administration of physiotherapy sessions for cervicogenic headaches [12]. Another study indicated no statistically significant differences between the perceived disability levels of the patients who received mobilization or manipulation interventions for their cervicogenic headaches [15]. The headache and neck disability indices were comparable between the patients who received thoracic spine manipulation and the control group (MD: 7.39, 95% CI: 4.39–19.18; $p=0.214$) (MD: 6.90, 95% CI: 0.05–13.75; $p=0.48$) [21]. One study revealed statistically significant improvements in neck disability index and fear-avoidance belief questionnaires following neck-based exercise ($p<0.05$) [22]. In addition, findings from 12 studies indicated significant improvements in pain/disability-related perceptions in patients who received one or more of the following non-pharmacological interventions: (1) Spinal manipulative therapy, routine physiotherapy, (2) Mulligan natural apophyseal glide procedure, (3) exercise/mobilization intervention or manipulation treatments, (4) spinal minimal light massage, (5) multimodal therapy, (6) spine-oriented manual therapy, (7) massage therapy, (8) dry needling, (9) graston procedure with the exercise, (10) multimodal interventions including myofascial release, (11) Cervical mobilization, (12) Functional exercise protocol, (13) manual therapy, and (14) other combined measures [13,14,16,17,23-30].

Psychological distress and cognitive and social functioning

No study confirmed the influence of physical therapy, dry needling, or other similar non-pharmacological modalities on the psychological distress, cognitive functioning, and social functioning of patients with cervicogenic headaches.

Quality of life

Findings from two studies indicated the possible role of non-pharmacologic modalities in improving the health-related quality of life of patients with cervicogenic headaches [15,31].

Pain perception

Findings from thirty studies testified to the role of one or more of the non-pharmacological modalities in improving cervicogenic headache perception [12-41]. The overall results were either superior or comparable to the control group treatments.

Pressure pain thresholds

Results from two studies indicated statistically significant improvements in pressure pain thresholds in patients who underwent manual therapy and ischemic compression; however, one study revealed comparable pressure pain threshold improvements in patients with spinal mobilization and control intervention [18,36,38].

Performance of neck muscles

Findings from one study revealed statistically significant improvements in the performance of the deep neck flexor muscles (determined by their performance indices) in patients who were treated with exercise therapy and multimodal treatment for cervicogenic headache, compared to the control treatment [26].

Tone/fatigue of muscles

Results from a study indicated noticeable improvements in the sternocleidomastoideus/trapezius muscular muscle tone and fatigue following the administration of suboccipital relaxation and exercise procedures for cervicogenic headache, compared to the outcomes of the control procedure [40].

Risk of bias (ROB)

The ROB assessment revealed a low level of bias in the randomization procedure of 23 studies; however, some concerns regarding bias were reported in four studies, and no randomization bias-related information could be tracked in three studies (Fig. 2).

Low bias due to deviation from the required procedures, missing outcome data, outcome measurement, and result selection was found in 25, 18, 19, and 25, studies, respectively. Overall, a high risk of bias was reported in four studies, some bias-related concerns were tracked in eight studies, and low ROB was revealed in 18 studies. In addition, nearly 75% of the included studies were associated with a low ROB; some bias-related concerns were found in 15–25% of studies; however, no bias-related information was available in 10% of the included studies (Fig. 3).

DISCUSSION

The results of this study indicate the non-inferiority of the non-pharmacological approaches to conventional treatments for cervicogenic headaches. In addition, high patient satisfaction levels based on the improved range of motion of the cervical spine substantiate the successful treatment outcomes following the administration of dry needling, manual therapy, spine mobilization, multimodal therapy, and other combined interventions. The results also reveal statistically significant improvements in disability perceptions, psychological distress, quality of life, pain perceptions, pain pressure thresholds, neck muscle performance, and muscle fatigue in patients receiving non-pharmacological modalities.

The findings of our study concord with the expert panel guidelines of Xiao *et al.* that advocate the use of physical therapy, cervical spine mobilization, and manipulation for patients with cervicogenic headaches [42]. The results further match the meta-analysis outcomes of Pourahmadi *et al.*, indicating the non-inferiority of dry needling to contemporary treatments for cervicogenic headache. Importantly, the findings strengthen the current evidence concerning the role of non-pharmacological modalities in reducing headache intensity and minimizing disability perceptions [3]. They further support the meta-analysis outcomes of Bini *et al.* that reveal the superiority of spinal manipulation to contemporary procedures, such as sham interventions, in minimizing the frequency and intensity of cervicogenic headaches [6]. The outcomes from this study also emphasize the current literature concerning the possible role of multimodal manual therapy approaches, including endurance exercises and cervical spine joint manipulation/mobilization, in improving cervicogenic headaches. In addition, the upper cervical spine muscles are potential targets of the non-pharmacological modalities, aiming to treat the cervicogenic headache [43].

The cervical disc pathology, C-fiber-based neurotransmission, and aseptic inflammation are thought to play a predominant role in the progression of cervicogenic headaches. The pain signals are transmitted through the C1-C3 nerves and the trigeminal nerve to the trigeminocervical nucleus and the neck and head's nociceptive nucleus. The possible causes of cervicogenic pain are chronic spasms/strain of the shoulder/neck/scalp muscles, whiplash, or neck trauma. The C2-3 zygapophyseal joint pathology causes cervicogenic headaches in 70% of the affected patients [1]. Other possible causes correlate with abnormalities in lower cervical/C3-4 zygapophyseal joints and upper cervical intervertebral discs. The descending inhibitory pathways and the spinal cord's neural inhibitory systems are activated by manipulative maneuvers; the consistent treatment is based on manual cervical traction and muscle stretching interventions [44]. The dry needling approach aims to improve cervical spine motion by minimizing the tension of the neck muscles. The increased blood flow and triggering of pain-reducing substances after dry needling intervention help to improve the function of the cervical spine's nerves. In addition, the triggering of the trapezius and suboccipital muscles via the deep/superficial dry needling further improves the neck's range of motion and pain intensity [20]. Similar mechanisms and processes are utilized by other non-pharmacological modalities to improve the cervicogenic pain and pain perception levels of the treated patients.

Limitations

This study is not devoid of potential limitations. First, no subgroup analysis was undertaken to comparatively analyze the outcomes of different non-pharmacological modalities. Second, we could not compare the non-pharmacological approaches, such as spinal manipulation and dry needling, with pharmacological treatments to understand their comparative efficacy in patients with cervicogenic headaches. Third, the absence of statistical analysis of our results due to consistent data further reduces their overall reliability. Finally, this study did not compare and analyze the long- versus short-term benefits of non-pharmacological approaches against cervicogenic headaches. Future studies should statistically compare the clinical outcomes of non-pharmacological and pharmacological modalities for cervicogenic headaches, to identify the best possible integrated treatments, aiming to improve the patient-reported outcomes.

CONCLUSION

The overall results of this study revealed the potential of non-pharmacological modalities, including dry needling and cervical spine manipulation, in improving the intensity and frequency of cervicogenic headaches. The high patient satisfaction level of 97.5–100% and improvement in disability/pain perceptions, after the non-pharmacological interventions, are landmark achievements that require further investigation to optimize the pain management approaches against cervicogenic headaches.

CONFLICTS OF INTEREST

Nil.

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