

## A comparison of low dose ultrasound and far-infrared therapies in patients with mechanical neck pain

Marwa Mohamed Hany Sedeek Abousenna<sup>1</sup>, Amr Saadeldeen Mohamed Shalaby<sup>2</sup>, Aksh Chahal<sup>3</sup>, Abu Shaphe<sup>4</sup>

### Abstract

**Objective:** To compare the effect of low-dose continuous ultrasound and far-infrared interventions for reducing pain in patients with mechanical neck pain.

**Method:** The experimental study was conducted from April 2016 to January 2017 at the electrotherapy laboratory of the Department of Physical Therapy, College of Applied Medical Sciences, Jazan University, Jazan, Saudi Arabia, and comprised female patients diagnosed with mechanical neck pain. They were divided into two equal groups, with Group A receiving 3 sessions per week of low-dose continuous ultrasound on the cervical region for 7 weeks, and Group B receiving far-infrared treatment on the same patterns. Both groups received stretching, strengthening exercises and transcutaneous electrical nerve stimulation. Pain tolerance was assessed at baseline and post-intervention using digital algometer. Data was analysed using SPSS 17.

**Results:** Of the 30 women with a mean age of  $21.36 \pm 1.14$  years, there were 15 (50%) in each of the two groups. There was a significant decrease in post-intervention bilateral values compared to baseline in both groups. Group B showed higher significant values than Group A ( $p < 0.05$ ).

**Conclusions:** Far-Infrared was found to be much better than low-dose continuous ultrasound for reducing pain in patients suffering from mechanical neck pain.

**Keywords:** Pain tolerance, Ultrasound, Infrared, Trigger points, Mechanical neck pain, Algometer. (JPMA 71: 397 2021)

**DOI:** <https://doi.org/10.47391/JPMA.190>

### Introduction

Mechanical neck pain (MNP) is a mechanical disorder affecting the neck region, which is manifested by neurological impairments caused by tightness of neck muscles due to poor postural alignment.<sup>1</sup> Incidence of neck pain in the general population may reach up to two-third population. As a significant disabling health problem that might cause work absence,<sup>2</sup> MNP showed a higher incidence in females (18%) than males (13.2%).<sup>3</sup>

It is a still debatable problem<sup>4</sup> caused by multiple factors, such as occupational, personal, environmental and psychosocial factors.<sup>5,6</sup> The pathology of MNP has been correlated to the pathology of anatomical structures of the cervical region,<sup>7</sup> precipitated by occupational contributing factors, such as repetitive motion, stress, awkward or uncomfortable posture that imposes twice the workload on the cervical muscle which results in the formation of contraction knot called myofascial trigger point.<sup>6</sup>

Myofascial trigger points of head, neck and shoulder, described as hypersensitive spots of pain caused by skeletal muscle tightness that are painful on compression or

<sup>1</sup> Department of Physical Therapy, College of Applied Medical Sciences, Jazan University, Saudi Arabia; <sup>2</sup> Department of Basic Science, Physical Therapy, Cairo University, Egypt; <sup>3,4</sup> College of Applied Medical Sciences, Jazan University, Saudi Arabia.

**Correspondence:** Abu Shaphe. e-mail: [mshaphe@jazanu.edu.sa](mailto:mshaphe@jazanu.edu.sa)

stretch, contribute to the major cause of MNP.<sup>8</sup> MNP is often described by the patient as stiffness of neck and shoulder, fatigue and dull pain which is exacerbated by neck and shoulder movement.<sup>3</sup> Some studies have described MNP as a pain affecting the cervical, occipital or posterior scapular area.<sup>7</sup> However, some patients showed headache and hyperalgesia affecting the mandibular region, over the masseter and temporalis muscles.<sup>5</sup>

To exclude causes of neck pain other than MNP, neck pain is assessed by taking patient history, conducting physical examination and radiological assessment.<sup>9</sup> Physical examination includes assessment of cervical active range of motion (ROM). It has been found that there is a considerable decrease in active ROM in patients complaining of MNP compared to asymptomatic persons.<sup>10</sup> Another method of assessing MNP is self-administered questionnaires which assess the effect of neck pain on the patient in terms of functional level, disability, psychological impact, any improvement of the problem and the effect of therapeutic modalities on patients.<sup>11</sup>

Owing to its high reliability, an electronic algometer is used to effectively measure pain thresholds and tolerance.<sup>12</sup> Manual therapy, like spinal manipulation therapy (SMT), stretching and strengthening exercises, has been found to be more effective than the use of oral anti-inflammatory drugs.<sup>13</sup> Transcutaneous electrical nerve stimulation (TENS) is an effective non-invasive electric modality<sup>14</sup> that is most

commonly used to relieve pain in many painful conditions, with evidence suggesting conventional TENS mode to be more comfortable and effective in pain relief than the low TENS mode.<sup>15</sup> The conventional TENS mode stimulates large diameter Aβ (Aβ) fibers through the application of low-intensity alternating current (AC) that stimulates the gate control theory and, in turn, diminishes pain awareness.<sup>16</sup>

Heat therapy produces muscle relaxation and pain reduction through decreasing pain receptors' sensitivity, and increase ROM by increasing collagen extensibility, and improving blood flow.<sup>17</sup> Considered to be one of the physical therapy modalities used to produce superficial local and generalised heating, infrared radiation (IRR) can increase circulation and produce an analgesic effect in many conditions, such as tension headache, myalgia, muscle spasm and haematoma.<sup>17</sup>

Although studies have described many positive effects of IRR on reducing pain, improved wound healing, and increased endorphins level,<sup>17,18</sup> few studies have evaluated the therapeutic effect of near IRR on chronic neck pain using subjective and objective assessment methods.<sup>19</sup> Ultrasound (US) therapy is another non-invasive modality used to relieve pain.<sup>20</sup> It transfers energy to the tissues through its mechanical vibrations, which are the same as sound waves but at higher frequency.<sup>21</sup> US is known to be harmless, non-invasive and an inexpensive modality.<sup>22</sup>

The physiological effects of US are based on the selected frequency and intensity. Intensity of 0.5 to 0.7 W/cm<sup>2</sup> has shown to be effective in pain relief and increased soft-tissue extensibility.<sup>23</sup> The amount of US that is absorbed in tissues is based on the frequency of the applied US with 3MHz frequency in continuous mode which can elevate tissue temperature from 34.3°C to 37.3°C.<sup>24</sup> This thermal effect of US produces multitude of effects, including analgesic effect, increased metabolic activity, improved circulation and muscle relaxation.<sup>25</sup>

Since systematic reviews failed to provide enough evidence supporting the priority of using different therapeutic modalities on MNP, such as electrotherapy and manual therapy, till date no definite useful treatment can be agreed upon.<sup>26</sup> Some studies used US with 0.1 W/cm<sup>2</sup>,<sup>27</sup> and others used IRR. The current study was planned to compare the effect of US and far infrared (far-IR) on reducing pain for patients suffering from MNP.

## Patients and Methods

The experimental study was conducted from April 2016 to January 2017 at the electrotherapy laboratory of the Department of Physical Therapy, College of Applied

Medical Sciences, Jazan University, Jazan, Saudi Arabia, After approval from the institutional ethics review board, the sample size was calculated using a statistical power analysis programme named as G\*Power 3.1.9.4 calculator.<sup>28,29</sup> An effective sample size of 28 was obtained by applying a 2-tailed priori paired t-test while keeping power at 0.80 or 80%, effect size, or Cohen's d, 0.56, mean difference 1.4±2.5 and level of significance 0.05 from a pilot study done prior to this study.

The sample was raised using convenience sampling method. Those included were female patients diagnosed as MNP cases by a radiologist. Individuals who were pregnant or with spinal fractures, systemic inflammatory disease, tumour or malignancy, cervical radiculopathy, previous surgeries in spine, history of neck trauma and rheumatoid arthritis were excluded. After taking written informed consent, the subjects were randomised into two equal groups using a website Randomization.com online tool (<http://www.randomization.com>).<sup>30</sup>

All patients received 7 treatment sessions delivered by one physiotherapist to maintain the quality of the technique.

All patients were documented for pressure tolerance measurement test to assess pain tolerance algometry (JTECH Commander Echo Algometer Model 1225101) at baseline and post-intervention by one assessor who was blind to the study. Low value on algometry indicated minimal pain tolerance and vice-versa. Each patient was asked to indicate the specific area of pain and trigger points. The tip of the applicator was used to press on the identified trigger points with the patient in prone position. The maximal amount of pain that a patient could tolerate against the applied pressure gradually on an identified trigger point was noted as the mean of three trials. Increased value of pain tolerance post-intervention indicated relief in pain.

Participants in Group A received US therapy (Enraf-Nonius Tensmed S82, Model 1427970) on marked treatment area of cervical region in prone position. The treatment head with 4cm circumference area was used. The treatment dose was set as mode continuous US, frequency 3 MHz, intensity 0.5W/cm<sup>2</sup> and time 10 minutes.<sup>31</sup> Participants in Group B received Far-IR therapy (Far-Infrared Ray Lamp Model B-608) on treatment area of cervical region in prone position. The distance between the infrared lamp and the neck was 40cm, time was set at 10 minutes. The patient felt mild warmth throughout the session and was instructed to inform the therapist when feeling intense heat.<sup>31</sup>

Additionally, all participants in both the groups received TENS with pulse frequency 120Hz, pulse duration 100µs,

and treatment time 15 minutes. Four self-adhesive electrodes were positioned on the marked treatment points allocated by the patients. The amplitude was increased gradually till the patient started to feel tingling sensations.<sup>31</sup>

All participants received active stretching exercises to a point where a slight stretch was felt within the pain limit. Rotation, flexion and side-bending ROM exercises were performed 10 times after treatment for every session. Strengthening exercises were given to all patients in both groups in the form of flexion and side-bending isometric exercises 10 times. All exercises were performed while the patients were in the sitting position.

Data was analysed using SPSS 17. Descriptive analysis was used to determine means and standard deviations of the collected data. Paired t-test and independent t-test were applied to compare intra-group and inter-group data. All tests were two-sided and  $p \leq 0.05$  was considered significant.

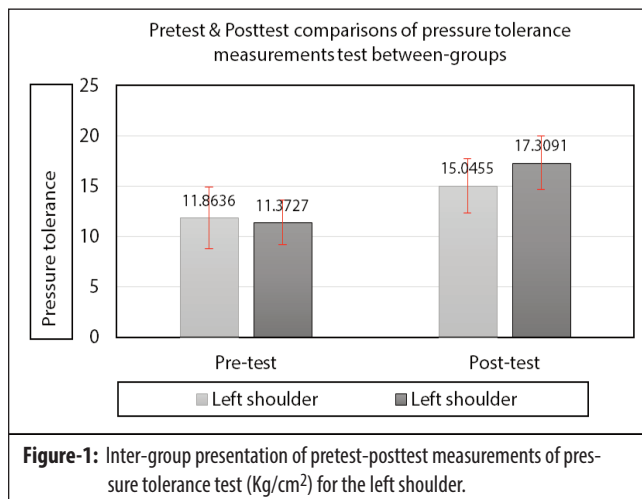
**Results**

Of the 30 women with a mean age of  $21.36 \pm 1.14$  years, there were 15(50%) in each of the two groups. The mean age in Group A was  $21.18 \pm 0.4$  years and in Group B it was  $21.54 \pm 0.9$  years. There was significant improvement in

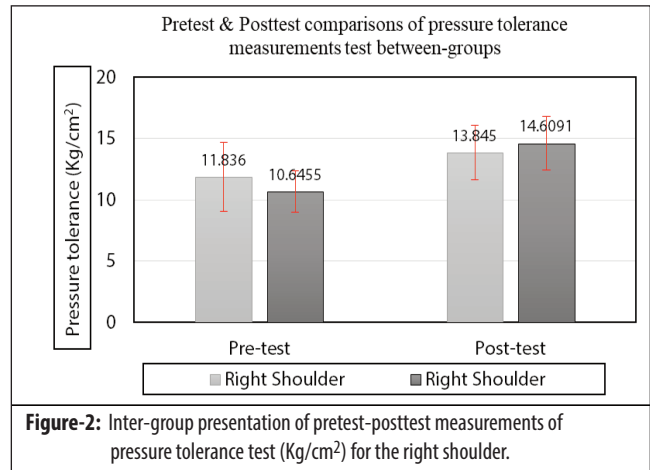
**Table:** Intra-group comparison of pressure tolerance measurement test (Kg/cm<sup>2</sup>) for both shoulders.

Variables		Pre-measurement (Mean±SD)	Post-measurement (Mean±SD)	Mean differences (Pre-Post)	Sig. (2tailed) (p-value)
<b>Group A</b>					
(Low-dose Ultrasound)	Rt.	11.8636 ± 3.0617	15.0455 ± 2.68677	-2.009	.001**
	Lt.	11.836 ± 2.81541	13.845 ± 2.2110	-3.1819	.004**
<b>Group B</b>					
(Far-Infrared)	Rt.	11.3727 ± 2.21950	17.3091 ± 2.67075	-3.9636	.0001**
	Lt.	10.6455 ± 1.68426	14.6091 ± 2.19110	-5.9364	.0001**

\* = Significant differences if  $p < 0.05$ ; \*\* = Highly significant difference if  $p < 0.01$ ;  
 \*\*\*Extremely significant if  $p < 0.001$ ; SD = Standard deviation.



**Figure-1:** Inter-group presentation of pretest-posttest measurements of pressure tolerance test (Kg/cm<sup>2</sup>) for the left shoulder.



**Figure-2:** Inter-group presentation of pretest-posttest measurements of pressure tolerance test (Kg/cm<sup>2</sup>) for the right shoulder.

pressure tolerance in both groups post-intervention compared to baseline values ( $p < 0.05$ ), but Group B showed higher significant value than Group A for left and right side treatment area (Table).

Group A and Group B showed higher significant improvement for the left side over right side ( $p = 0.001$ ) post-intervention (Figures 1-2).

**Discussion**

The current study showed that patients who received Far-IR therapy had a highly significant difference in post-intervention scores compared to the baseline, while the patients who received US showed a significant difference. This means that the efficacy of Far-IR was better than US on reducing MNP. The results are in line with literature.<sup>32</sup> The mechanism by which Far-IR reduces pain can be explained by activation of gate control theory.<sup>33</sup> As the heat produced by Far-IR suppresses the activity of pain fibres and stimulates the endorphins release, pain gate mechanism is activated.<sup>21</sup>

In agreement with our results, several studies have reported that the main cause of MNP is muscle spasm which leads to reduction of blood flow, hypoxia and pain.<sup>33,34</sup> Tissue-heating caused by Far-IR increases the blood flow to the painful area and reduces muscle spasm and pain. Heat has a relaxing effect on skeletal muscle tone as it decreases the excitability of muscle spindle<sup>17</sup> and this also supports our results.

In the current study, the patients who received US showed a significant bilateral decrease in pain post-intervention, but not as much as those who received Far-IR, which means that US was not as effective as far-IR in reducing MNP. This is in agreement with a study which stated that the thermal changes in tissues produced by US are insufficient to

produce the desirable therapeutic effects when applied at traditional clinical parameters.<sup>24</sup> To achieve the desirable thermal effect, the tissue temperature should be raised between 40°C and 45°C for at least 5 minutes. Application of 3 MHz at 1.5W/cm<sup>2</sup> continuous mode of US can elevate tissue temperature from 34.3°C to 37.3°C only, while Far-IR can elevate tissue temperature as high as 42°C.<sup>21</sup>

One study investigated the effect of US with low intensity of 0.1W/cm<sup>2</sup> on myofascial trigger points and measured pain pressure threshold immediately after US treatment. They found that there are no changes for pressure pain threshold observed between pre- and post-intervention measurements with low-intensity US exposure.<sup>27</sup> This may explain the outcome of the current study concerning the effect of US with intensity of 0.5W/cm<sup>2</sup>.

Also, our results are in agreement with a study which concluded that both continuous and pulsed US produce thermal changes in the tissue (muscle), but this thermal change has minimal therapeutic value.<sup>35</sup>

Further studies are needed to measure the effect of US on MNP by using high doses of 1.5W/cm<sup>2</sup> and more frequent treatment sessions.

## Conclusion

Far-IR therapy was found to be more efficacious than low-dose continuous US therapy in reducing pain in MNP patients.

**Disclaimer:** None.

**Conflict of interest:** None.

**Source of Funding:** None.

## References

- Bogduk N. The anatomy and pathophysiology of neck pain. *Phys Med Rehabil Clin N Am* 2003; 14: 455-72.
- Kraatz S, Lang J, Kraus T, Münster E, Ochsmann E. The incremental effect of psychosocial workplace factors on the development of neck and shoulder disorders: a systematic review of longitudinal studies. *Arch Occup Environ Health* 2013; 86: 375-95.
- Fejer R, Kyvik KO, Hartvigsen J. The prevalence of neck pain in the world population: a systematic critical review of the literature. *Eur Spine J* 2006; 15: 834-48.
- De-la-Llave-Rincon AI, Alonso-Blanco C, Gil-Crujera A, Ambite-Quezada S, Svensson P, Fernández-de-Las-Peñas C. Myofascial trigger points in the masticatory muscles in patients with and without chronic mechanical neck pain. *J Manipulative Physiol Ther* 2012; 35: 678-84.
- La Touche R, Fernández-de-las-Peñas C, Fernández-Carnero J, Díaz-Parreño S, Paris-Alemany A, Arendt-Nielsen L. Bilateral mechanical-pain sensitivity over the trigeminal region in patients with chronic mechanical neck pain. *J Pain* 2010; 11: 256-63.
- Ming Z, Närhi M, Siivola J. Neck and shoulder pain related to computer use. *Pathophysiol* 2004; 11: 51-6.
- Ahn NU, Ahn UM, Ipsen B, An HS. Mechanical Neck Pain And cervicogenic Headache. *Neurosurg* 2007; 60(suppl\_1): S1-21-S1-7.
- Travell JG, Simons DG, Simons L. Myofascial pain and dysfunction: the trigger point manual. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 1993: pp 1-4.
- Swinkels R, Oostendorp R. Outcomes assessment and measurement in spinal musculoskeletal disorders. (Chapter 41). *Grieve's modern manual therapy: the vertebral column*. 3rd ed. London: Churchill Livingstone; 2005: pp 591-601.
- Hanten WP, Olson SL, Russell JL, Lucio RM, Campbell AH. Total head excursion and resting head posture: normal and patient comparisons. *Arch Phys Med Rehab* 2000; 81: 62-6.
- Kay TM, Myers AM, Huijbregts MP. FEATURE ARTICLES-how far have we come since 1992? A comparative survey of physiotherapists' use of outcome measures. *Physiother Can* 2001; 53: 268-75.
- Potter L, McCarthy C, Oldham J. Algometer reliability in measuring pain pressure threshold over normal spinal muscles to allow quantification of anti-nociceptive treatment effects. *Int J Osteopath Med* 2006; 9: 113-9.
- Bronfort G, Evans R, Anderson AV, Svendsen KH, Bracha Y, Grimm RH. Spinal manipulation, medication, or home exercise with advice for acute and subacute neck pain: a randomized trial. *Ann Intern Med* 2012; 156: 1-10.
- Bedwell C, Dowswell T, Neilson JP, Lavender T. The use of transcutaneous electrical nerve stimulation (TENS) for pain relief in labour: a review of the evidence. *Midwifery* 2011; 27: e141-e8.
- Defrin R, Ariel E, Peretz C. Segmental noxious versus innocuous electrical stimulation for chronic pain relief and the effect of fading sensation during treatment. *Pain* 2005; 115: 152-60.
- Prentice WE, Quillen WS, Underwood FB. The Physiologic Effects of therapeutic modality intervention on the body systems. (Chapter 18) *Therapeutic modalities for physical therapists*. 2nd ed. New York: McGraw-Hill Medical; 2002: pp 510-1.
- O'Young BJ, Young MA, Meyers JS, Stiens SA. Physical modalities: Adjunctive treatments to reduce pain and maximize function. *Pain Management Secrets E-Book*. Philadelphia: Mosby Elsevier; 2009: pp 342-50.
- Gale GD, Rothbart PJ, Li Y. Infrared therapy for chronic low back pain: a randomized, controlled trial. *Pain Res Manag* 2006; 11: 193-6.
- Chen SC, Lin SH, Lai MJ, Peng CW, Lai CH. Therapeutic effects of near-infrared radiation on chronic neck pain. *J Exp Clin Med* 2013; 5: 131-5.
- Chen J, Zhou D, Liu Y, Peng J, Li C, Chen W, et al. A comparison between ultrasound therapy and laser therapy for symptomatic cervical ectopy. *Ultrasound Med Biol* 2008; 34: 1770-4.
- Robertson V, Ward A, Low J, Reed A. *Electrotherapy explained. Principles and practice*. 4th ed. Edinburgh: Butterworth Heinemann; 2006: pp 341-55.
- Backhaus M, Burmester G, Gerber T, Grassi W, Machold K, Swen W, et al. Guidelines for musculoskeletal ultrasound in rheumatology. *Ann Rheum Dis* 2001; 60: 641-9.
- Artho PA, Thyne JG, Warring BP, Willis CD, Brismée JM, Latman NS. A calibration study of therapeutic ultrasound units. *Phys Ther* 2002; 82: 257-63.
- Watson T. Ultrasound in contemporary physiotherapy practice. *Ultrasound* 2008; 48: 321-9.
- Muftic M, Miladinovic K. Therapeutic ultrasound and pain in degenerative diseases of musculoskeletal system. *Acta Inform Med* 2013; 21: 170.
- Desai MJ, Saini V, Saini S. Myofascial pain syndrome: a treatment review. *Pain Ther* 2013; 2: 21-36.
- Srbely JZ, Dickey JP. Randomized controlled study of the antinociceptive effect of ultrasound on trigger point sensitivity: novel applications in myofascial therapy? *Clin Rehabil* 2007; 21: 411-7.

28. Faul F, Erdfelder E, Lang AG, Buchner A. G\* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods* 2007; 39: 175-91.
  29. Peng CY, Long H, Abaci S. Power analysis software for educational researchers. *J Exp Educ* 2012; 80: 113-36.
  30. Dallal GE. Randomization. [Online] [Cited 2003 March 27]. Available from: URL: <http://www.randomization.com>.
  31. Cameron MH. Physical agents in rehabilitation: from research to practice: 2nd ed. USA: Saunders St.Louis Missouri; 2012: pp196-8.
  32. Hurley MV, Bearne LM. Non-exercise physical therapies for musculoskeletal conditions. *Best Pract Res Clin Rheumatol* 2008; 22: 419-33.
  33. Rakel B, Barr JO. Physical modalities in chronic pain management. *Nurs Clin North Am* 2003; 38: 477-94.
  34. Nadler SF, Weingand K, Kruse RJ. The physiologic basis and clinical applications of cryotherapy and thermotherapy for the pain practitioner. *Pain Physician* 2004; 7: 395-400.
  35. Gallo JA, Draper DO, Brody LT, Fellingham GW. A comparison of human muscle temperature increases during 3-MHz continuous and pulsed ultrasound with equivalent temporal average intensities. *J Orthop Sports Phys Ther* 2004; 34: 395-401.
-