Clinical Rehabilitation

Effect of adding interferential currents stimulation to exercise on outcomes in primary care patients with chronic neck pain: a randomised controlled trial

Journal:	*Clinical Rehabilitation*
Manuscript ID	CRE-2018-6969.R2
Manuscript Type:	Original Article
Date Submitted by the Author:	21-Mar-2019
Complete List of Authors:	Albornoz-Cabello, Manuel; University of Sevilla, Department of Physical Therapy Pérez Mármol, José Manuel; University of Granada, Physiotherapy (Occupational Therapy) Barrios-Quintana, Cristo Jesus; Junta de Andalucia Servicio Andaluz de Salud, Physiotherapy Matarán-Peñarrocha, Guillermo Adolfo; Servicio Andaluz de Salud, Atención Primaria Castro-Sánchez, Adelaida María; University of Almería, Department of Nursing and Physical Therapy DE LA CRUZ-TORRES, BLANCA; University of Seville, Physiotherapy
Keywords:	Range of movement, Neck pain, Exercise, Interferential Currents

Abstract

Objective: to evaluate the effect of adding interferential current stimulation to exercise on pain, disability, psychological status and range of motion in patients with neck pain.

Design: A single blinded randomised controlled trial.

Setting: Primary care physiotherapy units.

Subjects: 84 patients diagnosed with non-specific mechanical neck pain. This sample was divided into two groups randomly: experimental (n=42) vs control group (n=42).

Interventions: Patients in both groups had a supervised therapeutic exercise program, with the experimental group having additional interferential current stimulation treatment.

Main measures: The main measures used were intensity of neck pain according to the Visual Analogue Scale; the degree of disability according to the Neck Disability Index and the CORE Outcome Measure; anxiety and depression levels according to the Goldberg scale; apprehension as measured by the Personal Psychological Apprehension scale; and the range of motion of the cervical spine. The sample was evaluated at baseline and posttreatment (10 sessions/two weeks).

Results: Statistically significant differences between groups at posttreatment were observed for Visual Analogue Scale (2.73±1.24 vs 4.99±1.56), Neck Disability Index scores (10.60±4.77 vs 18.45±9.04), CORE Outcome Measure scores (19.18±9.99 vs 35.12±13.36), Goldberg total score (6.17±4.27 vs 7.90±4.87), Goldberg anxiety subscale, Personal Psychological Apprehension Scale scores (28.17±9.61 vs 26.29±11.14), and active and passive right rotation.

Conclusions: Adding interferential current stimulation to exercise resulted in better immediate outcome across a range of measures.

Effect of adding interferential currents stimulation to exercise on outcomes in primary care patients with chronic neck pain: a randomised controlled trial

Introduction

Neck pain generates a very limiting symptomatology, such as pain, a decrease in neck range of motion, disability or an impairment of the patient's psychological function.[1] Conclusive evidence in patients with chronic pain recommends the use of multimodal rehabilitation approaches, using exercises combined with other therapeutic interventions.[2-4] Supervised therapeutic exercise has shown to be effective in the treatment of neck pain and other neck disorders.[3-4] Gross et al.[3], in a Cochrane systematic review evaluating effectiveness of exercise for neck disorders, reported that strength and endurance training and stabilization and stretching exercises had a small to large impact on neck pain relief in the short term. Hence, management of neck pain at present is largely a matter of exercise as the only reasonably well-studied and proven effective treatment.

Interferential current therapy uses the significant physiological effects of low-frequency electrical nerve stimulation without the painful and somewhat unpleasant side effects that are sometimes associated with low-frequency stimulation. An advantage of interferential current therapy is its capacity to reduce the impedance offered by the skin.[5-8] Several physiological mechanism approaches, such as the ‘gate control’ theory, claim that interferential current therapy may increase circulation and pain suppression by blocking nerve conduction.[5-9] Reviews have indicated an overall supportive evidence base for interferential current therapy, especially in pain-based management.[5,8,10]

Therefore, interferential current may increase the effectiveness of exercise in primary care patients with chronic neck pain.

The main aim of this study was to evaluate the effect of adding interferential current stimulation to exercise on pain, disability, psychological status and neck range of motion in primary care patients with chronic neck pain.

Methods

The design of this trial is a prospective single blinded randomised controlled trial. The trial was registered in the Australian New Zealand Clinical Trials Registry (Trial ID: ACTRN12616000964415). The study period was from September 2014 to June 2017. Written informed consent was obtained from each patient to be included in this study. The research protocol was approved by the Andalusian Research Ethics Committee of the Virgen Macarena - Virgen del Rocío University Hospital (Reference number: 0794-N-14). This clinical trial was performed in compliance with the Helsinki Declaration, 2013.

Patients diagnosed with nonspecific mechanical neck pain, from primary care medical services in the health care district (La Rinconada de Sevilla, Seville, Spain) were potential participants in the clinical trial. All patients that were treated at the physiotherapy service were informed of the objectives and procedures of the study. Patients that agreed to participate were screened by a research assistant (within 1-3 working days after admission) to assess their eligibility. A total of 84 patients met the selection criteria and agreed to participate. Patients were recruited prior to day five of admission. The participants in the clinical trial received the study interventions at the physiotherapy service.

Participants were included in this study if they met the following criteria: (1) non-specific mechanical neck pain (chronic neck pain diagnosed by a physician)[11]; (2) age between 18 and 65 years old; (3) both men and women were accepted; (4) lack of apprehension toward electrotherapy. The exclusion criteria were: (1) metal implants in the spine; (2) apprehension to electrotherapy (a score of >45 points on the Personal Psychological Apprehension scale);[10] (3) cervicogenic headache; (4) cervicogenic dizziness; (5) neck pain associated with neurological deficits; (6) unexplained fever; (7) cervical surgery associated with persistent pain; (8) specific diagnoses such as cervical myelopathy, cervical stenosis, osteomyopathy, and visceral pain referred to the neck or non-cervical cause.

Following the initial baseline evaluation, patients were randomly assigned to either the supervised exercise group or the interferential current therapy plus supervised exercise group. Randomisation was executed by a computerised random number generator before starting data collection by a researcher not involved in the recruitment or the treatment phases. Individual and sequentially numbered index cards with the random assignment were prepared. The cards were put inside sealed opaque envelopes. A research assessor, blinded during the baseline examination, opened the envelopes and allocated each patient to their corresponding treatment group.[12]

The interventions were provided by a physiotherapist with more than 11 years of experience in the physiotherapy service of San José de La Rinconada health centre (La Rinconada de Sevilla, Seville, Spain). Participants received 10 sessions from Monday to Friday for two weeks. The duration of each session was approximately one hour and a half. The physiotherapist recorded attendance at sessions.

The control group only received a supervised therapeutic exercise programme, in which the exercises were provided in group sessions and one on one. The control group

had no extra treatment during the study. The main objective of the supervised exercises was to induce relaxation and pain relief while improving the neck muscles' flexibility and strength. The supervised exercises included: 1) ergonomic advice on reducing repetitive motions and/or maintained positions; and 2) a protocol of active physiotherapy for neck and shoulder muscles. This protocol included: 2.1) active stretching exercises; 2.2) isometric muscle strengthening exercises; 2.3) ocular-cervical kinetic re-education programme; 2.4) homework including several exercises detailed below. The exercises were performed very slowly. They did not significantly increase heart rate. A more detailed description of the exercises is provided in Appendix 1.

The participants were also asked to complete the same exercises at home for at least 30 to 45 minutes once a day during the two weeks of treatment. To encourage participants to complete the home exercises, the information provided by the physiotherapist were clear and concise. After each session, the physiotherapist asked the participants how they felt after the exercises performed the day before and if they had any questions about them. The patients were also asked to keep a diary in order to detect questions during the period between sessions and to encourage daily practice. The physiotherapist explained the difference between the pain that disappears quickly after the exercises are executed and the characteristics of chronic neck pain. Patients used a pain diary to see the subjective effectiveness of the home exercises. They were also encouraged to improve their self-care and perception of self-efficacy. This part of the control intervention (home exercises) was applied one on one.

Application of the interferential current therapy was also one on one. The experimental group also received the same supervised exercise programme as the control group before their interferential current therapy treatment. The interferential current therapy intervention was applied by an electrotherapy, ultrasound and combined

therapy device using SONOPULS 692® (brand: ENRAF NONIUS). The interferential current therapy used the following parameters: bipolar application method with 4000 Hz carrier frequency and 60 Hz amplitude modulated frequency, with a modulation frequency of 90 Hz, with five 10 cm2 electrodes placed in opposition to the neck (C5-C6-C7) for 25 minutes. The intensity (voltage) of the interferential current therapy was adapted to the sensitivity of each patient. During the treatment time, current intensity was increased between three to five times, within the limits of patients' perception without exceeding excitability and pain thresholds. The increased intensity was intended to retard the apparition of accommodative phenomena.[13,14]

Sociodemographic and clinical data were recorded using an *ad hoc* questionnaire prepared by the researchers. These data were provided by the patients and collected from their medical report. Body Mass Index was also calculated and recorded at baseline. Assessments were completed at two points: at baseline (before randomisation), and posttreatment. The person collecting the outcome data did not know which group the patient was in, that is, it was an assessor blinded to the grouping of participants. The primary outcome measure was intensity of neck pain as assessed by the 10 mm Visual Analogue Scale.[15] Several secondary outcome measures were also included in the clinical trial. The Neck Disability Index[16,17] and CORE Outcome Measure [18,19] were used to evaluate the degree of disability. The CORE Outcome Measure consists of five dimensions: pain, neck function, well-being in relation to specific symptoms, general quality of life and disability (social and work).[18,19] Anxiety and depression levels were assessed by the Goldberg Scale.[20,21] The Personal Psychological Apprehension Scale evaluated the frequency and persistence of neuroticism/psychological apprehension by ups and downs, feeling of misery, and emotional tension, among others items related to the application of electrotherapy.[10] The neck (or cervical) Range of Motion was

determined by active and passive range of motion measurements. These measurements were executed in the sagittal plane (flexion and extension mobility), in the frontal plane (right and left flexion), and in the transverse plane (right and left rotations). A conventional two-leg goniometer (angular measurement) and a metric tape (linear measurement) were used. The Range of Motion measurements were performed with the subjects in a sitting position to stabilize the pelvis and the thoracic-lumbar spine.[22]

Statistical analyses were carried out by an assessor blinded to the treatment allocation, using SPSS statistical software (SPSS Inc., Chicago, IL), in its version 22.0. Firstly, the normal distribution of variables was verified by the Kolgomorov-Smirnov test, after a descriptive analysis. The homogeneity of variances was observed by Levene's test. Linearity was evaluated by bivariate scatter plots of observed residual values against the expected values. Comparisons between groups were conducted for baseline demographic and clinical data using Student t-test for continuous data and chi-square test for categorical data.

Separate 2x(2) mixed model analysis of variance ANOVA were used to evaluate interaction time*groups, including the time effects (baseline, 2 weeks posttreatment) and group effects (supervised exercise group versus interferential current therapy + supervised exercise group) for each outcome measure. All analyses followed the intention to treat principle and groups were analysed as randomised. Changes in outcome scores between and within groups were measured by Student t-tests for paired or independent samples as appropriate (95% confidence interval). Effect sizes were calculated using Cohen's *d* coefficient. A p-value < 0.05 was considered statistically significant.

The sample size was obtained using GPower 3.1. In order to calculate the sample size, based on previous research,[23] a between-group effect size at posttreatment of 1.00

point was used on the Visual Analogue Scale (primary outcome). A sample size of 23 participants per arm was estimated to provide 95% confidence interval (CI) with a power of 80%, assuming a significance level (α) of 0.05 (2-tailed).

RESULTS

An initial sample of 103 patients were assessed for eligibility. None of the participants screened expressed a wish to not be included in the study. However, 84 patients met the inclusion criteria. A flow diagram of the recruitment and follow-up with participants, following CONSORT guidelines, is depicted in figure 1. The sociodemographic and clinical features are shown in table 1. From both groups, 100% were evaluated at posttreatment.

Differences between groups were observed for the primary outcome, Visual Analogue Scale (d = 1.604), and secondary outcomes: Neck Disability Index scores (d = 1.086), CORE Outcome Measure scores (d = 1.418), Goldberg total score (d = 0.378), Goldberg anxiety subscale (d = 0.178), and Personal Psychological Apprehension Scale scores (d = 0.181). Table 2 shows pre-post-intervention values, and between- and within-group change scores with associated 95% CI for neck disability, CORE Outcome Measure, anxiety, depression and total Goldberg, apprehension and pain intensity. Differences between groups were also observed for active (d = 0.191) and passive right rotation (d = 0.336) measured with a goniometer. Table 3 shows pre-post-intervention values, and between- and within-group change scores with associated 95% CI for range of joint mobility of the cervical spine through both linear and angular determination. All the differences between groups were in favour of the experimental intervention.

Discussion

Adding interferential current stimulation to exercise resulted in greater improvements in levels of perceived pain intensity, degree of neck disability, anxiety/depression symptoms, levels of apprehension, and active and passive right rotation of neck than supervised therapeutic exercise alone. These additional effects compared to exercise alone may be explained by the fact that interferential current stimulation produces an amplitude-modulated frequency parameter, which is a low-frequency current activated deep inside the treatment area because of the interaction between two medium-frequency circuits. This amplitude-modulated frequency may stimulate the nerve and other tissues, controlling pain by activating the pain gating mechanism and stimulating the descending pain suppression mechanisms.[5] Since the population suffers from non-specific mechanical neck pain, this method may cover a more extensive area and a higher number of body tissues such as muscles, ligaments, nerves and cervical joints.[13] The findings obtained may be valuable for rehabilitation and care teams for the treatment of the population with non-specific chronic neck pain.

Regarding the levels of cervical pain intensity, this clinical trial showed greater improvement in the experimental group (a decrease of clinical pain of 3.86 points on a ten-point scale/ large effect) compared to the control group. With regard to neck disability, differences between the groups after treatment were also observed. However, both groups achieved a significant improvement in levels of disability. These results are reinforced by previous literature.[24-26] Regarding neck range of motion, the global sample experienced an increase of active and passive right rotation of neck measured with a goniometer (angular measurement). However, the experimental group showed a greater improvement in these range of neck motions than the control group. These results could be explained by the increase in stretch tolerance and mechanical structural changes,

probably induced by the modification of the viscoelastic properties of the cervical musculature after interferential current therapy and exercises.[25, 27, 28]

Along these lines, several clinical trials have evaluated the effectiveness of electrotherapy versus manual therapy, mobilisations or manipulations in patients with neck pain.[24-28] The study conducted by González-Iglesias et al.[25] compared the effectiveness of a control group receiving an electrotherapy/thermal programme, versus an experimental group receiving a thoracic spine "distraction" manipulation in addition. Both groups showed a reduction of pain levels. Escortell-Mayor et al.[24] in a clinical trial of primary care patients with neck pain evaluated the effectiveness of transcutaneous electric nerve stimulation intervention versus manual therapy. This trial showed a clinically relevant reduction of pain, neck disability and increased quality of life in the short term, but no differences between groups were observed. Acedo et al.[23] compared the application of transcutaneous electric nerve stimulation and interferential current therapy on muscle relaxation of the upper trapezius in patients with chronic nonspecific neck discomfort. These authors reported similar pre-post-treatment improvement of pain intensity for both groups. In contrast, the findings of this clinical trial showed that combining interferential current stimulation with exercise was more effective than supervised exercises alone for improving perceived pain intensity, degree of neck disability and active-passive right rotation of neck.

On the other hand, more than half of the sample showed high levels of anxiety and depressive symptoms, according to the Goldberg scale (50th percentile above 9 points). Only one other study reported data about the levels of these symptoms in chronic neck pain.[28] This research showed that 55.6% reported having suffered from a depressed mood. Nevertheless, to our knowledge, no studies have evaluated the effectiveness of the interventions conducted in this clinical trial on anxiety and

depressive symptoms. The sample with chronic neck pain significantly decreased their levels of anxiety after the supervised therapeutic exercise programme in combination with interferential current stimulation.

The main weaknesses and limitations of the study are related to the immediate follow-up and the lack of a control group for the additional interferential treatment. The trial did not have any long-term follow-up, so it could not be determined whether the effect lasted beyond the intervention. It also cannot be determined whether the interferential treatment would be more or less effective in the absence of concomitant exercise. Similar studies in the future could include a comparison group for interferential current stimulation, as the positive effects of this treatment could simply be the result of extra attention and time given to the patients in the experimental group. The effects of expectation, sometimes referred to as the placebo response, could be significant and might well account for a significant proportion of the difference between the groups. Nevertheless, part of the control intervention (supervision of exercises at home) was also applied one on one.

The main implication of this clinical trial is that the benefits obtained through interferential current therapy and supervised therapeutic exercise seem to be higher than those achieved through supervised therapeutic exercise alone at posttreatment. Clinicians could combine both therapeutic interventions to maximise outcomes in non-specific neck pain in public and private physiotherapy services. However, although there is reasonable evidence, further research is needed to control for the effects of expectation before clinical staff start using this treatment. Moreover, further investigations are recommended to show that the benefit lasts for at least three to six months after completing the treatment.

Clinical messages

- The addition of interferential stimulation therapy to exercise in people with non-specific neck pain reduces pain, disability, mood disturbance and apprehension and increases range of movement after the intervention.
- We only report an immediate effect; therefore, the long-term effects are unknown.

Acknowledgements

We would like to thank the members of the rehabilitation teams and related staff from the Spanish Public Health System for their contribution to this clinical trial. We are also grateful for the participation of the patients included in the study.

Conflict of interest

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. Saturno PJ, Medina F, Valera F, Montilla J, Escolar P, Gascón JJ. Validity and reliability of guidelines for neck pain treatment in primary health care. A nationwide empirical analysis in Spain. *Int J Qual Health Care*. 2003; 15(6): 487–93.

2. Furlan AD, Yazdi F, Tsertsvadze A, Gross A, Van Tulder M, Santaguida L, et al. A Systematic Review and Meta-Analysis of efficacy, cost-effectiveness, and safety of selected complementary and alternative medicine for neck and low-back pain. *Evid Based Complement Alternat Med*. 2012; 2012:1–61.

3. Gross AR, Paquin JP, Blanchette S, Lalonde P, Christie T, Dupont G, et al. Exercise for mechanical neck disorders: A Cochrane systematic review update. *Physiother*. 2015; 101: eS486.

4. Kay TM, Gross A, Goldsmith C, Santaguida PL, Hoving J, Bronfort G. Exercises for mechanical neck disorders. *Cochrane Database Syst Rev*. 2005; 20 (3):CD004250.

5. Fuentes C J, Armijo-Olivo S, Magee DJ, Gross D. Does amplitude-modulated frequency have a role in the hypoalgesic response of interferential current on pressure pain sensitivity in healthy subjects? A randomised crossover study. *Physiother*. 2010; 96(1): 22–9.

6. Watson T. *Electrotherapy: evidence-based practice*. Churchill Livingstone; 2008.

7. Robertson V, Ward A, Low J, Reed A. *Electrotherapy Explained. Principles and Practice*. 4a ed. Philadelphia: Elsevier Ltd; 2006.

8. Shah SGS, Farrow A, Esnouf A. Availability and use of electrotherapy devices: A survey. *Int J TherRehabil*. 2007; 14(6): 260-264.

9. Lindsay DM, Dearness J, McGinley CC. Electrotherapy usage trends in private physiotherapy practice in Alberta. *Physiother Canada Physiothérapie Canada*. 1995; 47(1):30–4.

10. Albornoz Cabello M, Rebollo Roldán J, García Pérez R. Escala de Aprensión Psicológica Personal (EAPP) en Fisioterapia (*Personal PsychologicalAppraisalScale (PPAS) in Physiotherapy*). *Rev IberoamFisioter y Kinesiol*. 2005; 8(2): 77–87.

11. Binder A. The diagnosis and treatment of nonspecific neck pain and whiplash. *Eura Medicophys*. 2007; 43(1):79–89.

12. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *Int J Surg*. 2012; 10(1):28–55.

13. Hurley DA, Minder PM, McDonough SM, Walsh DM, Moore AP, Baxter DG. Interferential therapy electrode placement technique in acute low back pain: A preliminary investigation. *Arch Phys Med Rehabil*. 2001;82(4):485–93.

14. Albornoz M, Martín J. Estimulación eléctrica transcutánea y neuromuscular (*Transcutaneous and neuromuscular electrical stimulation*). Spain. Editorial Elsevier, 2010.

15. Jensen MP, Turner JA, Romano JM, Fisher LD. Comparative reliability and validity of chronic pain intensity measures. Pain. 1999; 83: 157-62.

16. Cleland JA, Fritz JM, Whitman JM, Palmer JA. The reliability and construct validity of the Neck Disability Index and patient specific functional scale in patients with cervical radiculopathy. *Spine (PhilaPa 1976)*. 2006;31(5):598–602.

17. Ortega JAA, Martínez ADD, Ruiz RA. Validación de una versión española del Índice de Discapacidad Cervical (*Validation of a Spanish version of the Cervical Disability Index*). *Med Clin (Barc).*2008; 130(3): 85–9.

18. Murphy DR, Lopez M. Neck and back pain specific outcome assessment questionnaires in the Spanish language: a systematic literature review. *Spine J*. 2013; 13(11): 1667–74.

19. Fankhauser CD, Mutter U, Aghayev E, Mannion AF. Validity and responsiveness of the Core Outcome Measures Index (COMI) for the neck. *Eur Spine J.* 2012; 21(1): 101–14.

20. Goldberg D, Bridges K, Duncan-Jones P, Grayson D. Detecting anxiety and depression in general medical settings. *BMJ.* 1988; 297(6653): 897–9.

21. Retolaza Balsategui A, Mostajo A, de la Rica J, Díaz de Garramiola A, Pérez de Loza J, Aramberri I, et al. Validación del Cuestionario de Salud General de Goldberg (versión 28 ítems) en consultas de Atención Primaria (*Validation of the Goldberg General Health Questionnaire (28 items version) in Primary Care consultations*). *Rev Asoc Esp Neuropsiq*. 1993; 13(46): 187–94.

22. De-la-Llave-Rincón AI, Fernández-de-las-Peñas C, Palacios-Ceña D and Cleland JA. Increased forward head posture and restricted cervical range of motion in patients with carpal tunnel syndrome. *J Orthop Sports PhysTher*. 2009; 39: 658–664.

23. Acedo AA, Antunes ACL, Dos Santos AB, De Olveira CB, Dos Santos CT, Colonezi GLT, et al. Upper trapezius relaxation induced by tens and interferential current in computer users with chronic nonspecific neck discomfort: An electromyographic analysis. *J Back Musculoskelet Rehabil*. 2015; 28(1): 19–24.

24. Escortell-Mayor E, Riesgo-Fuertes R, Garrido-Elustondo S, Asúnsolodel Barco A, Díaz-Pulido B, Blanco-Díaz M, Bejerano-Álvarez E. Primary care randomized clinical trial: Manual therapy effectiveness in comparison with TENS in patients with neck pain. *Man Ther*. 2011; 16: 66-73.

25. González-Iglesias J, Fernández-de-las-Peñas C, Cleland JA, Alburquerque-Sendín F, et al. Inclusion of thoracic spine thrust manipulation into an electro-therapy / thermal program for the management of patients with acute mechanical neck pain: A randomized clinical trial. *Man Ther*. 2009; 14(3): 306–13.

26. Seo HG, Bang MS, Chung SG, Jung SH, Lee S-U, Han SC, et al. Effect of Electrical Stimulation on Botulinum Toxin: a Therapy in Patients With Chronic Myofascial Pain Syndrome: A 16-Week Randomized Double-Blinded Study. *Arch Phys Med Rehabil*. 2013; 94(3): 412–8.

27. Rodríguez-Fernández ÁL, Garrido-Santofimia V, Güeita-Rodríguez J, Fernández-De-Las-Peñas C. Effects of Burst-Type Transcutaneous Electrical Nerve Stimulation on Cervical Range of Motion and Latent Myofascial Trigger Point Pain Sensitivity. *Arch Phys Med Rehabi*. 2011; 92: 1353–8.

28. Goode AP, Freburger J, Carey T, Carolina N, Hill C. Prevalence, Practice Patterns, and Evidence for Chronic Neck Pain. *Arthritis Care Res (Hoboken)*. 2010; 62(11): 1594–601.

Table 1. M (SD), absolute frequency of patients' characteristics and between-groups differences at baseline.

Sociodemographic and clinical characteristics	Electrical stimulation therapy + Supervised exercises Group M (SD)/ n (%) N = 42	Supervised exercises Group M (SD)/ n (%) N = 42
Mean age	49.81 (9.52)	44.52 (11.77)
Weight (kg)	74.50 (16.74)	70.19 (10.69)
Height (cm)	1.68 (0.08)	1.67 (0.83)
Body mass index	26.40 (5.16)	25.46 (4.94)
Sex		
Females	29	33
Male	13	9
Civil Status		
Married	37	29
Single	1	10
Divorced	3	3
Widower	1	0
Educational level		
No studies	0	0
School level	16	25
Bachelor level	22	11
University level	4	6
Pharmacologic treatment		
Yes	25	30
Not	17	12

M (SD) = Mean (Standard deviation); n = absolute frequency.

Table 2. Baseline, post-treatment, pre-post-treatment changes and between-group differences (95% confidence interval) for perceived disability, anxiety and depression symptoms, psychological apprehension, and pain intensity.

Outcome/ Group	Baseline M (SD)	Two weeks Post-treatment M (SD)	Within-Group Score Changes	Between-Group Score Changes
Pain Intensity (VAS) (0-10)				
Interferential current therapy group	6.60 (1.30)	2.73 (1.24)	3.86 (3.48, 4.25)**	-2.27 (-2.88, -1.65)**
Supervised exercises group	6.23 (1.49)	4.99 (1.56)	1.23 (0.87, 1.59)**	
NDI				
Interferential current therapy group	26.45 (7.65)	10.60 (4.77)	15.86 (13.88, 17.83)**	-7.86 (-11.01, -4.70)**
Supervised exercises group	26.10 (9.68)	18.45 (9.04)	7.64 (5.70, 9.59)**	
COM				
Interferential current therapy group	39.48 (11.91)	19.18 (9.99)	20.30 (16.26, 24.33)**	-15.94 (-21.07, -10.81)**
Supervised exercises group	43.21 (13.46)	35.12 (13.36)	8.10 (6.30, 9.90)**	
Total Goldberg				
Interferential current therapy group	9.90 (4.74)	6.17 (4.27)	3.74 (2.85, 4.63)**	-1.74 (-3.73, 0.25)**
Supervised exercises group	8.33 (4.72)	7.90 (4.87)	0.43 (-0.14, 0.99)	
Goldberg – Anxiety subscale				
Interferential current therapy group	5.86 (2.73)	4.05 (2.93)	1.81 (1.03, 2.59)**	-0.52 (-1.79, 0.74)**
Supervised exercises group	5.10 (2.60)	4.57 (2.91)	0.52 (-0.08, 1.13)	
Goldberg – Depression subscale				

Interferential current therapy group	3.93 (2.81)	3.02 (2.40)	0.90 (0.35, 1.46)**	0.10 (-1.01, 1.20)
Supervised exercises group	3.19 (2.66)	2.93 (2.67)	0.26 (-0.17, 0.69)	
EAPP				
Interferential current therapy group	30.50 (10.56)	28.17 (9.61)	2.33 (1.08, 3.59)**	1.88 (-2.63, 6.40)**
Supervised exercises group	26.62 (10.41)	26.29 (11.14)	0.33 (-0.89, 1.57)	

M (SD) = Mean (Standard deviation); VAS = Visual Analogue scale; NDI = Neck Disability Index; COM = Core Outcome Measure; EAPP = Personal Psychological Apprehension scale.

*p<0.05, **p<0.01.

Table 3. Baseline, post-treatment, pre-post-treatment changes and between-group differences (95% confidence interval) for neck range of motion.

Outcome/ Group	Baseline M (SD)	Two weeks Post-treatment M (SD)	Within-Group Score Changes	Between-Group Score Changes
Active flexion (tape)				
Interferential current therapy group	4.77 (1.81)	3.94 (1.44)	0.82 (0.44, 1.21)**	-0.15 (-0.83, 0.52)
Supervised exercises group	6.52 (10.79)	4.10 (1.67)	2.42 (-0.95, 5.79)	
Passive flexion (tape)				
Interferential current therapy group	3.74 (1.77)	2.50 (1.34)	1.24 (0.88, 1.61)**	-0.54 (-1.18, 0.10)
Supervised exercises group	3.93 (1.71)	3.03 (1.60)	0.89 (0.57, 1.22)**	
Active flexion (goniometer)				
Interferential current therapy group	37.05 (9.28)	40.45 (10.88)	-3.41 (-5.49, -1.32)**	1.14 (-3.67, 5.95)
Supervised exercises group	35.50 (10.06)	39.31 (11.29)	-3.81 (-5.10, -2.52)**	
Passive flexion (goniometer)				
Interferential current therapy group	41.14 (10.43)	46.95 (11.87)	-5.81 (-7,49, -4,13)**	3.19 (-1.79, 8.17)
Supervised exercises group	39.45 (11.07)	43.76 (11.05)	-4.31 (-5.85, -2.77)**	
Active Extension (tape)				
Interferential current therapy group	17.13 (2.92)	17.05 (2.82)	0.08 (-0.94, 1.09)	0.70 (-0.76, 2.15)
Supervised exercises group	17.08 (1.89)	16.36 (3.81)	0.72 (-0.42, 1.87)	
Passive Extension (tape)				
Interferential current therapy group	18.12 (3.42)	18.06 (2.99)	0.06 (-1.11, 1.24)	0.81 (-0.69, 2.31)

Supervised exercises group	17.94 (1.76)	17.25 (3.88)	0.69 (-0.52, 1.89)	
Active Extension (goniometer)				
Interferential current therapy group	43.05 (6.51)	43.81 (9.13)	-0.76 (-2.82, 1.30)	-1.81 (-5.79, 2.17)
Supervised exercises group	44.40 (7.77	45.62 (9.22)	-1.21 (-2.08, -0.35)**	
Passive Extension (goniometer)				
Interferential current therapy group	48.12 (7.22)	49.33 (10.63)	-1.21 (-3.62, 1.19)	-0.76 (-5.20, 3.68)
Supervised exercises group	49.02 (8.80)	50.10 (9.81)	-1.07 (-1.83, -0.31)**	
Active right lateral-flexion (tape)				
Interferential current therapy group	9.42 (2.76)	8.83 (2.07)	0.59 (-0.04, 1.22)	0.56 (-0.43, 1.55)
Supervised exercises group	8.92 (2.42)	8.27 (2.48)	0.65 (0.44, 0.86)**	
Passive right lateral-flexion (tape)				
Interferential current therapy group	8.70 (2.38	7.79 (2.05)	0.91 (0.53, 1.29)**	0.64 (-0.23, 1.51)
Supervised exercises group	8.05 (2.29)	7.15 (1.98)	0.90 (0.63, 1.17)**	
Active right lateral-flexion (goniometer)				
Interferential current therapy group	30.62 (6.89)	33.21 (5.57)	-2.60 (-4.57, -0.62)*	0.74 (-1.83, 3.31)
Supervised exercises group	30.02 (5.96)	32.48 (6.26)	-2.45 (-3.23, -1.68)**	
Passive right lateral-flexion (goniometer)				
Interferential current therapy group	34.57 (6.63)	38.19 (6.17)	-3.62 (-5.41, -1.83)**	1.38 (-1.42, 4.18)
Supervised exercises group	33.24 (5.70)	36.81 (6.70)	-3.57 (-4.69, -2.45)**	
Active left lateral-flexion (tape)				

Interferential current therapy group	9.69 (2.59)	8.75 (2.29)	0.95 (0.59, 1.30)**	0.55 (-0.46, 1.57)
Supervised exercises group	8.75 (2.29)	8.19 (2.38)	0.80 (0.58, 1.03)**	
Passive left lateral-flexion (tape)				
Interferential current therapy group	8.40 (2.34)	7.75 (2.08)	0.85 (0.37, 1.33)**	0.48 (-0.36, 1.32)
Supervised exercises group	7.76 (2.19)	7.07 (1.80)	0.70 (0.36, 1.03)**	
Active left lateral-flexion (goniometer)				
Interferential current therapy group	31.67 (7.08)	34.05 (5.72)	-2.38 (-3.87, -0.90)**	0.95 (-1.66, 3.57)
Supervised exercises group	29.79 (5.70)	33.10 (6.31)	-3.31 (-4.20, -2.42)**	
Passive left lateral-flexion (goniometer)				
Interferential current therapy group	36.48 (7.74)	39.71 (6.38)	-3.24 (-4.94, -1.54)**	2.00 (-0.99, 4.99)
Supervised exercises group	33.83 (5.98)	37.71 (7.36)	-3.88 (-5.35, -2.42)**	
Active right rotation (tape)				
Interferential current therapy group	8.79 (2.57)	7.96 (2.33)	0.84 (0.40, 1.29)**	0.42 (-0.70, 1.55)
Supervised exercises group	7.87 (2.17)	7.53 (2.84)	0.34 (-0.35, 1.03)	
Passive right rotation (tape)				
Interferential current therapy group	7.74 (2.28)	6.74 (2.24)	0.99 (0.40, 1.28)**	0.64 (-0.27, 1.55)
Supervised exercises group	6.86 (1.97)	6.10 (1.95)	0.75 (0.50, 1.00)**	
Active right rotation (goniometer)				
Interferential current therapy group	53.38 (12.07)	58.81 (9.88)	-5.43 (-8.55, -2.31)**	1.81 (-2.31, 5.93)**
Supervised exercises group	54.81 (8.27)	57.00 (9.08)	-2.19 (-3.10, -1.28)**	

Passive right rotation (goniometer)				
Interferential current therapy group	60.60 (9.43)	66.19 (10.39)	-5.60 (-7.51, -3.68)**	3.38 (-0.99, 7.76)**
Supervised exercises group	59.52 (8.64)	62.81 (9.75)	-3.29 (-4.36, -2.12)**	
Active left rotation (tape)				
Interferential current therapy group	8.94 (2.34)	8.07 (2.26)	0.87 (0.52, 1.22)**	0.82 (-0.09, 1.73)
Supervised exercises group	8.16 (1.99)	7.25 (1.92)	0.91 (0.58, 1.24)**	
Passive left rotation (tape)				
Interferential current therapy group	7.89 (2.26)	6.81 (2.26)	1.08 (0.72, 1.45)**	0.88 (-0.01, 1.76)
Supervised exercises group	6.92 (1.89)	5.93 (1.78)	0.99 (0.70, 1.27)**	
Active left rotation (goniometer)				
Interferential current therapy group	58.55 (10.12)	61.95 (9.52)	-3.41 (-5.05, -1.76)**	4.17 (0.01, 8.25)
Supervised exercises group	54.21 (8.36)	57.79 (9.29)	-3.57 (-4.83, -2.32)**	
Passive left rotation (goniometer)				
Interferential current therapy group	64.31 (10.51)	68.93 (10.32)	-4.62 (-6.11, -3.12)**	5.07 (0.67, 9.47)
Supervised exercises group	60.29 (8.92)	63.86 (9.96)	-3.57 (-4.93, -2.21)**	

M (SD) = Mean (Standard deviation).

*p<0.05, **p<0.01.

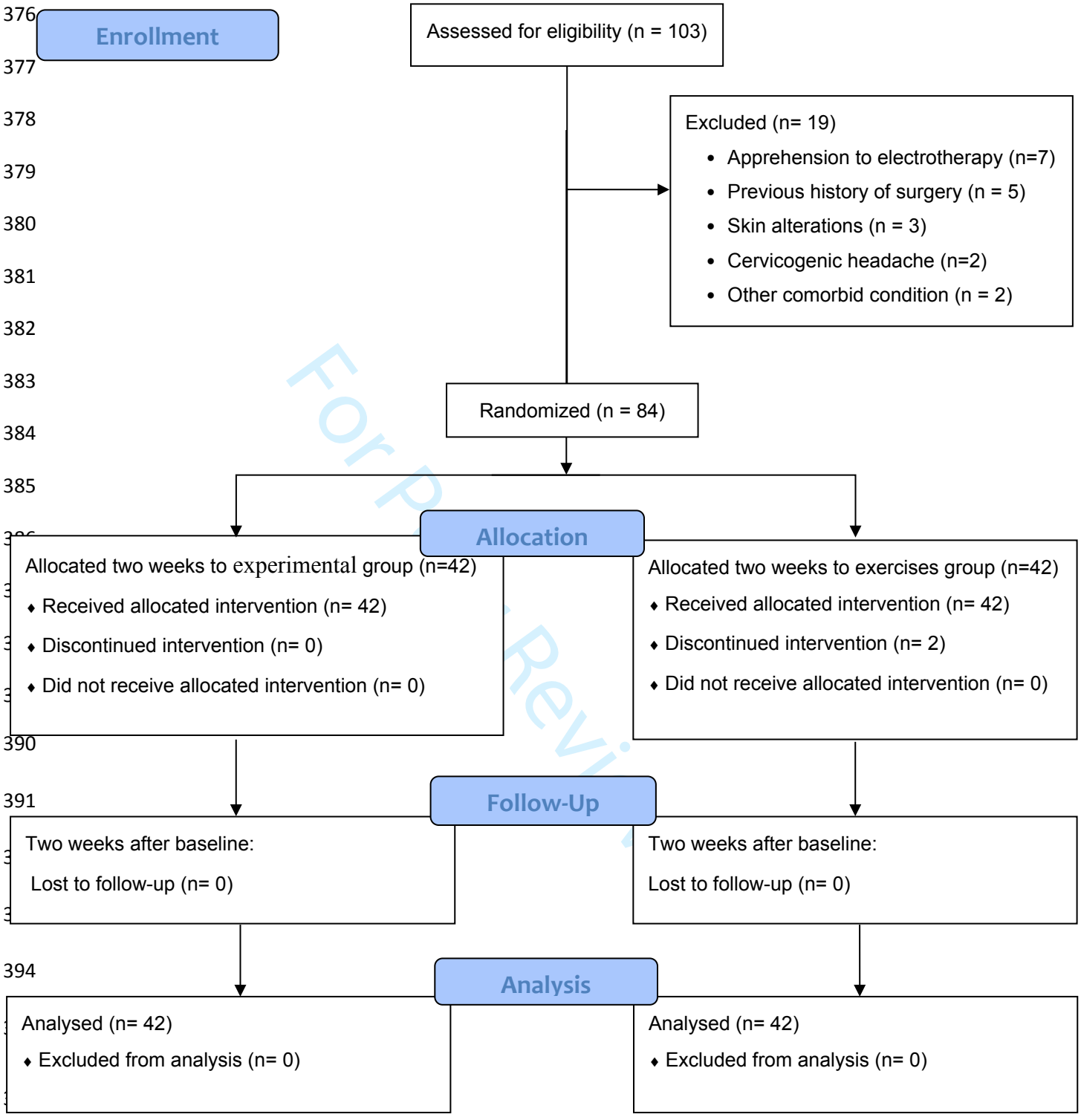

Figure 1. Design and flow of participants through the trial following CONSORT 2010 guidelines.

Appendix 1. Detailed description of the supervised exercises protocol.

The exercises were applied in series of three repetitions, with a minimum of three repetitions per series. The number of repetitions per series was increased up to a maximum of five, in a progressive manner, according to perceived muscular fatigue. In the first two sessions, only ergonomic advice and stretching exercises were provided. Starting in the third session, isometric strengthening exercises were included. The times in the position of maximum stretch were between three and ten seconds according to the patient's tolerance. The muscle groups worked on were the muscles of the posterior region of the neck, the trapezius, angular scapula, the scalene muscles and the sternocleidomastoid. Isometric contractions were maintained between five and ten seconds. To work on isometric contraction, we worked in a more functional way: flexion, extension, lateral flexion and rotation movement. From the fourth session to the end of the intervention programme, isometric strengthening exercises were complemented with the ocular-cervical kinetic re-education exercises. The exercises were cumulative, so the first sessions were shorter. The time was progressively increased from twenty minutes (first sessions) to forty-five minutes (last sessions).