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Brief communication (Original)

Treatment of chronic neck pain by two combined physiotherapy programs: comparison of phonophoresis and ultrasound

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Background: Chronic neck pain is common. The value of various physiotherapy, phonophoresis, and ultrasound is not known.
Objective: We determined the short-term effect of combined physiotherapy methods on pain intensity, disability, and quality of life in patients with chronic neck pain (CNP). We also compared the short-term effectiveness of phonophoresis (PP) and therapeutic ultrasound (US).
Methods: Fifty-five patients (48 women, 7 men) aged 25 to 65 years who had neck pain at least twelve weeks participated in this study. The patients were randomly divided into two groups: US (n = 29) and PP (n = 26). The patients in both groups received the same combined physiotherapy treatment programme including thermotherapy, TENS, therapeutic massage, therapeutic exercises, and recommendations for daily living activities. Additionally, the patients in the PP group received phonophoresis (5% lidocaine), and the US group received ultrasound therapy. All patients received 14 sessions of treatment throughout three weeks. Pain intensity, disability, and quality of life were measured at baseline and after the treatment programme. Pain intensity was assessed by using a visual analog scale, the Neck Pain Disability Index was used to assess disability and the SF-36 Health Survey was used to assess quality of life. A Wilcoxon signed rank test, Mann–Whitney *U* test, and effect size were used for statistically analysis.
Results: In both groups, pain intensity, disability and quality of life scores were found to have improved after the treatment programme ($p < 0.05$). However, the efficiency of both treatment programmes was similar ($p > 0.05$) and the effect sizes for pain intensity, disability, and quality of life were large in both groups.
Conclusion: The results suggest that phonophoresis and ultrasound combined with physiotherapy methods can have positive effects in the management of patients with chronic neck pain. However, no superiority of phonophoresis or ultrasound was determined.

Keywords: Disability, neck pain, phonophoresis, physiotherapy, quality of life, ultrasound

Neck pain is a highly prevalent condition with about two thirds of the adult population affected at some time in their lives. [1]. Neck pain has an extensive differential diagnosis. By far the most common causes are biomechanical, such as axial neck pain, whiplash-associated disorder, and cervical radiculopathy [2]. A number of different treatments are available to patients and are accepted as standard forms of practice, including common conservative strategies such as medication, physical therapy methods, manual treatments, and patient education [3, 4]. The treatment goals are to relieve pain, reduce muscle spasm, improve range of motion and strength, correct postural problems, and ultimately improve functional status, and quality of life [5]. Common physiotherapy strategies include physical agents, exercises, stretching, and traction [6].

Therapeutic ultrasound (US) has been widely used in the treatment of musculoskeletal disorders. US converts electrical energy into an acoustic waveform, which is then converted into heat as it passes through tissues of varying resistance [7]. Phonophoresis (PP) is generally defined as driving a topically applied medication through the skin with US. The advantage of this transcutaneous drug administration is that higher concentrations of the drug can be delivered to

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the treatment area, without gastrointestinal irritation or the drug being metabolized by the liver [8]. PP has been used to enhance transdermal drug delivery in sports medicine and orthopedic rehabilitation [7, 9-11]. PP is believed to accelerate functional recovery by decreasing pain and promoting healing [9].

Physical rehabilitation is defined as a combination of physical agents. Rehabilitation specialists often use concomitant intervention in their daily practice. Each intervention is usually used as an adjunct [12]. Studies that have evaluated therapeutic ultrasound in combination with other modalities such as massage, exercise have been accepted but their conclusions have been interpreted within the context of their strengths and limitations [13]. Combinations of physiotherapy modalities for the treatment of back problems are also commonly used. On the other hand, the results of evidence-based studies for chronic neck pain (CNP) have shown that there are insufficient data to make a recommendation because of different combinations, invalidated outcomes, and poor descriptions of the actual interventions [5]. Thus, it is necessary to determine the efficacy of different combined physiotherapy treatments.

Pain is widely accepted as one of the most important determinants of quality of life because of its widespread adverse health effects, including diminishing mental health and well-being and impairing the individual's ability to perform daily activities [14]. The first aim of this study was to determine the short-term effect of combined physiotherapy treatment included thermotherapy, transcutaneous electrical nerve stimulation (TENS), massage, therapeutic exercises, recommendations for daily living activities, therapeutic US (with or without PP) on pain intensity, disability, and quality of life in patients with CNP. The second aim of this study was to compare the short-term effectiveness of PP and therapeutic US within a combined physiotherapy program. Our hypotheses were that our combined physiotherapy treatment is effective and PP with lidocaine within combined physiotherapy would have superior efficacy compared to combined therapeutic US.

Material and methods

Subjects

Sixty-six patients with CNP, ranging in age from 25 to 65 years old, participated in this study. The subjects were examined and treated in a private outpatient physical therapy clinic in Denizli, Turkey. All the patients were eligible if they had CNP for more than 12 weeks, and the mechanical CNP was caused by myofascial pain, cervical radiculopathy and cervical spondylosis [2]. Subjects with systemic, neurological and psychiatric diseases, previous history of spine surgery, patients with radiculopathy who had motor findings or with a contraindication for the use of ultrasound (malignancy, diabetes, tuberculosis, deep vein thrombosis, abscesses, sensory disturbances) were excluded. Approval for the study was granted by the Medical Ethic Committee of Pamukkale University and informed consent was obtained from all the study participants.

Outcome measurements

Pain intensity, disability, and quality of life were measured at baseline and after the treatment program.

Pain intensity was assessed using a visual analog scale (VAS) ranging from 0 to 10 (0 = no pain, 10 = intolerable pain), wherein the patient marked a point according to her/his level of pain [15].

Disability was assessed using the Turkish version of the Neck Disability Index (NDI) [16].The NDI contains 10 items, 7 related to activities of daily living, 2 related to pain, and 1 related to concentration. Each item is scored from 0 to 5, and the total score is expressed as a percentage, with higher scores corresponding to greater disability [17].

Health-related quality of life was assessed using the Turkish version of the Medical Outcome Study Short-Form 36 Health Survey (SF-36) The SF-36 includes 8 health domains: physical functioning, physical components of pain, bodily pain, general health, vitality, social functioning, emotional components of pain, and mental health. Scores in each category ranged from 0 to 100 and higher scores indicated a better quality of life [18].

Pretreatment and post-treatment outcomes were assessed by the same physiotherapist.

Interventions

A total of 66 patients were randomly assigned by the sealed envelope method to 2 groups of ultrasound (A) and phonophoresis (B) with 33 patients in each.

All CNP patients received 14 sessions of treatment within a 3-week period. Each session lasted for at least one hour. The treatment program was given to patients by the same physiotherapist. All patients in both groups were treated with same combined

physiotherapy program including thermotherapy, TENS, classic massage, therapeutic exercises and recommendations for daily living activities [4, 5]. Thermotherapy was applied as a 20-minute hot pack to the cervical and thoracic area. Conventional TENS was applied as an electrotherapy agent at 100 Hz and 40 □s with 7 mm × 9 mm plate electrodes according to the pain localization and 5 minutes of massage was applied on cervical and thoracic area. After the initial treatment session, a supervised exercise program was applied after each treatment session. The exercise program included stretching exercises (for anterior, lateral and rotational directions), postural exercises (shoulder circumduction, scapular adduction, pectoral stretching) and isometric neck exercises according to each patient's need. If muscle spasm was severe, isometric exercises were not performed. Exercises were performed as 3 sets of 5 repetitions. A brochure of the exercises was prepared by the physiotherapist and given to the patients with the advice to perform 2 sets of exercises at home. Recommendations were also given to patients for daily living activities.

US therapy was applied to the patients in the US group whereas the PP group received phonophoresis with 5% lidocaine [4, 10]. Continuous ultrasonic waves of 1.1 MHz frequency and 1-1.5 watt/cm^2 power were applied for 8 minutes. The dosage was adjusted according to the treatment area. The treatment was applied using circular movements with a 4 cm^2 US head.

Patients did not receive any other treatments including medicine or other physical therapy methods during the treatment period. The physiotherapy treatment program was applied to the patients by two physiotherapists, one of whom also assessed the patients. Therefore, this study was not a blind study.

Statistical analysis

SPSS 9.0 for Windows programme was used for statistical analysis. All demographics and quantitative data were described as mean ± standard deviations and percentage. Results were significant at the 0.05 level. Wilcoxon Signed rank test was used to compare the pre- and post- treatment changes in each group. Mann Whitney-U test was used to detect group differences. Effect sizes were calculated by dividing the mean change by the SD of the mean change scores [19]. After the treatments, the percentages of decreased pain scores in the US and PP groups depending on the level of pretreatment were calculated, and the average values of the percentage of decrease in the pain were calculated.

Results

A total of 66 patients were initially included in the trial, but 11 dropped out during the study for different reasons (not enough time to attend regularly = 7, worsening of symptoms = 1, and other reasons = 3) and 55 patients completed the study. The data of patients who attended the treatment program regularly in both groups (Ultrasound Group n = 29; 82.8% female) and (Phonophoresis Group n = 26; 92.3% female) were used for statistically analysis.

Baseline data

Demographics and baseline clinical data of the sample are presented in **Table 1**. There were no significant differences between the groups in either demographic or baseline clinical data ($p > 0.05$).

Table 1. Demographics and baseline clinical data of the groups

	Phonophoresis group (n = 26) mean±SD	Ultrasound group (n = 29) mean±SD	*p**
Age (yr)	41.75±8.79	42.06±9.28	0.382
Height (cm)	161.88±6.7	161.65±6.10	0.384
Weight (kg)	69.84±13.21	71.10±11.19	0.526
Body mass index (kg/m^2)	26.73±5.06	27.23±4.25	0.631
Duration of symptoms (yr)	5.05±4.27	3.20±2.77	0.053
Visual Analog Scale (cm)	4.71±2.0	4.54±1.42	0.839
Neck Disability Index score	17.92±5.19	16.75±7.80	0.217
Short-Form 36 Health Survey	281.08±107.23	324.84±131.02	0.186

*Mann–Whitney *U* test

Pain

After the treatment, pain VAS scores decreased in both groups ($p < 0.05$) (**Table 2**). When the two treatment groups were compared regarding changes in VAS, there was no statistically significant difference between the groups ($p > 0.05$) (**Table 3**). At the end of 14 sessions of treatment, the average decrease in the pain scores of the patients in the US and PP groups was 32.70±83.40% and 36.62±66.43%, respectively.

Disability

At the end of the therapy, statistically significant improvements were determined in both groups regarding total scores of NDI ($p < 0.05$) (**Table 2**). After the therapy, no difference was observed between the US group and the PP group ($p > 0.05$) (**Table 3**).

Quality of life

The total score of SF-36 increased in both groups after the therapy ($p < 0.05$) (**Table 2**). However, no difference was found between the US group and the PP group after therapy ($p > 0.05$) (**Table 3**).

The effect sizes of outcome measurements were calculated in terms of pain intensity, disability, and quality of life. The effect sizes of all outcome measurements were large in both groups (**Table 4**).

Table 2. Comparison of pre- and post-treatment of outcome measures in groups

	Pre-treatment mean±SD	**Post-treatment mean±SD**	***p****
Phonophoresis group (n = 26)			
Pain intensity (Visual Analog Scale)	4.71±2.0	2.54 ±1.97	0.000
Disability, (Neck Disability Index)	17.92±5.19	12.19±5.76	0.000
Quality of life (Short-Form 36 Health Survey)	281.08±107.23	375.77±120.27	0.001
Ultrasound group (n = 29)			
Pain intensity (Visual Analog Scale)	4.54±1.42	2.57 ±1.88	0.000
Disability, (Neck Disability Index)	16.75±7.80	12.00±7.22	0.001
Quality of life (Short-Form 36 Health Survey)	324.84±131.02	389.98±150.82	0.002

*Wilcoxon signed rank test

Table 3. Comparison of changes in clinical outcome measures after therapy

	Phonophoresis group (n = 26) mean±SD	**Ultrasound group (n = 29) mean±SD**	***p****
Pain intensity (Visual Analog Scale)	2.54±1.97	2.57±1.88	0.839
Disability, (Neck Disability Index)	12.19±5.76	12.00±7.22	0.905
Quality of life (Short-Form 36 Health Survey)	375.77±120.27	389.98±150.82	0.879

*Mann–Whitney *U* test

Table 4. Effect size of the groups

	Phonophoresis group (n = 26)	**Ultrasound group (n = 29)**
Pain intensity (Visual Analog Scale)	1.28	1.36
Disability, (Neck Disability Index)	2.11	1.66
Quality of life (Short-Form 36 Health Survey)	3.12	2.58

Discussion

The results of this study showed that a combined physiotherapy treatment program was an effective treatment approach for improvement in pain intensity, disability, and quality of life in patients with mechanical CNP. However, using PP within the combined physiotherapy treatment did not increase the effectiveness.

Although combined rehabilitation interventions are commonly used in physical medicine and rehabilitation outpatient clinics, scientific evidence to support their use is insufficient since randomized controlled trials of rehabilitation are limited [5]. In addition, systematic meta-analyses have shown a lack of evidence for the effectiveness of physical therapy and even of multidisciplinary rehabilitation in cases of CNP [20, 21]. On the other hand, there are studies in literature that indicate the positive effects of different combined physiotherapy programs composed of active and passive modalities on pain, muscle spasm and level of disability [22-24]. In the current study, the combined physiotherapy program was composed of both active and passive physiotherapy treatment modalities. The active modality was therapeutic exercises, and the passive modalities were thermotherapy, TENS, therapeutic massage and US. The improvement in the patients of the current study may be explained by the positive effects of the active and passive physiotherapy treatment modalities that were used. Exercise therapy is widely used in the treatment of chronic neck pain in order to improve physical function and reduce symptoms [25]. The combined treatment programs used in the current study included therapeutic exercise, which is known to be an effective method for pain relief in CNP according to evidence based studies [2, 5, 26]. Besides the active treatment method, patients also received passive treatment methods. Hayden et al. found that applying exercise together with other conservative methods was more effective in reducing pain and improving functionality compared to applying exercise alone [27]. Heat therapy is one of the most commonly used physical modalities as a passive treatment. It increases blood flow and tissue extensibility and decreases muscle spasm and pain. Hot pads as a thermotherapy method provide superficial heat with limited subcutaneous penetration. Ultrasound provides deep heat with higher subcutaneous penetration [7]. Therapeutic massage is one of the most popular complementary treatments for neck pain [28], as it decreases muscle spasm and pain and increases blood flow [29].

Therapeutic US is frequently used in physiotherapy clinics for various musculoskeletal disorders [30]. Although the exact mechanism of action is unknown, heating is the most important effect. Therapeutic US facilitates regional blood flow and increases connective tissue extensibility. Nonthermal effects are less understood and include molecular vibration, which increases cell membrane permeability and thereby enhances metabolic product transport [31]. Much research has been conducted on the effects of US on living tissue, and positive effects have been reported [32]. On the other hand, a recent review reported that there was little evidence that active therapeutic US was more effective than placebo US in treating people with pain or a range of musculoskeletal injuries or in promoting soft tissue healing [30]. There is also a lack of evidence at present regarding whether to include or exclude the use of therapeutic ultrasound in the physical rehabilitation of patients with acute and chronic neck pain [5]. These conflicting results could be explained by dependency on the intensity and duration of the application of therapeutic ultrasound for physiological effects. Arto et al. tested US machines used in clinical settings for proper calibration of time and power output. The results showed that more than one third of machines tested in that study were outside the standard for power output, and approximately one quarter of the mechanical timers were outside the standard [32].

PP is the penetration of a topically applied medication through the skin with US [8]. Topically applied medication can induce local and systemic effects [33]. For PP to be effective, the important issue is the diffusion of the drug to target sites such as subcutaneous tissue, muscle, synovium, ligaments, tendons, and joints. Cagnie et al. examined the influence of ultrasound on the transdermal delivery of ketoprofen in humans and the results indicated that in contrast to sham phonophoresis, ultrasound can increase the transdermal delivery of ketoprofen [11].

The hypothesis of the current study was that PP with lidocaine within combined physiotherapy would have superior efficacy compared to combined therapeutic US. It was found that both combined physiotherapy programs had similar effectiveness and there was no superiority of either phonophoresis or ultrasound. The reason could be could be the design of the treatment program. Therapeutic US or PP were not used in isolation. The program had both active and passive physiotherapy including therapeutic US or PP.

Therefore, it was not possible to determine which modality or modalities had an effect on the outcome measurements. Similar results were reported by Ay et al. in patients with myofascial pain syndrome (MPS). The ef□cacy of PP with diclofenac gel, therapeutic US and placebo US methods combined with an exercise program was compared in patients with MPS. Both diclofenac PP and therapeutic US were determined to be effective on pain, range of motion and disability in the treatment of patients with MPS, but PP was not found to be superior to therapeutic US [34]. Previous studies on patients with soft tissue injuries including epicondylitis, tendinitis, tenosynovitis [7], and knee osteoarthritis [10] have also shown that PP was not superior to therapeutic US.

This study had a control group making it a randomized controlled study and all scales used in the study were tested for validity and reliability. These are the strengths of the study. This study also has several limitations. The sample size of the current study was not large. Many therapy modalities were included as part of combined physiotherapy program. The treatment protocol was a standard combined physiotherapy program for chronic neck pain patients in the hospital where the study was conducted. To our knowledge, no other study has investigated the effectiveness of a similar physiotherapy treatment protocol in patients with chronic neck pain. Different conservative management methods of mechanical neck pain have been tested with conflicting results and at present no treatment strategy is generally accepted [35]. The other limitation of the current study is the absence of long-term follow up.

Conclusions

The results of the current study suggest that combined physiotherapy treatment including active and passive modalities is effective for improvement in pain intensity, disability, and quality of life in patients with mechanical CNP. However, topical applications of lidocaine with therapeutic US within a combined rehabilitation program had no superior effect to the use of therapeutic US within a combined physiotherapy program. There is a need for future studies to compare therapeutic US versus PP in isolated application, not within a combined treatment program.

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